COMPRESSION FIELD THEORY FOR STRUCTURAL CONCRETE SUBJECTED TO FLEXURE AND SHEAR

BY

STANLEY MUSE SHITOTE

A thesis submitted in fulfilment for the degree of Master of Science in the University of Nairobi.

1984

TO MY PARENTS

DECLARATION

This is my original work and has not been presented for a degree in any other university.

S. M. SHITOTE

This thesis has been submitted for examination with my approval as University Supervisor.

DR. W. M. ONSONGO

ACKNOWLEDGEMENTS

I wish to thank my supervisor, Dr. W. M. Onsongo for his guidance and suggestions throughout the preparation of this work. Indeed, without his keen supervision and interest, the successful completion of this work would have been very difficult.

I am also indebted to the technicians of the Civil Engineering Department, in particular Philip Maina and James Thairu for their assistance in the laboratory work. My special thanks also go to my friends whose encouragement and direct involvement ensured the successful completion of the experimental program. I feel obliged to at least mention Messrs Ndinika, Mulli, Atibu, Mwandau, Nyangaga and Amulyoto for their help in the preparation of the test specimens and collection of data.

The work done by the Print Bureau, under the leadership of Mrs. Mutiso, in typing the manuscript is also gratefully acknowledged. I also wish to acknowledge Mr. Okoth for his assistance in stencilling the figures.

I also thank my wife, Clasina, for her encouragement throughout the project. My children, Nanzala, Mukhwana and Mulongo were also a great source of inspiration.

Finally, I wish to thank the German Academic Exchange Service (D.A.A.D.) for the direct sponsorship of the project and also acknowledge the financial assistance received from the National Council of Science and Technology of the Republic of Kenya.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

SUMMARY

In structural design, a rational model enables the engineer to develop a better understanding of actual structural behaviour and leads to simple general methods of design. For structural members subjected to structural actions involving shear, such a model is absent.

In this thesis, a rational model called the compression field theory is applied to the case of structural concrete subjected to combined flexure and shear . The compression field theory is a recently developed method of analysis which involves a consideration of equilibrium compatibility and the stress-strain characteristics of the concrete and the reinforcing steel.

The thesis shows how the complete response of a given section under flexure and shear can be predicted using the equations developed from the compression field theory. A program has also been written to enable a computer aided solution.

Further to the theoretical predictions, the thesis also presents a test programme in which experimental data is collected in order to verify the trends established from the theoretical model.

A comparative study is then carried out between the theoretical and experimental trends to assess the

capability of the model. It is established that within the assumptions of the theoretical model and the limitations of the experimental program, the trends predicted by the compression field theory model and those from the laboratory test data are in good agreement.

NOTATION

A_ℓ	Area of bottom longitudinal steel
A'_ℓ	Area of top longitudinal steel
A_v	Area of transverse steel (2 legs)
a	Shear span
b	Width of section
C_1	Compression force in concrete above neutral axis
C_2	Compression force in concrete below neutral axis
C_s	Compression force in top longitudinal steel
c	The ratio $\frac{t_v f_{vy}}{q}$
d	Depth from extreme compression fibre to centre of mass of bottom longitudinal steel
d'	Depth from extreme compression fibre to centre of mass of top longitudinal steel
E	Modulus of elasticity for steel
f'_c	Peak concrete cylinder stress
f_{cp}	Principal stress in concrete
f_ℓ	Stress in bottom longitudinal steel ($f_{\ell y}$ = yield stress)
f'_ℓ	Stress in top longitudinal steel ($f'_{\ell y}$ = yield stress)
f_v	Stress in transverse steel (f_{vy} = yield stress)
f_y	General yield stress value for steel
h_ℓ	Distance between centres of mass of top and bottom longitudinal steel
j	Lever arm factor
M_p	Pure moment value
M	Moment in section for combined case

q	Shear flow
s_v	Spacing of transverse steel
T	Tension force in bottom longitudinal steel
t_v	The ratio $\frac{A_v}{s_v}$
V	Shear force in section
$\bar{X}_2$	Distance from bottom longitudinal steel to point of action of C_2
y	Depth of any fibre in section measured from extreme compression fibre
y_n	Depth to neutral surface measured from extreme compression fibre for combined flexure and shear case
α, β	Equivalent rectangular stress block factors defined by equations (A.1) and (A.2)
$\gamma_{\ell t}$	Shear strain
ε_{co}	Concrete strain corresponding to peak concrete stress
ε_{cp}	Principal compressive strain in concrete
ε_{ct}	Extreme top fibre compression strain
$\varepsilon_{d1}, \varepsilon_{d2}$	Measured diagonal strains
ε_{ℓ}	Strain in bottom longitudinal steel ($\varepsilon_{\ell y}$ = yield strain)
ε'_{ℓ}	Strain in top longitudinal steel ($\varepsilon'_{\ell y}$ = yield strain)
ε_v	Strain in transverse steel (ε_{vy} = yield strain)
ε_t	Principal tensile strain in concrete
η	The ratio $\frac{\varepsilon_v}{\varepsilon_{vy}}$
ϕ	Curvature
θ	Principal angle of compression measured with respect to the beam longitudinal axis

$\sigma_{c\ell}$ Stress in concrete in longitudinal direction

σ_{ct} Stress in concrete in vertical direction

τ Shear stress in concrete

λ Effective peak concrete stress in beam

Ω_{cp}, Ω_t, Ω_ℓ, Ω_{vy} Ratios defined as $\frac{\varepsilon_{cp}}{\varepsilon_{co}}$, $\frac{\varepsilon_t}{\varepsilon_{co}}$, $\frac{\varepsilon_\ell}{\varepsilon_{co}}$ and $\frac{\varepsilon_{vy}}{\varepsilon_{co}}$ respectively

CHAPTER 1

INTRODUCTION

The role of rational models in enabling the engineer to develop a better understanding of actual structural behaviour has been pointed out by Collins, M.P. and Mitchell, D. (1980). They have also noted that due to the absence of such a model for shear, and combinations of loading including shear, procedures for design are quite unsatisfactory compared to those for flexure and axial load. Thus although safe designs are possible, "there is still a lack of understandable central philosophy resulting in complaints about design codes that are unworkably complicated". In this thesis, the behavioral response of structural concrete loaded in flexure and shear is predicted using a rational model called the compression field theory. The work is aimed at contributing to the present effort being undertaken to increase our understanding of the behaviour of members loaded in flexure and shear. The thesis also presents an experimental program conducted to test the performance of the theory.

The compression field theory is a recently developed method of analysis which has been successfully used to rationally explain the behaviour of structural concrete in pure torsion (Mitchell, D.

and Collins, M.P. 1974) and for the case of combined torsion, flexure and axial load (Onsongo, W.M. 1978). The full approach, as in the case of the well known theory for pure flexure, involves a consideration of equilibrium, compatibility and the stress-strain characteristics of the concrete and reinforcing steel.

The thesis first discusses the development of the compression field theory model from early design procedures. Basic equations for a proposed reinforced concrete beam model are then derived. Predictions of behavioral response for a series of beams are then done with material properties and loading conditions as the main parameters. The predicted behavioral responses are plotted on suitable graphs.

The experimental program designed to test the validity of the theory is also described. The test program contained eight reinforced concrete beams which were heavily instrumented to enable adequate data acquisition to validate or otherwise the various trends predicted by theory, in particular those involving strains.

For the beams tested, the actual material properties and loading condition are used to obtain theoretical predictions. The theoretical predictions are then plotted side by side with the experimental responses obtained from the laboratory test specimens. A comparative study is then done to assess agreement

between theoretical and experimental behaviour of the beams by observing trends of predicted and experimental responses.

The paper by Collins, M.P. and Mitchell, D (1980) includes a design procedure for a case of combined shear and flexure loading using the compression field theory. The design method proposes superposition of effects of shear and flexure in the elastic range and the imposition of various limiting factors in the non elastic range. The model in this thesis uses the equilibrium and compatibility relationships in an iterative scheme both in the elastic and non-elastic range to predict the response under combined flexure and shear.

CHAPTER 2

LITERATURE REVIEW

From about the turn of the century when Ritter and Mörsch proposed design procedures for shear, active research has been going on with the aim of developing a rational model for structural concrete members under not only shear loading but also its interaction with other structural actions. This is evident from the long lists of selective research papers available on this subject, for example in the Joint ASCE-ACI Task Committee 426 (1973), Joint ASCE-ACI Task Committee 426 (1974) and others. The research includes work on shear transfer mechanisms, factors affecting shear and serviceability of beams, methods of analysis for shear, modes of shear failure and distress and design procedures. It is, however, noted that a full understanding of the behaviour of structures subjected to shear does not yet exist.

As already noted, the present research utilizes the compression field theory model for prediction of structural concrete response in flexure and shear. In this chapter, the work accomplished by researchers in the development of this theory from early design procedures is discussed. As much as possible the review is restricted to the area of shear since the behaviour in flexure is already well understood.

2.1 Early Design Procedures

Early design procedures for shear were by the truss analogy introduced by Ritter and by Mörsch at the turn of the century. The method assumes that a reinforced concrete beam can be replaced by a pin jointed truss (Figure 2.1) in which transverse steel acts as ties and cracked concrete as struts. A problem, however, lies in the determination of the angle of inclination of concrete struts. As quoted by Collins, M.P. and Mitchel, D. (1980), Mörsch in 1922 made the following statement regarding this problem; "we have to comment with regards to practical application that it is absolutely impossible to mathematically determine the slope of the secondary inclined cracks according to which one can design the stirrups. For practical purposes one has to make a possibly unfavourable assumption for the slope, θ, and therefore, with $\tan 2\theta = \infty$, we arrive at our usual calculation for stirrups which presumes $\theta = 45$ degrees. Originally this was derived from the initial shear cracks which actually exhibit this slope."

Cracking is assumed to occur in directions mutually perpendicular to the principal tensile stresses, that is, parallel to the direction of principal compression stresses. The above statement by Mörsch indicates that it is impossible to calculate

the direction of principal compression stresses in cracked concrete. As will be shown in Chapter 3, this is no longer the case as the compression field theory model predicts the angles of principal compression from considerations of compatibility of strains in cracked concrete.

2.2 Performance of the Truss Analogy

In addition to the difficulty in choice of inclination of compression, the truss analogy model has been found to be extremely over-simplified in that it does not attempt to satisfy compatibility and it ignores some of the mechanisms of shear transfer proposed in the Joint ASCE-ACI Shear Committee 426 (1973).

The mechanisms of shear transfer proposed in the above report are indicated in Figure 2.2. These mechanisms are such that the total shear carried, V_T, is given by:

$$V_T = V_s + V_{cz} + V_d + V_{ay} \quad \text{.....(2.1)}$$

where V_s = Shear carried by transverse steel

V_{cz} = Shear carried by compression zone

V_d = dowel shear carried by longitudinal steel

V_{ay} = Vertical component due to interface shear

The truss analogy ignores the components V_{cz}, V_d

and V_{ay}. It is, however, noted that there is still disagreement as to the presence and roles of these components of shear and the subject of shear transfer mechanisms is not yet well understood. Extensive research by several researchers has been devoted to establishing the contributions of these various transfer mechanisms. Notable work done on this subject includes that by Leonhardt, F. and Walther, R. (1964), Leonhardt, F. (1965), Fenwick, R.C. and Paulay, T. (1968). Gergely, P. (1969), Hofbeck, J.A., Ibrahim, I.A., and Mattock, A.H. (1969) and more recently Jimenez, R., White, R.N., and Gergely, P. (1982).

Further, the mode of failure has been linked to the failure in one or a combination of the mechanisms of shear transfer. The failure of these mechanisms is deemed to be affected by the manner in which inclined cracks develop and grow, which in turn depend on the relative magnitudes of the shearing stress, v and the flexural stress, f_x. For beams with concentrated loads, the following expression (Joint ASCE-ACI Shear Committee 426(1973) has been deduced:

$$\frac{f_x}{v} = \alpha_3 \frac{(a)}{(d)} \frac{(bw)}{(b)} \quad \text{.....(2.2)}$$

where α_3 is a coefficient depending on variables like geometry of beam, type of loading, amount and arrangement of reinforcement,

type of steel and interaction between steel and concrete.

b, bw are respectively the flange and web width of the beam.

From the above relationship, the variations in the inclined cracking load and shear capacity of rectangular beams are considered a function of varying $\frac{a}{d}$ (Bresler, B. and Macgregor, J.G. (1967)). For rectangular cross section beams, inclined cracks will normally occur in the range $2.0 < \frac{a}{d} < 6.0$.

The compression field theory assumes that the concrete and reinforcing steel act together and proceeds to rationally explain the behaviour of a cracked concrete beam by proposing that a redistribution of stresses occurs such that there is equilibrium of forces and compatibility of strains. It is of interest to note that the original truss analogy by Ritter and Mörsch did not satisfy compatibility of deformations.

Inspite of the simplifications of the truss analogy it must be noted that the model has been found to be an excellent conceptual tool in study of the beams with web reinforcement and to indicate the presence of tensile stresses in stirrups and compression stresses in concrete between inclined crack. In addition, the model correctly shows effects of variations of stirrup angle

to these stresses and thus may derive basic equations for design of web reinforcement. It also clearly shows that stresses in the longitudinal tensile reinforcement are larger than predicted from beam theory. These advantages are lso revealed by the compression field theory.

2.3 Modifications to the Truss Analogy and Development of the Compression Field Theory

The truss analogy yields typically conservative results. In view of this and the other limitations already noted, attempts have been made to modify the approach for use in design for shear. In fact most design codes have developed modified forms of this model for handling design of structures subjected to shear. Modifications considered by the American Concrete Institute and the European Concrete Committee design procedures are mentioned by Collins, M.P. and Mitchell, D. (1980).

The compression field theory utilizes a different concept from the truss analogy as already noted in section 2.2. Most significant is the fact that the requirements of compatibility are not overlooked. The inclination of principal compression stresses is determined from these requirements.

The problem of determining the inclination of principal compression in concrete is analogous to the

problem investigated by Wagner in 1929 in studying buckling shear resistance of thin webbed metal girders (Collins, M.P. and Mitchel, D. 1980). Wagner assumed that after buckling, shear resistance of thin webbed metal girders cannot resist compression and that shear would be carried by a field of diagonal tension. By considering the deformation of the system, he assumed that the angle of inclination of the diagonal tensile stresses would coincide with the angle of inclination of principal tensile strains in order to determine the inclination of diagonal tension.

Wagner was dealing with material which after buckling could be considered to have no compression strength but resisted further loading in a tension field. Structural concrete can also be considered to have no tensile strength after cracking and further loading in the post-cracking range is resisted in a field of principal compression by the concrete while the reinforcing steel is assumed to take up the tension forces. Recognizing the analogy between this and the problem of Wagner, it has been shown (Onsongo, W.M. 1978) that the angle of principal compression strain in concrete with respect to the beam longitudinal axis is given by:-

$$\frac{\varepsilon_\ell + \varepsilon_{cp}}{\varepsilon_v + \varepsilon_{cp}} = \tan^2\theta \qquad \text{.....(2.3)}$$

This relationship which is used to establish

the compatibility requirements of the compression field theory links the strains in concrete, the longitudinal steel and the transverse steel. The full geometrical interpretation of equation (2.3) was, however, not done until the work of Onsongo (1978).

Basic equations for shear using the compression field theory have been derived by Collins, M.P. (1978). The model has been further discussed by Collins, M.P. and Mitchell, D. (1980) in a paper in which additional behavioral aspects have been proposed. The paper also includes design examples. From the design examples, it has been shown that the amount of reinforcement required by the compression field theory is in general comparable to amounts required by existing empirical design procedures. This presents hope of moving towards a rational model. In the next chapter, the model is applied to beams loaded in flexure and shear.

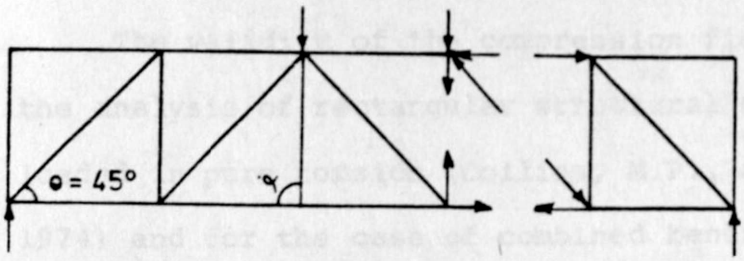


Fig.2.1: Distribution of force in classical Truss Analogy

(Joint ASCE-ACI Task committee 426(1973))

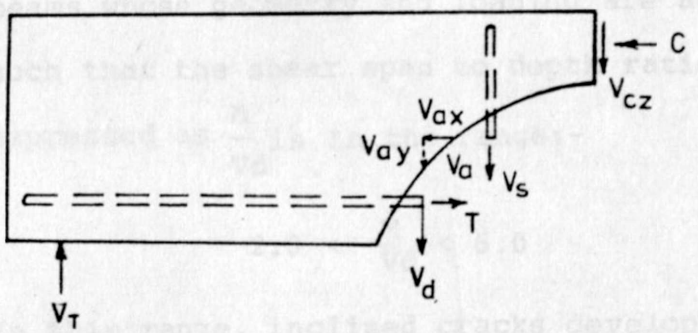


Fig.2.2: Forces Acting at an Inclined crack

(Joint ASCE-ACI Task committee 426(1973))

V_{ay}, V_{ax}	Components due to interface shear, Va
V_d	dowel shear carried by longitudinal steel
V_{cz}	Shear carried by the compression zone
V_s	Shear carried by the shear reinforcement

CHAPTER 3

COMPRESSION FIELD THEORY FOR COMBINED FLEXURE AND SHEAR LOADING

The validity of the compression field theory for the analysis of rectangular structural concrete beams loaded in pure torsion (Collins, M.P., and Mitchel, D. 1974) and for the case of combined bending, axial load and torsion (Onsongo 1978) has already been established. In this chapter the theory is further developed for analysis of structural concrete subjected to combined flexure and shear. The theory is developed using rectangular reinforced concrete beams whose geometry and loading are assumed to be such that the shear span to depth ratio, which can be expressed as $\frac{M}{Vd}$ is in the range:-

$$2.0 < \frac{M}{Vd} < 6.0$$

In this range, inclined cracks develop due to a combination of shear and flexural stresses and the mode of failure could be due to either shear or flexure.

Figure 3.1 shows the assumed cracked beam model together with the loading condition. In Figure 3.2, the assumed distribution of stresses across the section is shown.

3.1 Assumptions

For the development of the theoretical model, the following basic assumptions were made:

(i) Under the applied loads, the beam is fully cracked in the region below the neutral axis.

(ii) The longitudinal strains along any line in a section vary linearly (Bernouli-Navier hypothesis).

(iii) All strains at a point in a plane are compatible.

(iv) The direction of principal compression strain evaluated from a set of compatible strains at a point in a plane of loading is coincident with the direction of principal compression stress at that point in the plane.

(v) The resultant concrete compression force above the neutral axis can be evaluated using the well known rectangular stress-block theory used for pure flexure.

(vi) Transverse steel content is the same in all faces.

(vii) In the fully cracked region concrete resists load in principal compression and the tensile strength of concrete can be ignored.

(viii) The stress-strain relationships for reinforcing steel are bilinear (Figure 3.3 (a)).

(ix) The stress-strain relationships for a standard concrete cylinder tested under compression may be taken to be parabolic (Figure 3.3 (b)).

(x) The principal compression stress in the structural concrete beam, f_{cp}, is assumed to be related to the principal compression strain ε_{cp} and the principal tensile strain ε_t as follows:

$$f_{cp} = \frac{f'_c}{0.8 + 0.34\left(\frac{\varepsilon_t}{\varepsilon_{co}}\right)}\left(2\frac{\varepsilon_{cp}}{\varepsilon_{co}} - \left(\frac{\varepsilon_{cp}}{\varepsilon_{co}}\right)^2\right) \leq f'_c$$

(xi) The shear flow variation down the section is assumed to be linear with a change of slope at the neutral surface (Figure 3.1).

These assumptions are necessary for the purpose of setting up of equilibrium and compatibility relationships. Assumptions (i) to (ix) are the usual accepted ones in the well established flexural theory of concrete. Assumption (x) has resulted from recent tests by Vecchio and Collins (1982) while assumption (xi) is a reasonable new one required to enable the setting up of the relevant equations of equilibrium.

3.2 Equilibrium Considerations

3.2.1 Concrete Stresses

Figure 3.1 shows the assumed cracked beam model subjected to a shear force, V, and a flexural moment, M. A typical element, A, which is assumed to be in the plane of shear flow will be subjected to a shear stress τ longitudinal stress, σ_{cl} and a transverse stress, σ_{ct} for the combined loading case. Assuming concrete has no tensile strength, the stresses can be considered equivalent to a field of principal compression in the cracked concrete, at an inclination, θ, with respect to the beam longitudinal axis which is determined by the equilibrium requirements and requirements of compatibility of deformations (see also Onsongo 1978).

Consider the typical element, A, just described. The stresses at equilibrium can be resolved using Mohr's circle of stresses as illustrated in Figure

3.4 (a). This leads to the following relationships:-

$$\tau = \tfrac{1}{2} f_{cp} \sin 2\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

$$\sigma_{ct} = \tau \tan\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

$$\sigma_{c\ell} = \frac{\tau}{\tan\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.3)$$

The assumed shear flow distribution is shown in Figure 3.1. Now, at any given level of section, the shear stress, τ, when integrated across the width b results in the shear flow q. For the section shown in Figure 3.1, it is reasonable to assume that the shear stress, τ, is constant across the width b at any level. Hence,

$$q = \tau b \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.4)$$

The determination of shear flow at the level of tension steel in the bottom face, q_b, is possible by considering the element shown in Figure 3.4 (d). In general, the applied moment, M, is related to the internal tension force, T, and the lever arm jd, as:-

$$M = Tjd \quad \ldots\ldots\ldots\ldots\ldots (3.5)$$

For the type of section and reinforcement details shown,

$$T = A_\ell f_\ell \qquad f_\ell \leq f_{\ell y}$$

Differentiating equation (3.5),

$$\frac{\partial M}{\partial x} = \frac{\partial T}{\partial x} jd + Td \frac{\partial j}{\partial x}$$

But $\frac{\partial M}{\partial x} = V$ by definition

From Figure 3.4 (d) we deduce that

$$\frac{\partial T}{\partial x} = q_b$$

hence $$V = q_b jd + Td\frac{\partial j}{\partial x}$$

Assuming that $\frac{\partial j}{dx}$ is negligible, we deduce that

$$q_b = \frac{V}{jd} \quad \ldots\ldots\ldots\ldots\ldots (3.6)$$

From the assumed distribution, the shear flow at the neutral axis, q_n, is determined by recognizing that the shear flow equilibrates the applied shear, V, and hence:-

$$q_n = \frac{2}{d}\left(V + \frac{q_b y_n}{2}\right) - q_b \quad \ldots\ldots\ldots (3.7)$$

It has been assumed that the amount of compression longitudinal steel in the top face, A'_s, is nominal and hence will not significantly affect the shear flow distribution. When a high content of top longitudinal steel is used, a value for the shear flow at the top compression steel, q_t, can be computed in a similar manner as for q_b. For such a case, the expected distribution and equations are presented in Appendix D. For simplicity, only cases with nominal top face longitudinal steel content are considered in the present analysis.

The components of the principal compression stress set up in concrete are resisted by the longitudinal and transverse reinforcing steel. The compressive stresses in concrete can be related to the steel stresses by considering the equilibrium of the

appropriate free body diagrams.

3.2.2 Transverse Equilibrium

Consider the free body diagram of Figure 3.4 (b). Assuming that the transverse steel is placed perpendicular to the longitudinal axis and that within the spacing, s_v, the applied shear and the internal compression stresses in concrete are uniform, the following relationship is deduced:-

$$A_v f_v = \sigma_{ct} dA;$$

and using equation (3.2) this equation becomes

$$\frac{A_v f_v}{s_v} = \tau \tan\theta b \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8)$$

where the area of integration equals to $s_v b$.

Using equation (3.4), equation (3.8) becomes

$$\frac{A_v f_v}{s_v} = q \tan\theta \quad \ldots\ldots\ldots\ldots\ldots \quad (3.9)$$

3.2.3 Longitudinal Equilibrium

Consider the free body diagram of Figure 3.4 (c). The distribution of equivalent stresses is included. For no axial load, equilibrium requires that the tension force in the reinforcing steel in the section be balanced by the resultant compression force in the concrete. Further, equilibrium requires that the external moments applied be balanced by the internal moment due to these resultant forces at the section.

From Figure 3.4 (c), the following relationship is deduced.

$$A_\ell f_\ell - A'_\ell f'_\ell = \alpha\beta f'_c b y_n + \int_{y_n}^{d} \frac{\tau}{\tan\theta} b\,dy$$

and hence $$A_\ell f_\ell - A'_\ell f'_\ell = \alpha\beta f'_c b y_n + \int_{y_n}^{d} \frac{q\,dy}{\tan\theta} \quad \ldots.(3.10)$$

The values of the shear flow, q, can be determined at a number of points (see Figure 3.1) and using these, the integral in equation (3.10) can be approximately evaluated using Simpson's rule. For three ordinates; at the neutral surface, at the bottom level and in the middle of these two points and if q_n, q_b and q_m are the respective shear flows and θ_n, θ_b and θ_m the corresponding angles of principal compression, the compressive force, C_2, can be approximated as:-

$$C_2 = \frac{d-y_n}{6} (q_n \cot\theta_n + 4q_m \cot\theta_m + q_b \cot\theta_b) \quad (3.11).$$

Further, if $\bar{x}_2$ is the resultant of the above force measured from the tension steel in the bottom face, then, also by Simpson's integration rule:-

$$\bar{x}_2 = (d-y_n) \left(\frac{q_n \cot\theta_n + 2q_m \cot\theta m}{q_n \cot\theta_n + 4q_m \cot\theta_m + q_b \cot\theta_b} \right) \ldots(3.12)$$

The internal forces consititute a couple which equilibrates the applied moment, M, so that:-

$$M = C_2\bar{x}_2 + \alpha\beta f'_c b y_n \left(d - \frac{\beta y_n}{2}\right) + A'_\ell f'_\ell \quad .. \quad (3.13)$$

3.3 Geometrical Considerations

The compression field theory links the strains in the concrete diagonal to the strains in the longitudinal and transverse directions to realise a compatible displacement. While the local strains of the cracked beam may exhibit discontinuities, the average strains in the various directions are related to one another by this requirement of compatibility (Onsongo 1978). Considering Mohr's circle of strains shown in Figure 3.5, the following relationships are deduced.

$$\frac{\varepsilon_{cp} + \varepsilon_\ell}{\frac{\gamma_{\ell t}}{2}} = \tan\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.14)$$

$$\frac{\frac{\gamma_{\ell t}}{2}}{\varepsilon_{cp} + \varepsilon_v} = \tan\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3.15)$$

where the longitudinal strain, ε_ℓ, and the transverse strain, ε_v, are considered positive when tensile and the principal compression strain ε_{cp} is considered positive when compressive. Combination of equations

(3.14) and (3.15) yields the geometric relationship

$$\tan^2\theta = \frac{\varepsilon_\ell + \varepsilon_{cp}}{\varepsilon_v + \varepsilon_{cp}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.16)$$

and the shear strain $\gamma_{\ell t} = 2\sqrt{(\varepsilon_\ell + \varepsilon_{cp})(\varepsilon_v + \varepsilon_{cp})}$ .. (3.17)

Equation (3.16) represent the compatibility condition of strains and shows that given the three strains ε_ℓ, ε_v and ε_{cp}, the direction of the average principal compressive strain, θ, can be determined. The geometric interpretation of this equation was developed by Onsongo (1978).

It should be noted that the diameter of the circle is a measure of the maximum shear strain, γ_m, which can be expressed as:

$$\gamma_m = \varepsilon_\ell + \varepsilon_v + 2\varepsilon_{cp} \quad \ldots\ldots\ldots\ldots\ldots (3.18)$$

3.4 Stress-Strain Relationships for Materials

3.4.1 Concrete

From assumption (ix), the cylinder concrete stress-strain relationship is represented by:

$$f_{cp} = f'_c \, (2\Omega_{cp} - \Omega_{cp}^2) \quad \ldots\ldots\ldots\ldots (3.19)$$

This relationship is plotted in Figure 3.3 (b).

If it is assumed that the stress-strain relationship for concrete in a beam is identical to that of a standard cylinder test, then,

$$q = \tfrac{1}{2} f_{cp} \sin 2\theta b$$

(see equation (3.1)

and hence $$f_{cp} = \frac{2q}{b \sin 2\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.20)$$

From equation (3.19), it can be deduced that

$$\Omega_{cp} = 1 \pm \sqrt{\left(1 - \frac{f_{cp}}{f'_c}\right)} \quad \ldots\ldots\ldots\ldots\ldots (3.21)$$

From equation (3.21), the principal compression strain can be calculated.

In the development of the compression field theory for concrete subjected to pure torsion (Mitchell, D. and Collins, M.P. 1974) and combined flexure, torsion and axial load (Onsongo 1978), the concrete stress-strain relationship was taken to be identical to the stress-strain response obtained from a standard concrete cylinder test. Thus equation (3.19) was equally applicable to a concrete beam as to a standard concrete cylinder. However, recent tests (Vecchio, F. and Collins, M.P. 1982) have shown that the principal compressive stress in a cracked reinforced concrete panel subjected to uniform biaxial strain is a function not only of the principal compressive strain ε_{cp} but also of the co-existing

principal tensile strain, ε_t. Collins, M.P. (1983) has suggested the following stress-strain relationship:

$$f_{cp}=\frac{f_c}{0.8+0.34\Omega_t}\,(2\Omega_{cp}-\Omega_{cp}^2)\qquad\ldots\ldots(3.22)$$

The effect of equation (3.22) to the cylinder concrete stress-strain relationship is shown in Figure (3.6). In the current development, equation (3.22) is used in the form

$$f_{cp}=\lambda\,(2\Omega_{cp}-\Omega_{cp}^2)$$

where $\lambda=f'_c/(0.8+0.34\Omega_t)$

This enables the use of the equation in an iterative scheme so that equations (3.19), (3.20) and (3.21) still apply.

3.4.2 Steel

For reinforcing steel, the following relationship is used:-

$$f=E\varepsilon\leq fy$$

where f, fy are the respective steel stresses and ε, the strain

3.5 Direction of Principal Strains

Strains, computed from the stress-strain relationships just discussed enable determination of the angle of principal compression using equation (3.16). It will be assumed that for the cracked beam the direction of the average principal compressive stress, f_{cp}, is coincident with the direction of the average principal compressive strain calculated from equation (3.16). In fact, recent tests at the University of Toronto (Vecchio, F. and Collins, M.P. 1982) indicate that this assumption is reasonable. The tests showed a difference in the angles for principal stress and principal strain to a magnitude of about $\pm 5^{o}$. For simplicity of analysis, this difference can be ignored.

3.6 Solution Technique

The equilibrium and geometric equations which have been derived are adequate to enable the prediction of a cracked structural concrete beam subjected to flexure and shear loading. Assuming that the beam cross section, the stress-strain characteristics of the concrete and reinforcing steel are given, then for a specified extreme compression fibre strain, ε_{ct}, and a moment to shear ratio of loading, a, the following solution procedure is proposed.

Step 1

Assume pure flexure case. Using the well established flexural theory, calculate the depth to the neutral surface, y_p, corresponding to the top fibre strain, ε_{ct}. Hence, calculate the pure moment value, M_p.

Step 2

Recognising that the neutral surface depth, y_n, for the combined case of flexure and shear will be less than that for the pure flexure case, guess y_n; say $y_n = 0.75\, y_p$. Hence calculate curvature $\phi = \frac{\varepsilon_{ct}}{y_n}$. With ϕ, determine the longitudinal steel strains and in turn the corresponding stresses using the given stress-strain characteristics. Also, determine the internal forces.

Step 3

With the internal forces obtained in step 2, evaluate the internal moment, M, and the internal moment lever arm $jd = \frac{M}{A_\ell f_\ell}$. Determine the shear force in section from the moment shear ratio and hence using equations (3.6) and (3.7) establish the shear flow distribution.

Step 4

Determine the angles and strains with the established shear flows and hence calculate the longitudinal compression forces in cracked concrete using equation (3.11).

Step 5

Check equilibrium (equation 3.10). If equilibrium is not satisfied, repeat steps 2, 3, and 4 using the latest evaluated value of jd for each new iteration thus:-

$$M = Tjd$$

and $$V = \frac{M}{a}$$

Step 6

When equilibrium is satisfied, solution results are recorded. A new extreme compression fibre strain can be selected and the process repeated until the required complete response is obtained.

The equations involved in the various steps of the solution process together with a sample calculation are presented in Appendix A.

3.7 Theoretical Study Using Computer

The solution technique just presented has been programmed to enable a computer aided solution in predicting the behavioral response of rectangular reinforced concrete beams loaded in flexure and shear. The steps of the program and the full listing are given in Appendix B

Beams with varying material properties and loading conditions have been studied. The cases considered include behaviour with changing longitudinal steel content, transverse steel content, concrete strength and moment-shear ratio. The predicted moment-curvature responses are plotted in Figures 3.7, 3.8 and 3.9.

Figures 3.7 (a), (b) and (c) show that the effect of increasing the longitudinal steel content ρ_ℓ for a fixed $\frac{M}{Vd}$ ratio while keeping all other parameters constant is to decrease the section ductility and increase the moment capacity.

Figures 3.8 (a), (b) and (c) show that the effect of increasing the transverse steel content, ρ_{sv}, for a fixed $\frac{M}{Vd}$ ratio while keeping all other parameters constant is to decrease the section ductility and increase the moment capacity. However, the effect is not as dramatic as that due to variation of the longitudinal steel content particularly for large $\frac{M}{Vd}$ ratios.

Figures 3.9 (a), (b) and (c) show that the effect of increasing the concrete strength, f'_c, for a fixed $\frac{M}{Vd}$ ratio while keeping all other parameters constant is to increase section ductility and also increase the moment capacity. The increase in moment capacity for this particular section under study is small for concrete strengths above $30 N/mm^2$.

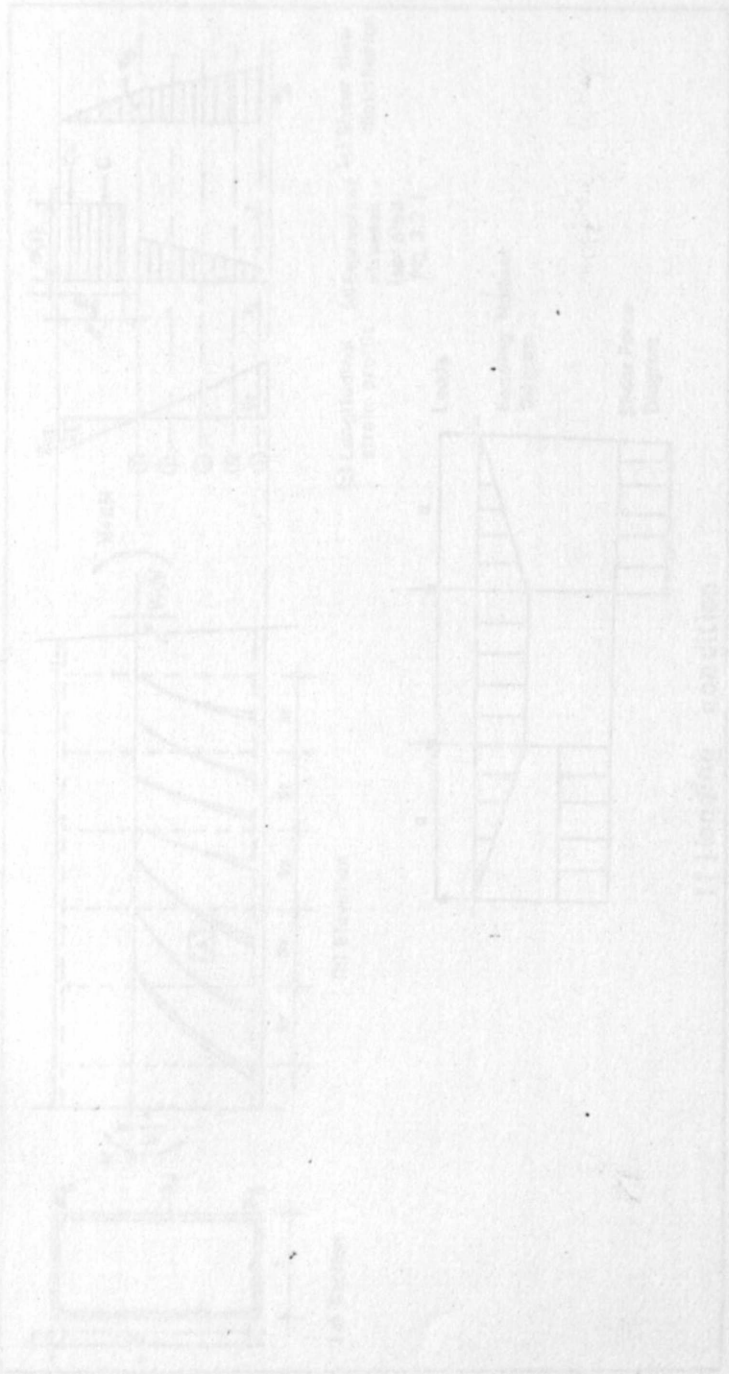
Figures 3.7, 3.8 and 3.9 indicate that the effect of increasing the $\frac{M}{Vd}$ ratio for fixed ρ_ℓ, ρ_{sv} and f'_c is to slightly decrease the ductility for slightly increased moment capacity.

The model prediction trends described above formed a useful basis for the design of an experimental program presented in Chapter 4.

3.8 Application of Theory to Prestressed Concrete Sections

The beam section shown in figure 3.10 was used in applying the theory to prestressed concrete sections. Apart from the main prestressing steel, nominal bars are used at corners for tying transverse steel. The basic equations for solving the combined flexure and shear case remain the same as those for reinforced concrete, effect of strain difference in the longitudinal direction due to prestressing operation being considered. The computer program is capable of

handling cases of prestressed concrete. Prediction of trends similar to those of Figures 3.7, 3.8 and 3.9 are possible.



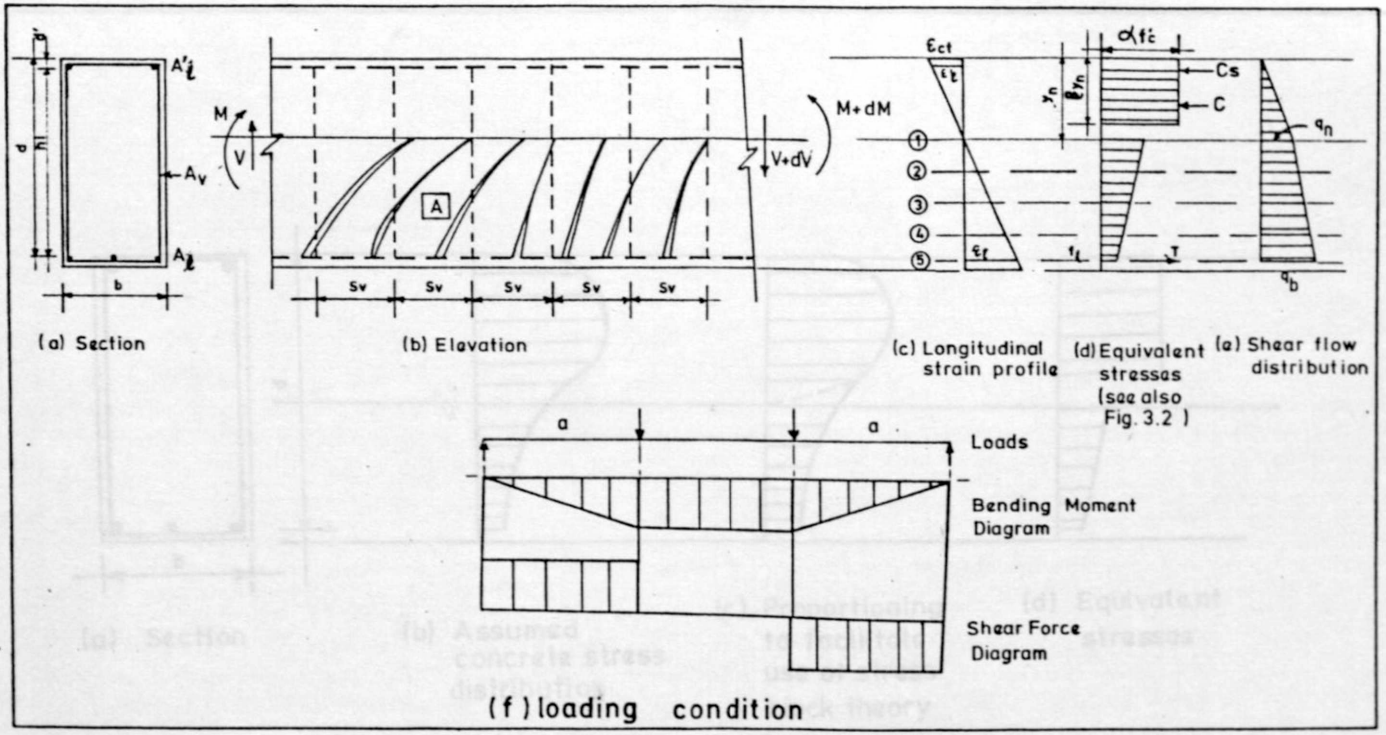


Fig. 3.1 : Concrete Beam Model

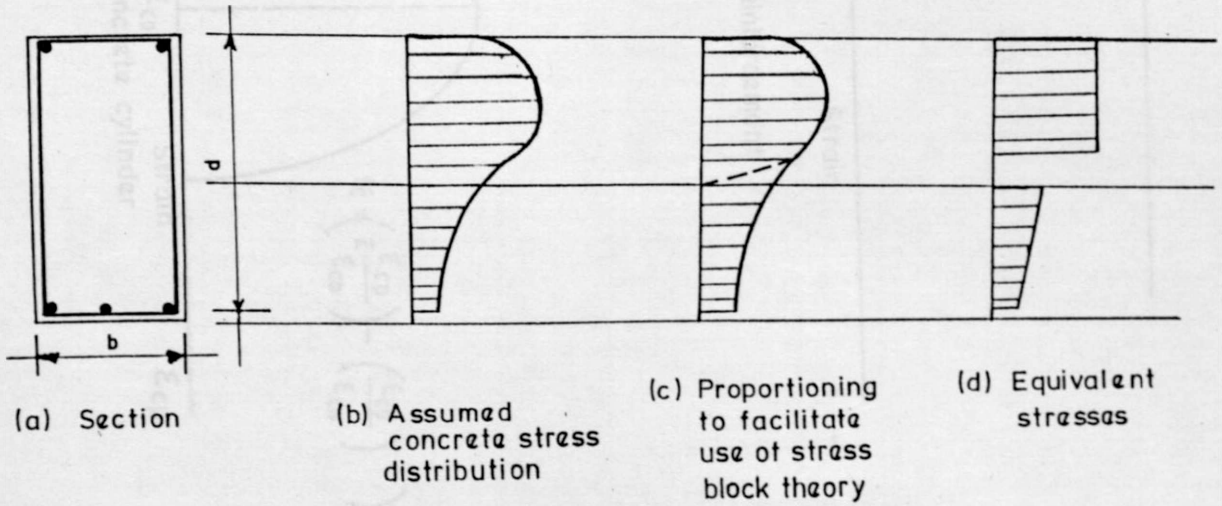
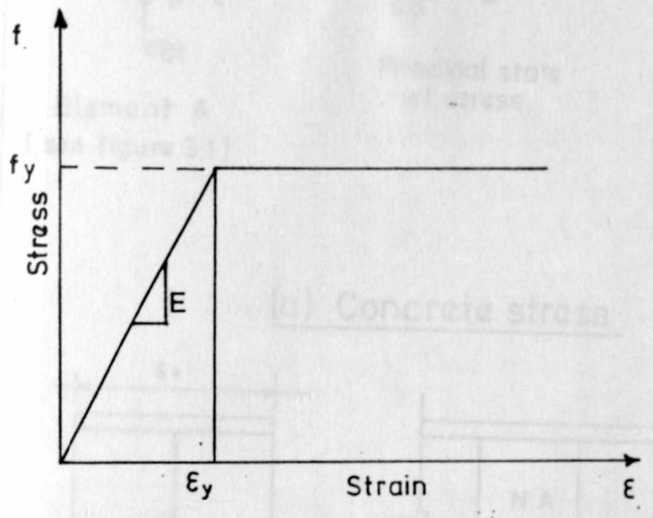
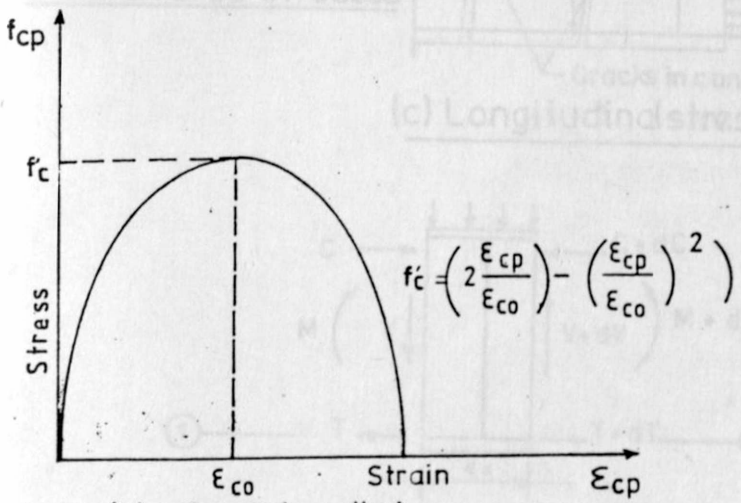


Fig. 3.2 : Distribution of stress on section

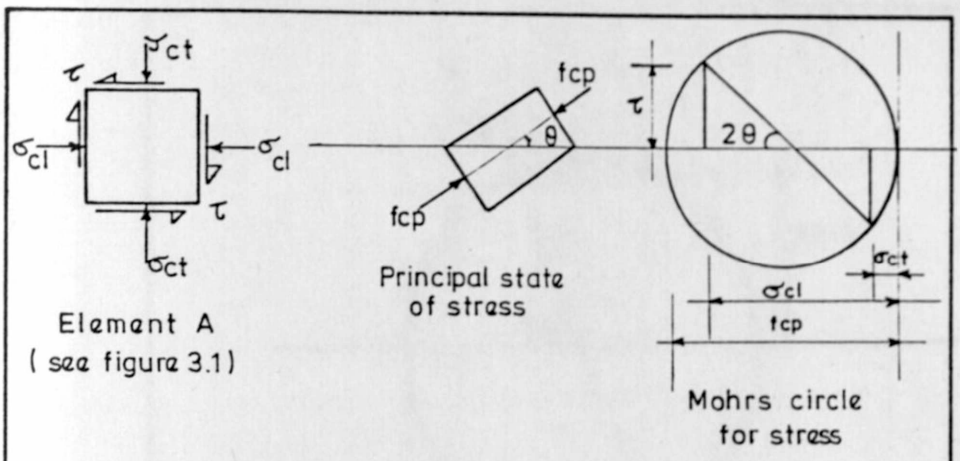


(a) reinforcement

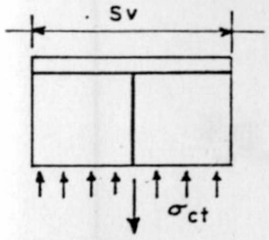


(b) Concrete cylinder

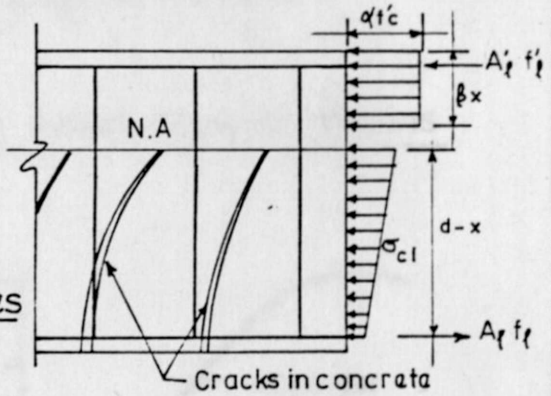
Fig. 3.3 : Material idealised stress-strain characteristics



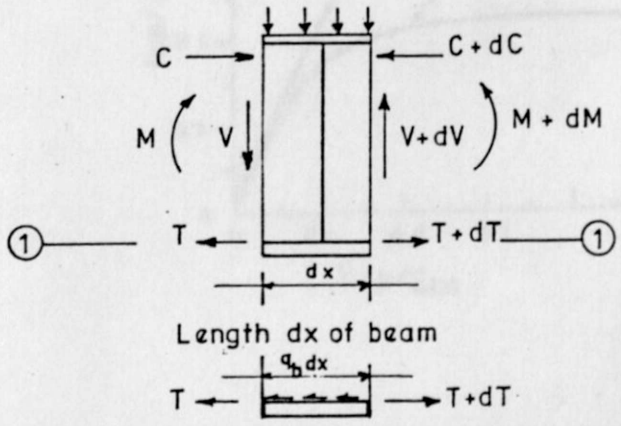
(a) Concrete stress



(b) Transverse stresses



(c) Longitudinal stresses



(d) Determination of shear Flow at level ① - ①

Fig. 3.4: Equilibrium considerations

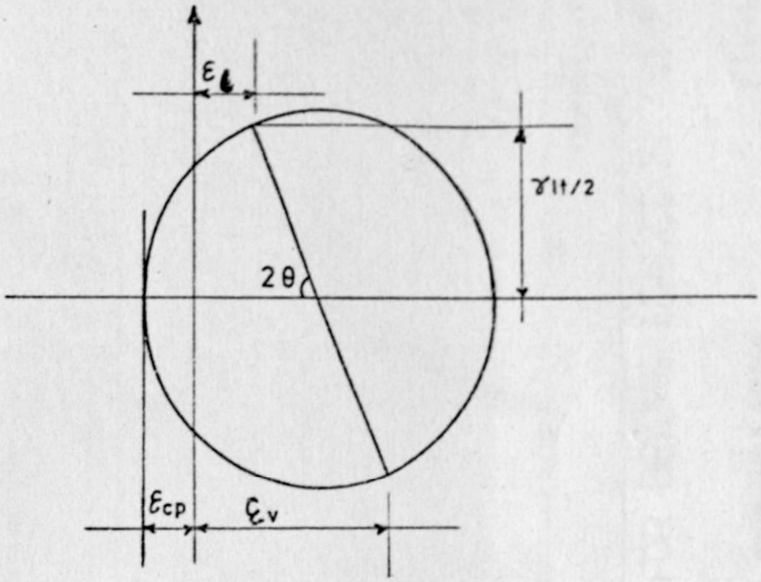


Fig. 3.5: Mohr's circle of strains

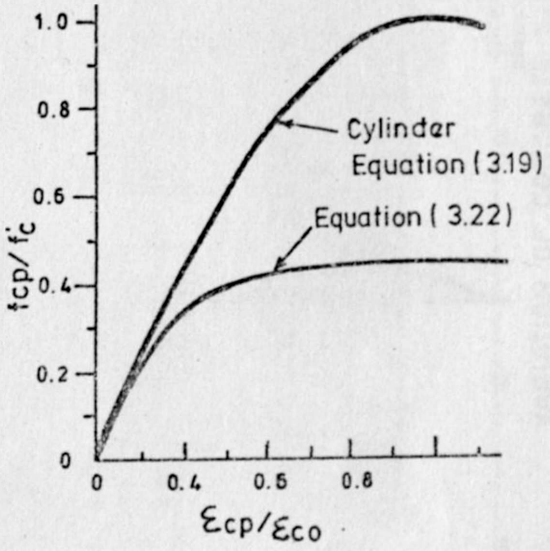


Fig. 3.6: Comparison of responses as predicted by equation (3.19) and (3.22) (Collins 1983)

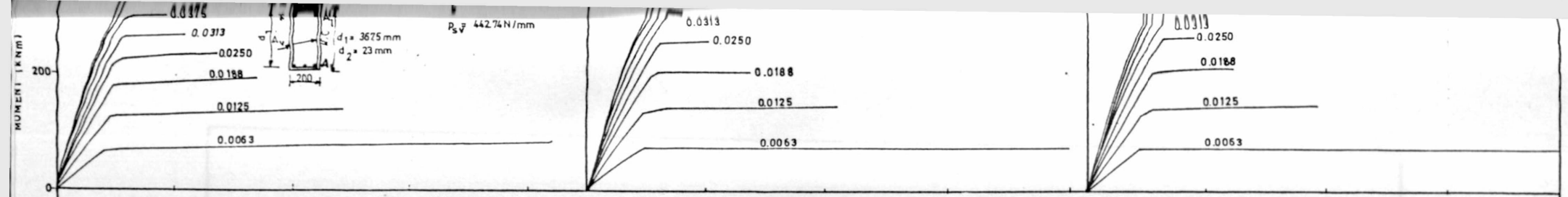


Figure 8 VARIATION OF LONGITUDINAL STEEL CONTENT

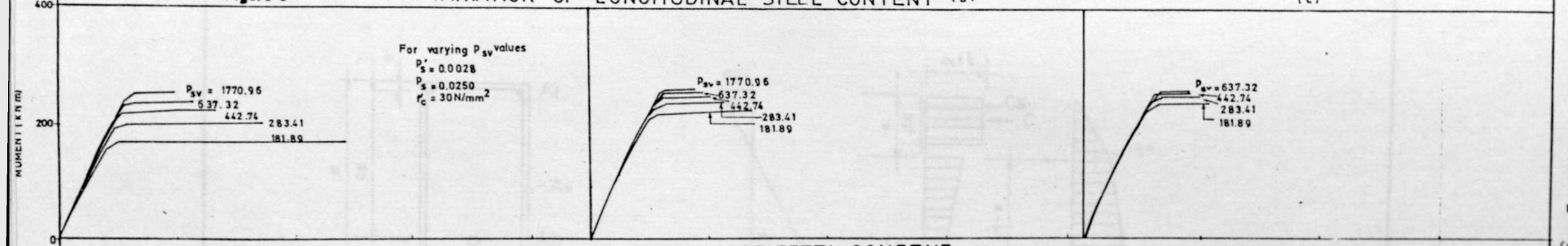


Figure 9 VARIATION OF TRANSVERSE STEEL CONTENT

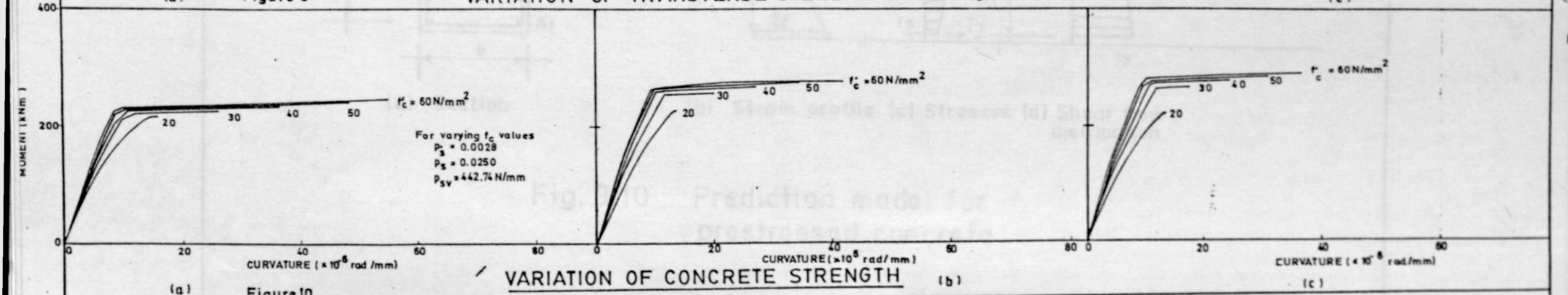
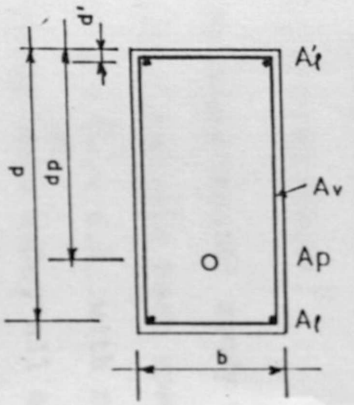


Figure 10 VARIATION OF CONCRETE STRENGTH

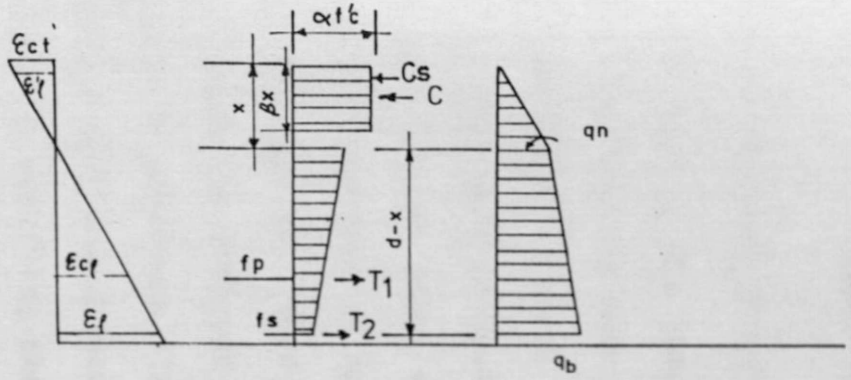
THEORETICAL PLOTS BASED ON COMPRESSION FIELD THEORY FOR BEAMS LOADED IN COMBINED MOMENT AND SHEAR

Note. In the derivation of these plots, the effect of equation 3.2.2 is not considered. However for the treads discussed in chapter 5, equation (3.2.2) is considered.



(a) Section

Fig. 3.10 :



(b) Strain profile (c) Stresses (d) Shear flow distribution

Prediction model for prestressed concrete

CHAPTER 4

DATA COLLECTION

4.1 Objectives and Choice of Test Specimens

In Chapter 3, the compression field theory model was developed for the case of combined loading in flexure and shear. It was noted that this rational model has been used to predict the response of reinforced concrete beams subjected to pure torsion and also for the case of combined bending, axial loading and torsion. This chapter describes a test program which was designed to test the validity of the trends of behaviour illustrated in Figures 3.7, 3.8 and 3.9 with the observations noted. The program also aimed at verifying the various other response characteristics predicted by the compression field theory model for the case of combined flexure and shear, in particular, the strains and angles of principal compression.

The experimental study was limited to rectangular reinforced concrete beam specimens in the loading range $2.0 < \frac{M}{Vd} < 6.0$ with rectangular solid sections. Eight beams were made, all of the same section size (200mm x 400mm). Six of the beams had the same length of 2700mm, the other two having lengths of 2600mm and 4000mm. The properties of the beams were varied so as to obtain the desirable variables as summarised in Table 4.1.

Specimens were loaded symmetrically about the centre with two point loads to provide regions for pure flexure and combined flexure and shear, Figure 4.1. The shear span, a, was chosen such that the desired $\frac{M}{Vd}$ ratio was satisfied. Except for beam CFT - TB8, the value of the shear span was kept at 1m and for CFT - TB8 the shear span was 1.65m.

4.2 Test Specimens

4.2.1 Materials

4.2.1.1 Concrete

All concrete mix design was according to a method outlined by Neville, A.M. (1973), the aggregates grading having been approximated to one of the four type curves in Road Note No. 4 (1968). The standard cylinder strength was taken as that obtained from a cylinder made from actual batches used in casting the beam. Recognising that the loading durations on the actual beam were much longer than the normal 5-minute test for a cylinder, some test cylinders were tested taking into account duration of load on the beam. It was noticed that whereas the peak concrete stress remained about the same in both cases, the concrete strain corresponding to the peak concrete stress was much larger in the later case than the former. In Figures 4.2(a)-(h), the concrete stress-strain relationships for all the beams, obtained from the

cylinder tests are presented. The parabolic equation assumed to approximate the stress-strain relationships for standard cylinder is also shown.

4.2.1.2 Steel

Test specimens were cut from the actual steel used. These were tested for stress-strain characteristics in tension. Figure 4.3(a)-(i) gives a summary of the steel test results. For simplicity, approximate bilinear relationships were deduced from these curves for use in predicting behavioral response of the test beams.

4.2.2 Preparation of Test Specimens

The general reinforcement details of the test specimens are given in Figure 4.4. The steel cage, carefully tied to shape and as rigid as possible was lowered into a timber mould which was set on a vibrating table and secured into position by 10mm thick cover blocks. Batching was then started and owing to the small capacity of the mixer, casting was done in five equal batches to fill the mould. It took about one hour to complete the casting for one beam. Cylinder moulds were also filled and proper vibration of the table done at each of these casting stages to prevent honey-combing of the beam and cylinders. Stripping was done after about forty eight hours and curing

done in wet conditions for a sufficient number of days to obtain the desirable strength after which instrumentation was done in readiness for testing.

4.3 Parameters of the Test Program

Longitudinal steel content, transverse steel content, concrete strength and the $\frac{M}{Vd}$ ratio were the basic parameters varied in the tests as identified in the theoretical study and as revealed in Figures 3.7, 3.8 and 3.9.

Beam CFT-TB8 had a different $\frac{M}{Vd}$ ratio from the other beams but with other parameters approximating those of beam CFT-TB2 to enable study the effect of changing $\frac{M}{Vd}$ ratio while holding other parameters constant. In beams CFT-TB2, CFT-TB4 and CFT-TB6, the longitudinal steel content was varied. Beam CFT-TB1, CFT-TB3, CFT-TB5 and CFT TB7 considered transverse steel variation while in beams CFT-TB2 and CFT-TB7 the parameter varied was the concrete strength. The details of the test program are summarised in Table 4.1.

4.4 Test Rig

Plate 4.2 shows the test rig in which the beams were tested. A schematic representation of the test set up is given in Figure 4.1.

Beams CFT-TB1, CFT-TB2 and CFT-TB4 were tested when the test rig arrangement was as shown in Plate 4.1.

In this arrangement, the left hand side support was secured in position using wedges and the jacks were not fixed to the vertical position using steel rods. This arrangement was however found unsuitable for the high loads required to fail the beams. At high loads the test rig tended to become unstable resulting in sudden unloading of the test specimen. Beams CFT-TB1 and CFT-TB2 were affected by this problem.

The test rig was revised so as to fully fix the line of the loading jacks as shown in Plate 4.2. One of the supports was rigidly fixed to steel columns using a trussed steel member. The jacks were held in the vertical position by an arrangement of steel plates and rods. It was necessary, as a further revision, to change the size of anchoring rods from 12mm diameter bars to 16mm bars to achieve stability of the test rig.

4.5 Calibration of Testing Machines

The machines used in transmitting load to the beam and for the crushing of test cylinders were calibrated against a spring type load sensor of 200 tons capacity to yield calibration curves of machine reading against the transmitted load. The curve for the two jacks that were used in loading the beams is presented in Figure 4.5 while Figure 4.6 gives the calibration curve for the compression machine used in cylinder crushing tests.

4.6 Instrumentation

For the measurement of the strains in the longitudinal, transverse and diagonal directions, targets were placed on the beam faces appropriately using durofix adhesive and left to dry for more than twelve hours. As in the case of Onsongo (1978), heavy instrumentation of the specimens was necessary for the purpose of obtaining enough strain measurements to give reasonable representative strain patterns to enable a comparison with the corresponding patterns predicted by the model. The Bernoulli-Navier hypothesis was also to be verified for the case of flexure and shear.

The target patterns varied from beam to beam as presented in Figures 4.7 (a) - (i). Before mounting the beam into the test rig, the positions of the targets were checked to ensure they were as close as possible to the desired gauge lengths. After proper positioning, the deflection gauges were set below the beam as shown in Plates 4.1 and 4.2 for monitoring of the central deflection of the beam.

4.7 Testing Procedure

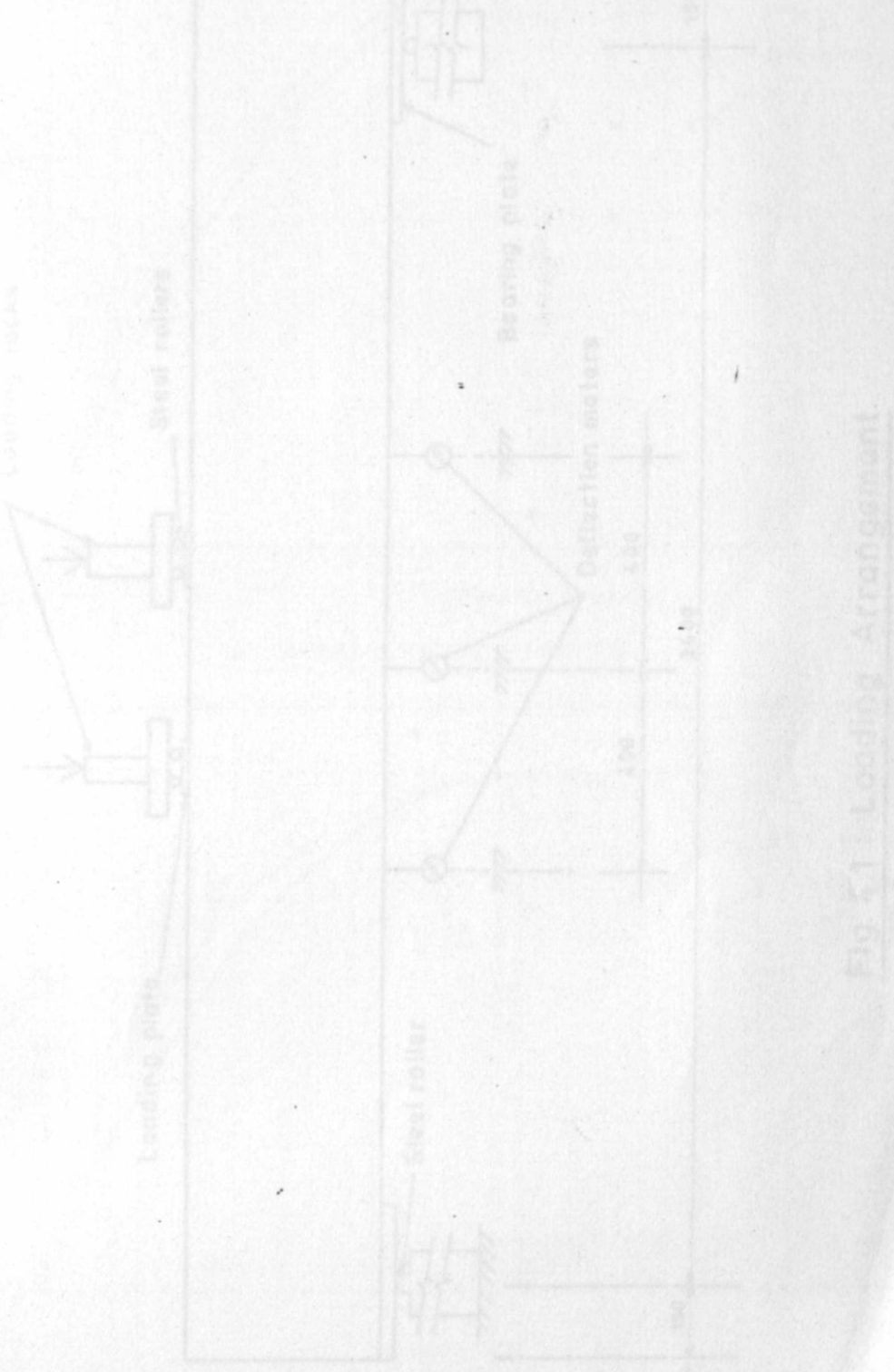
Using approximate material properties, the theoretical model was used to predict behaviour of the test specimen before the test. Approximate load levels were then decided at which loading would be

stopped and held for the purpose of strain readings.

All the initial strain readings were taken before loading was started. As a necessary check that these strains were correct, each of the strain readings was taken again before commencement of loading. The specimen was then loaded in steps guided by the predetermined intervals. After the longitudinal steel yielded, deformation of the beam as recorded by the deflection gauges was used as a criterion for the interval of reading of strains. This was continued until the beam failed.

A period of 30 to 40 minutes was spent at every load stage taking readings. The load was observed to fall slightly during this period. If the load fell by more than 10%, reading was stopped and the load adjusted back to the desired level before proceeding. However, in the post yield range, where the tendency was for the beam to continue deforming at a sustained load, the load was allowed to fall until a condition of equilibrium was achieved, by observing no further change in the deflection gauges. Appendix C gives a summary of the measured strains for all the beams. The moments are reported in kNm. It is useful to note here that the instruments available for measurement of loads and strains were calibrated in English units but the measured results are reported in metric units after the appropriate conversion. The loading

machine was calibrated in pounds per square inch while the demec meters were in inches per division.



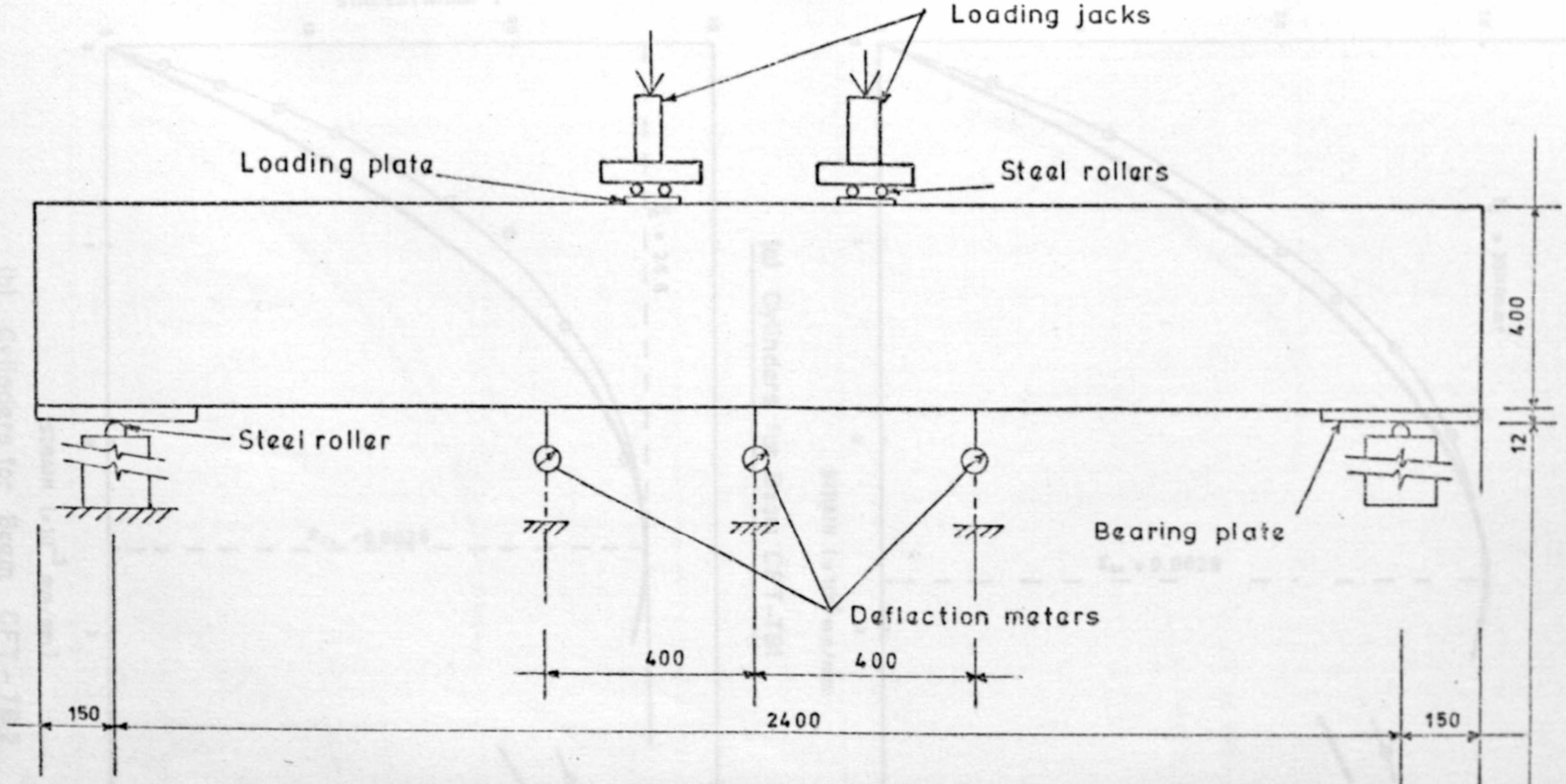
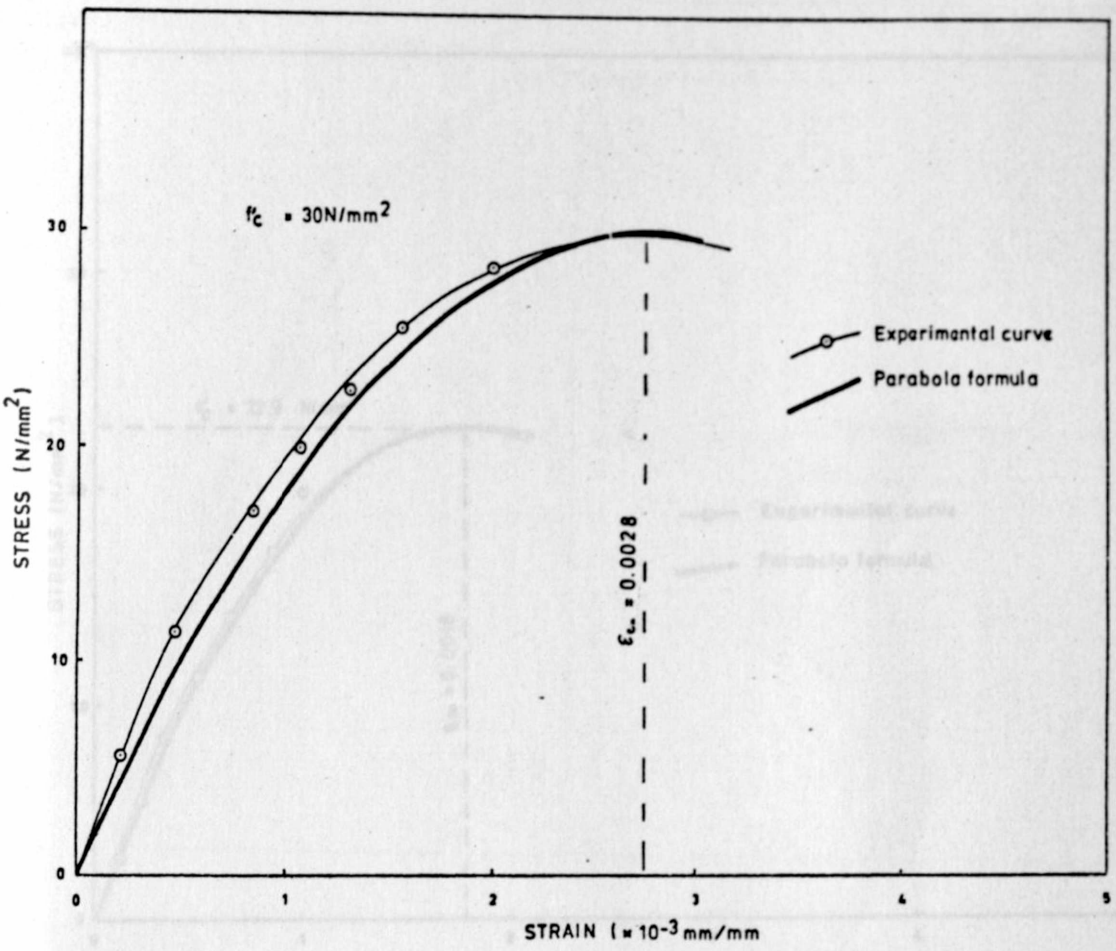
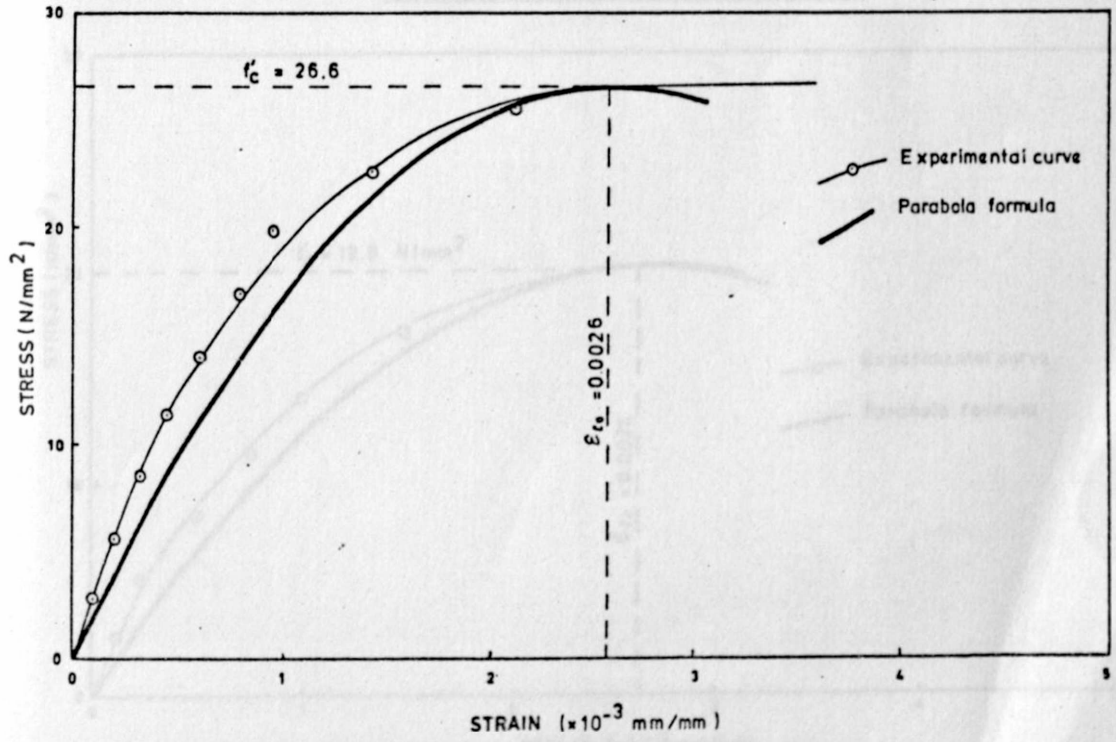


Fig. 4.1 : Loading Arrangement

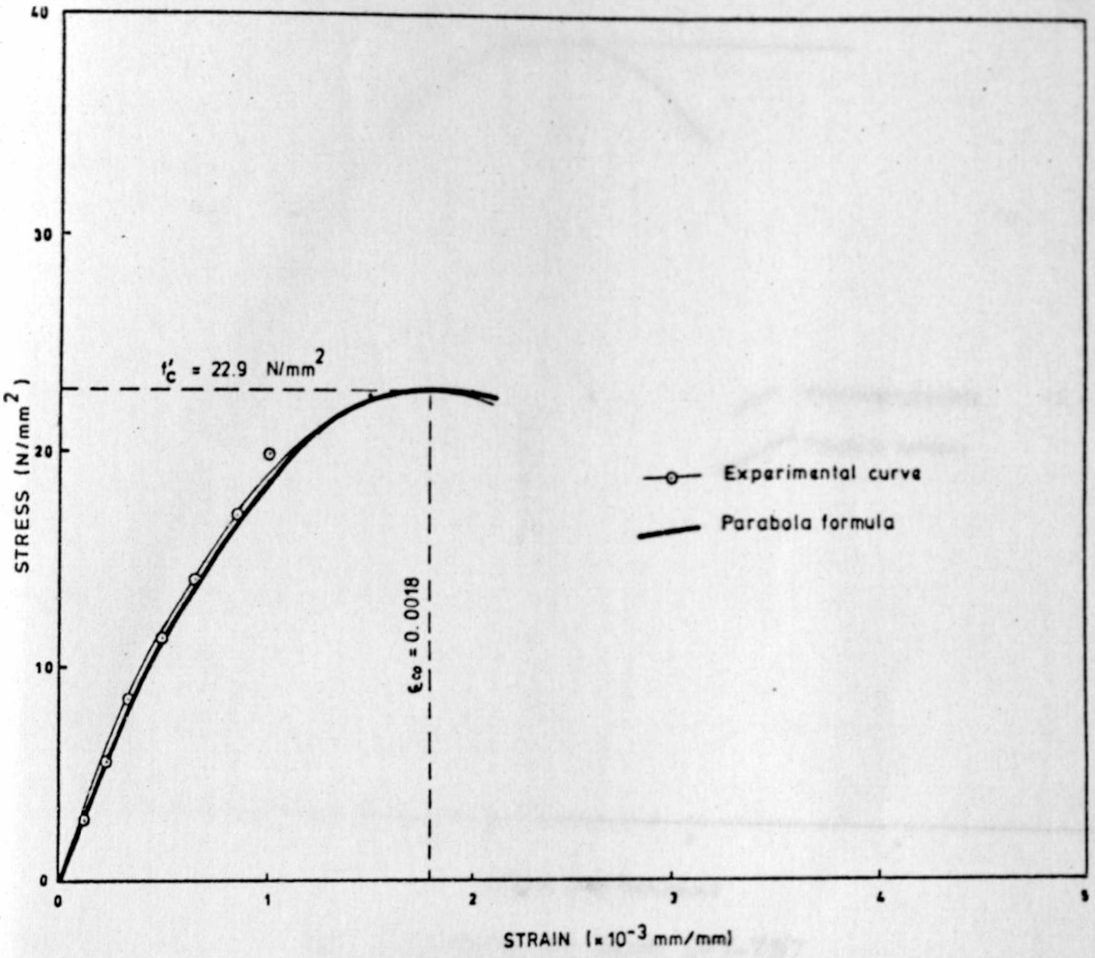


(a) Cylinders for Beam CFT-TB1

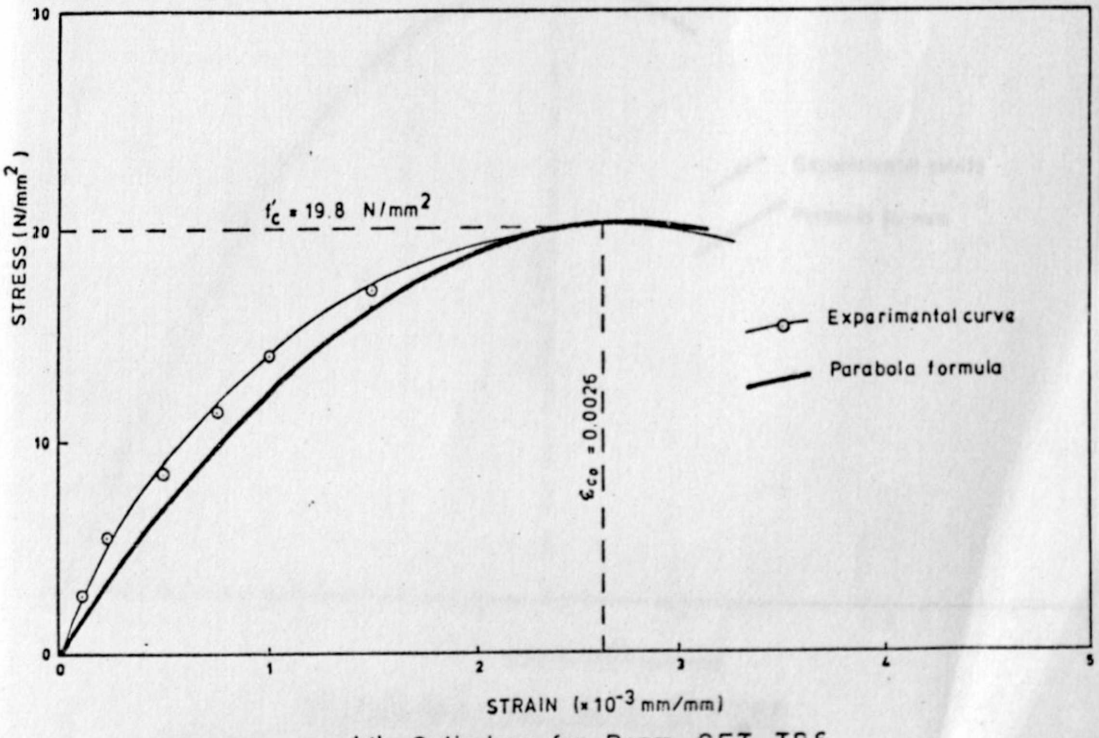


(b) Cylinders for Beam CFT-TB2

Fig. 4.2 : Concrete stress-strain Relationships

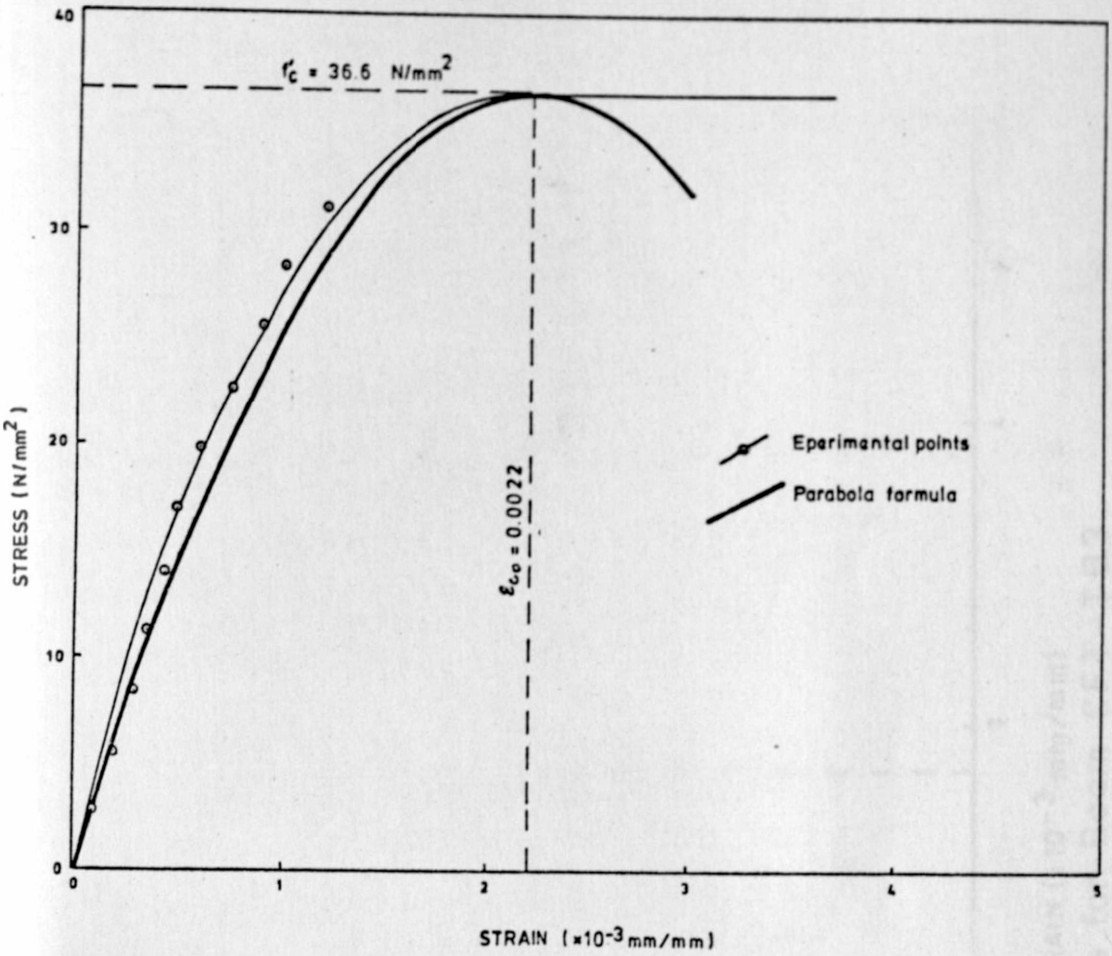


(c) Cylinders for Beam CFT-TB4

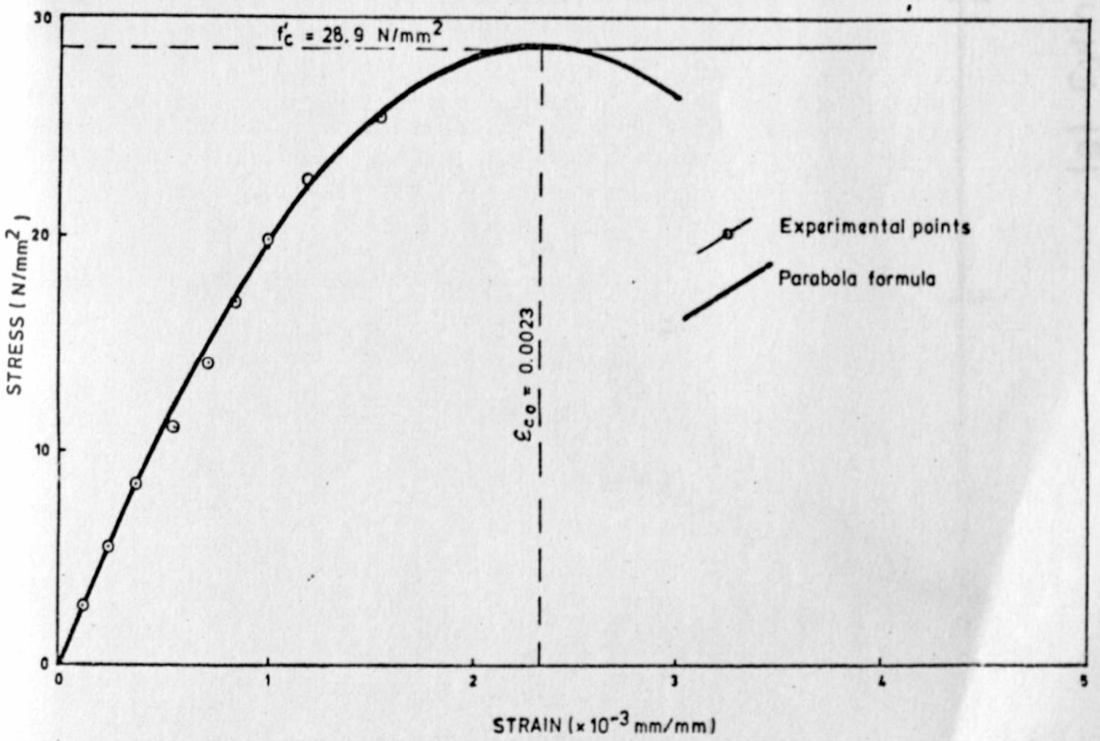


(d) Cylinders for Beam CFT-TB6

Fig. 4.2 : Concrete stress-strain Relationships

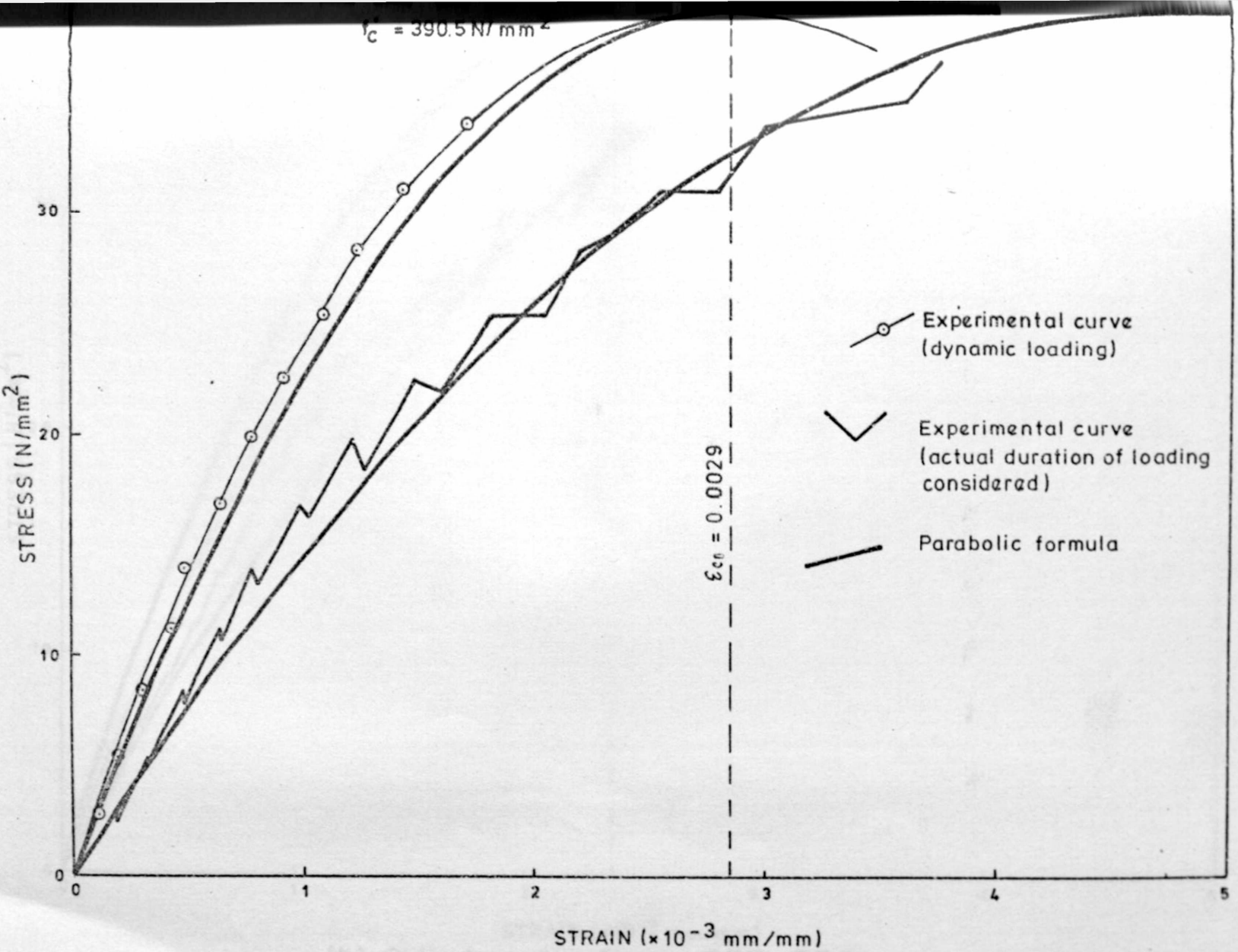


(e) Cylinders for Beam CFT-TB7



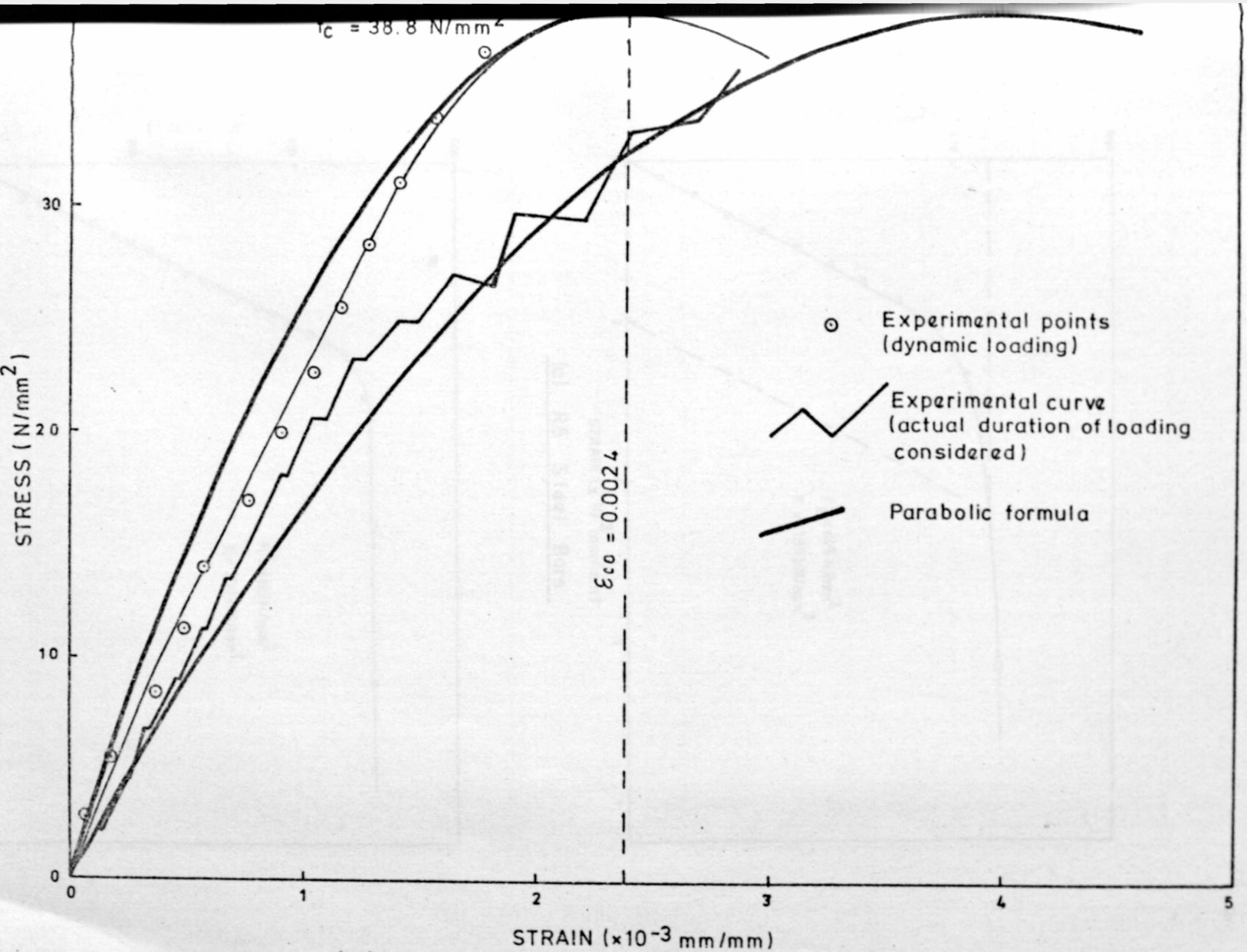
(f) Cylinders for Beam CFT-TB8

Fig. 4.2: Concrete Stress-Strain Relationships



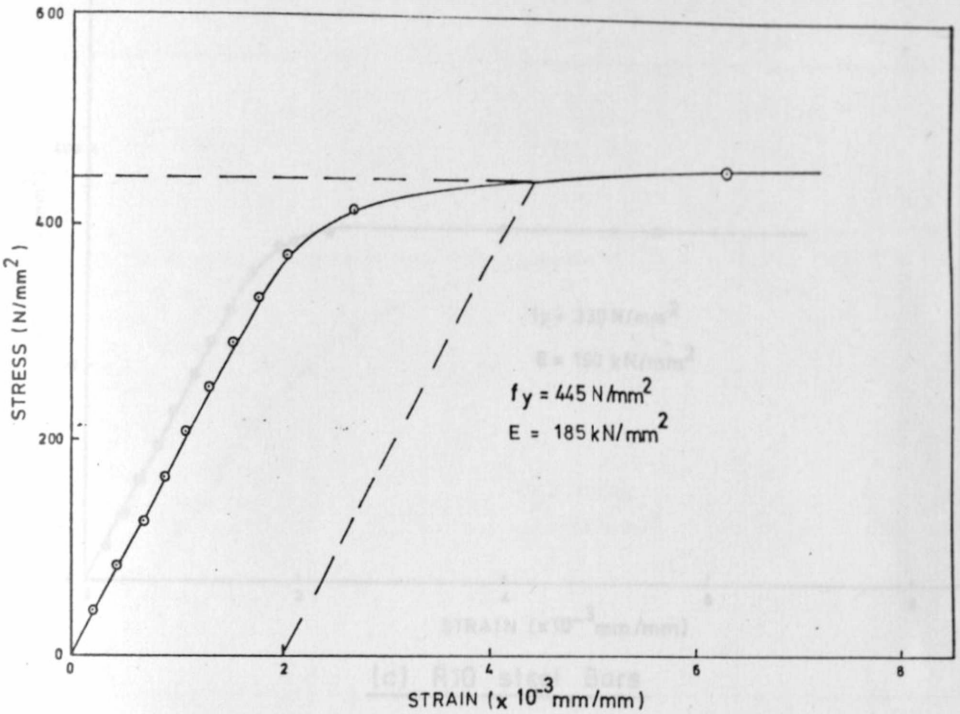
(g) Cylinders for Beam CFT-TB3

Fig. 4.2 : Concrete stress-strain Relationships

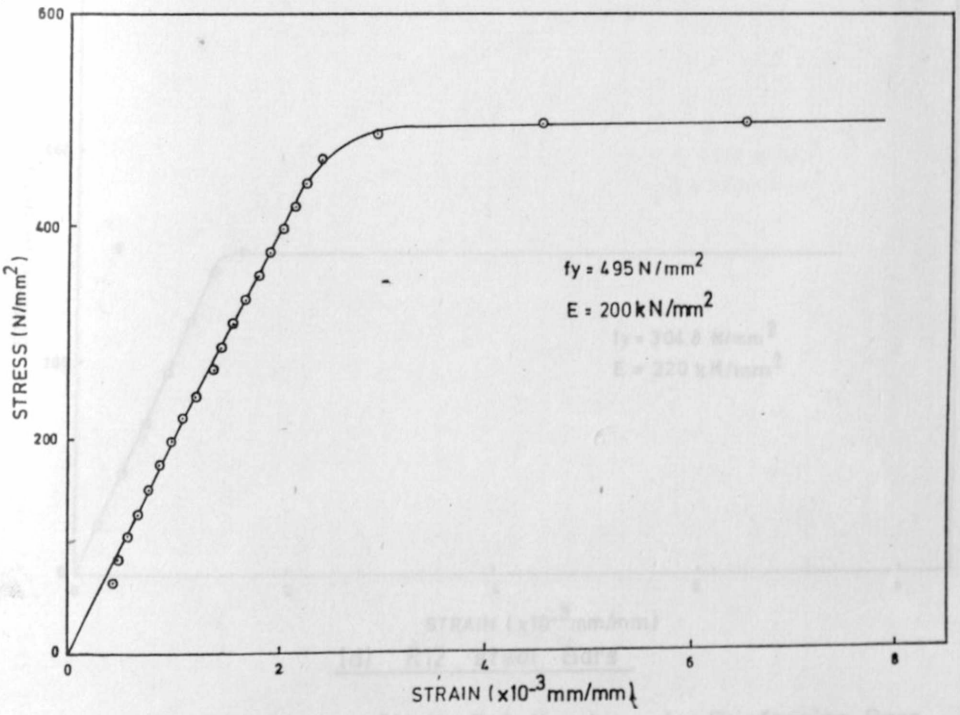


(h) Cylinders for Beam CFT-TB5

Fig. 4.2 : Concrete stress-strain relationships

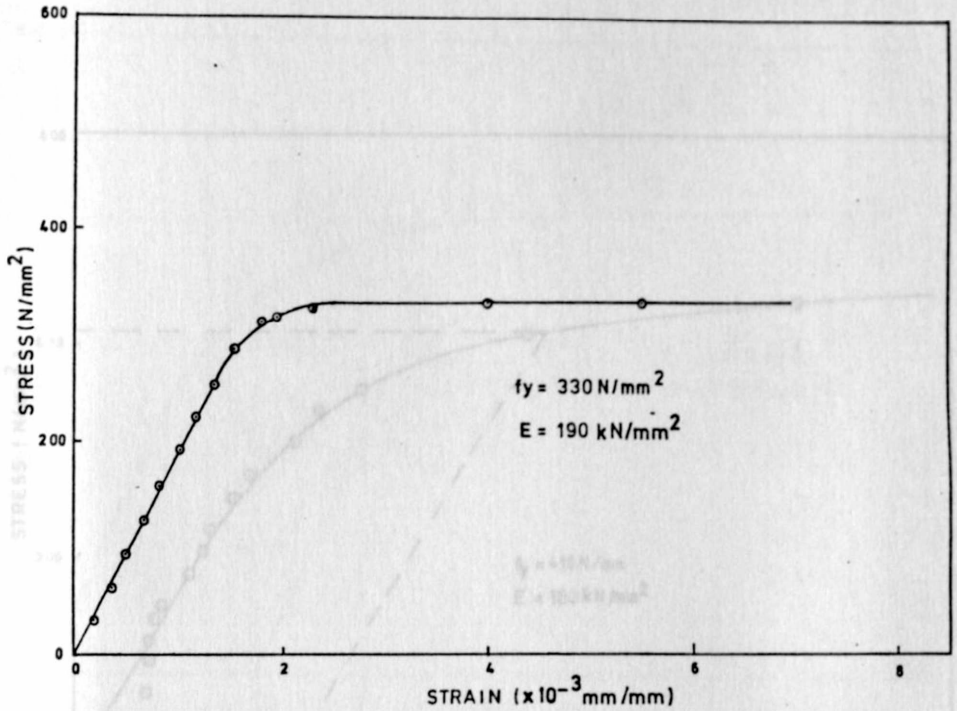


(a) R6 Steel Bars

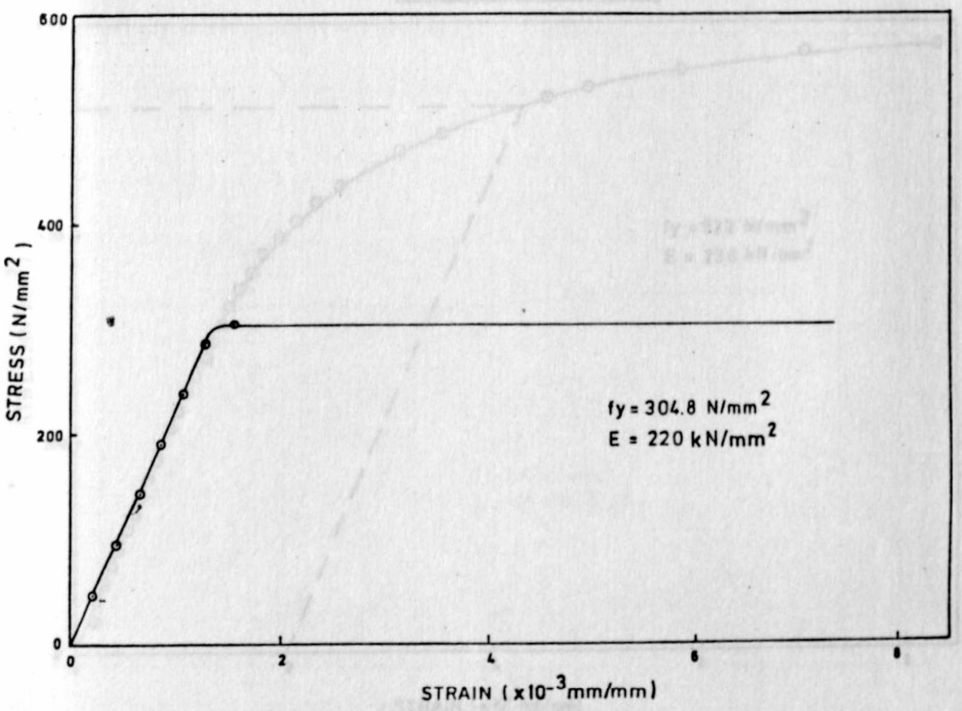


(b) R8 Steel Bars

Fig. 4.3 : Stress-Strain-Relationships for Reinforcing Bars

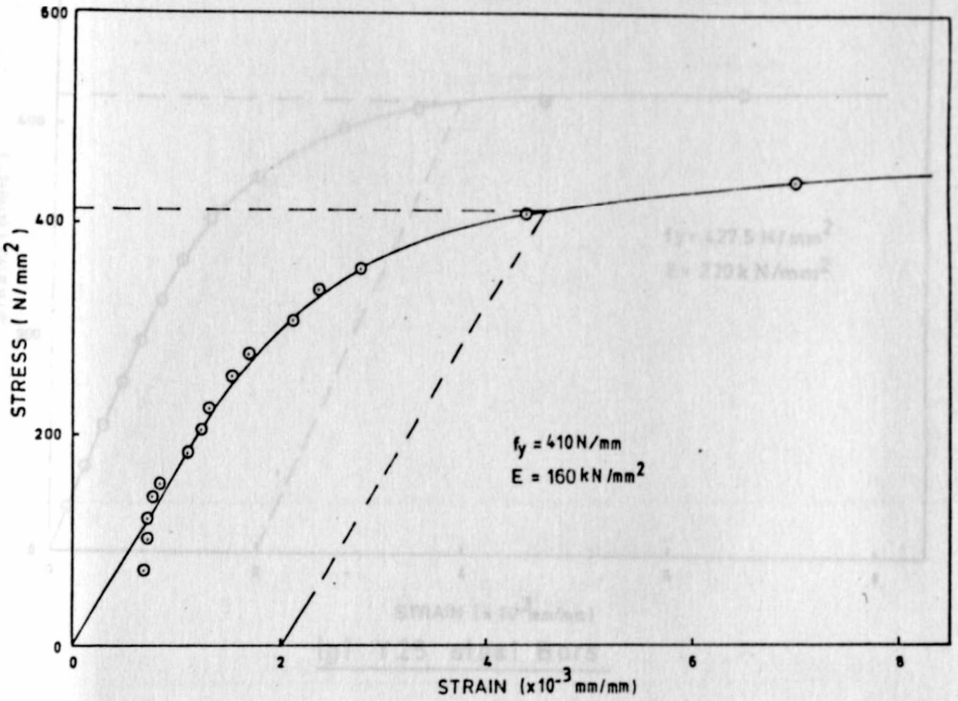


(c) R10 steel Bars

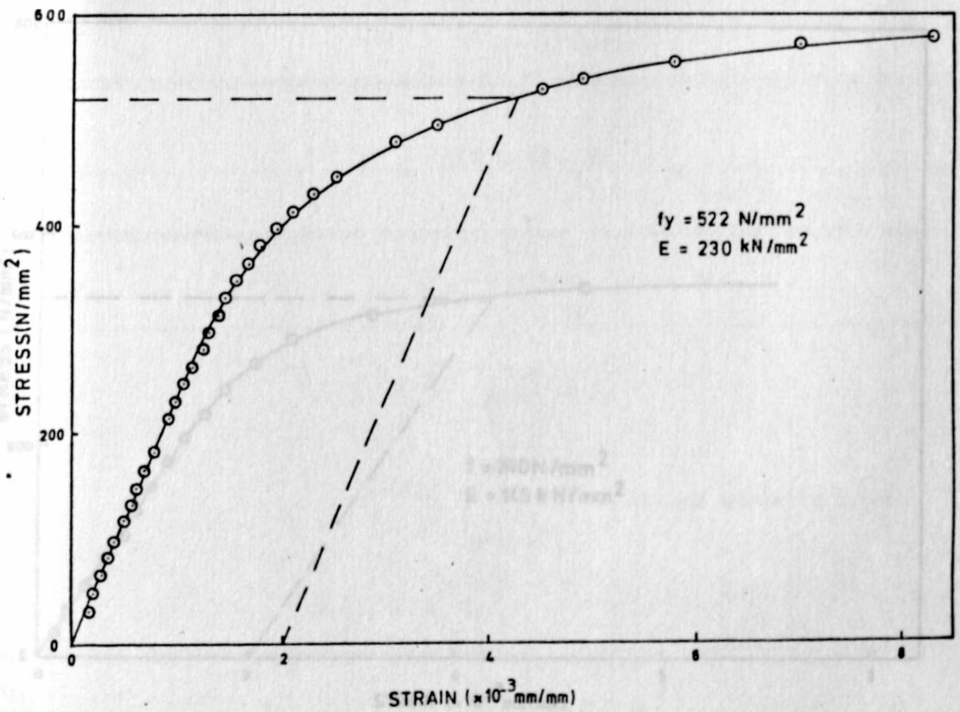


(d) R12 steel Bars

Fig. 4.3 : Stress - Strain Relationships for Reinforcing Bars

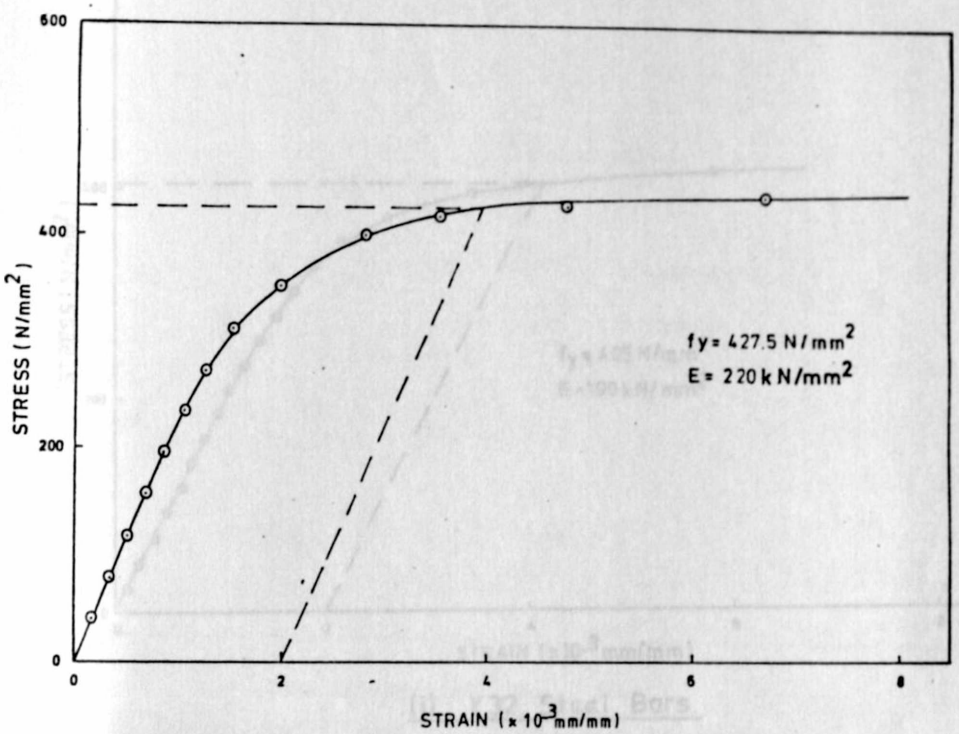


(a) Y10 steel Bars

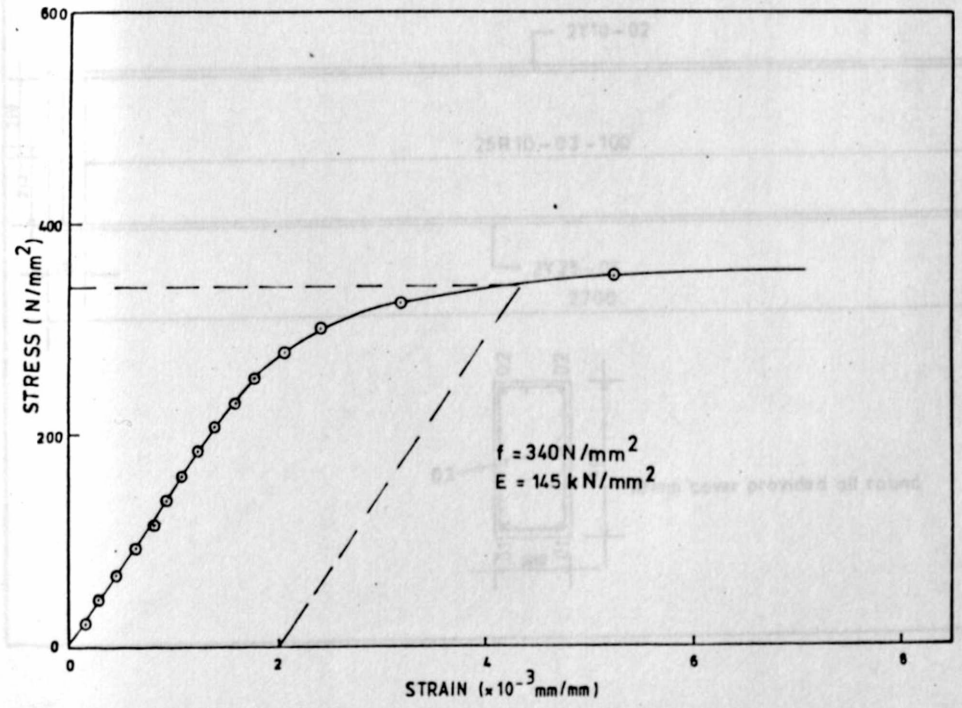


(f) Y12 steel Bars

Fig. 4.3 : Stress-Strain Relationships for Reinforcing Bars

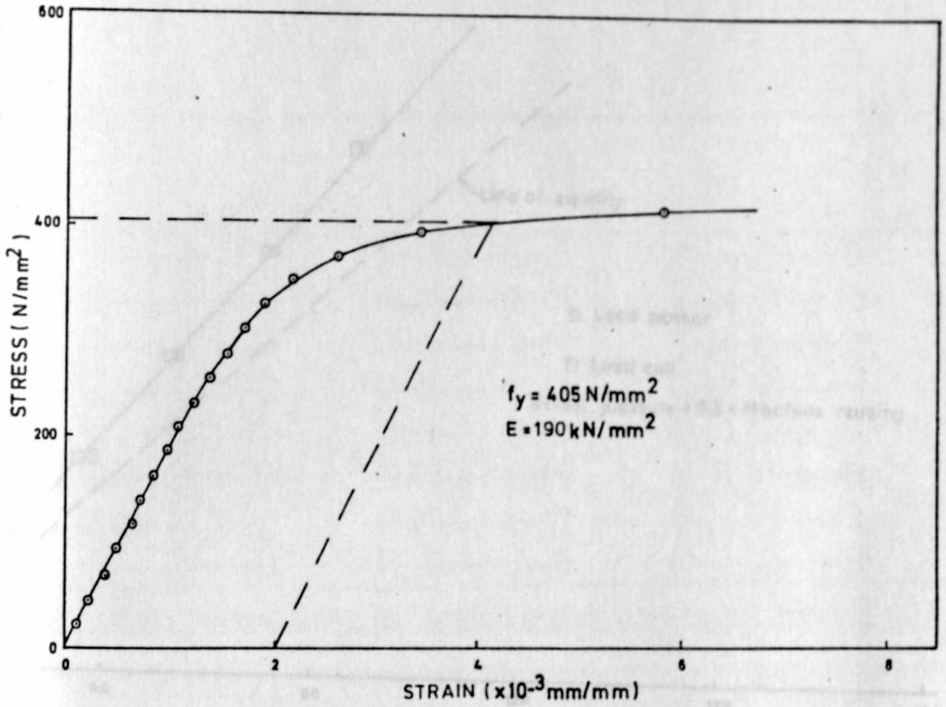


(g) Y25 steel Bars



(h) Y32A steel Bars

Fig. 4.3 : Stress-Strain Relationships for Reinforcing Bars



(i) Y32 Steel Bars

Fig. 4.3 : Stress-Strain Relationships for Reinforcing Bars

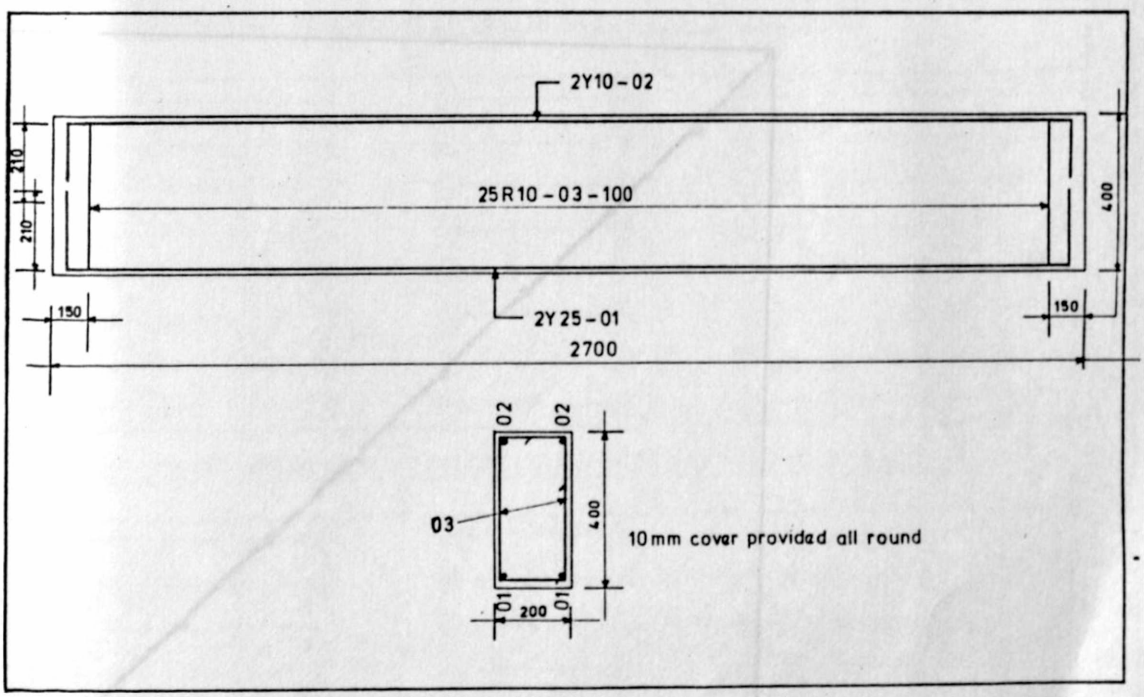


Fig. 4.4 : Typical Reinforcing Detail

(Bar sizes were varied for the various test specimens as shown in Table 4.1)

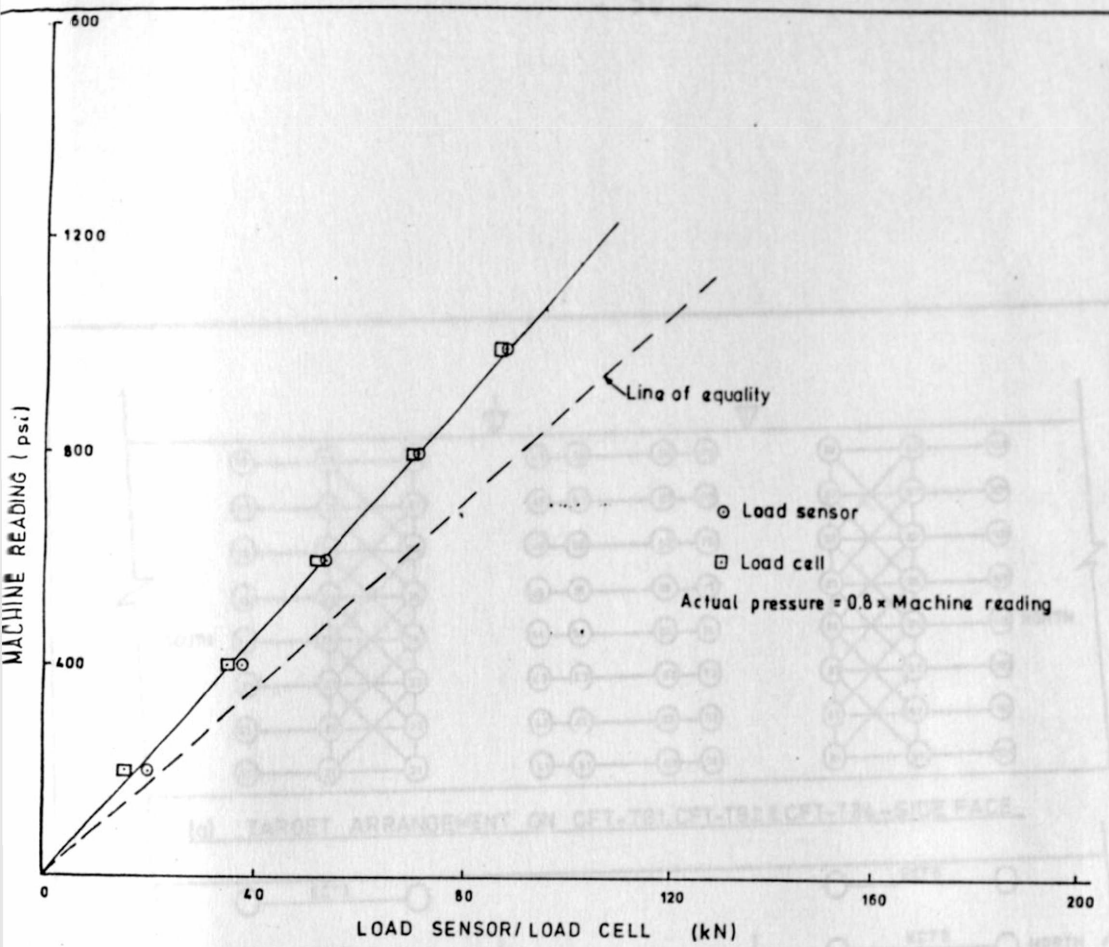


Fig. 4.5: Calibration of the Beam loading machine

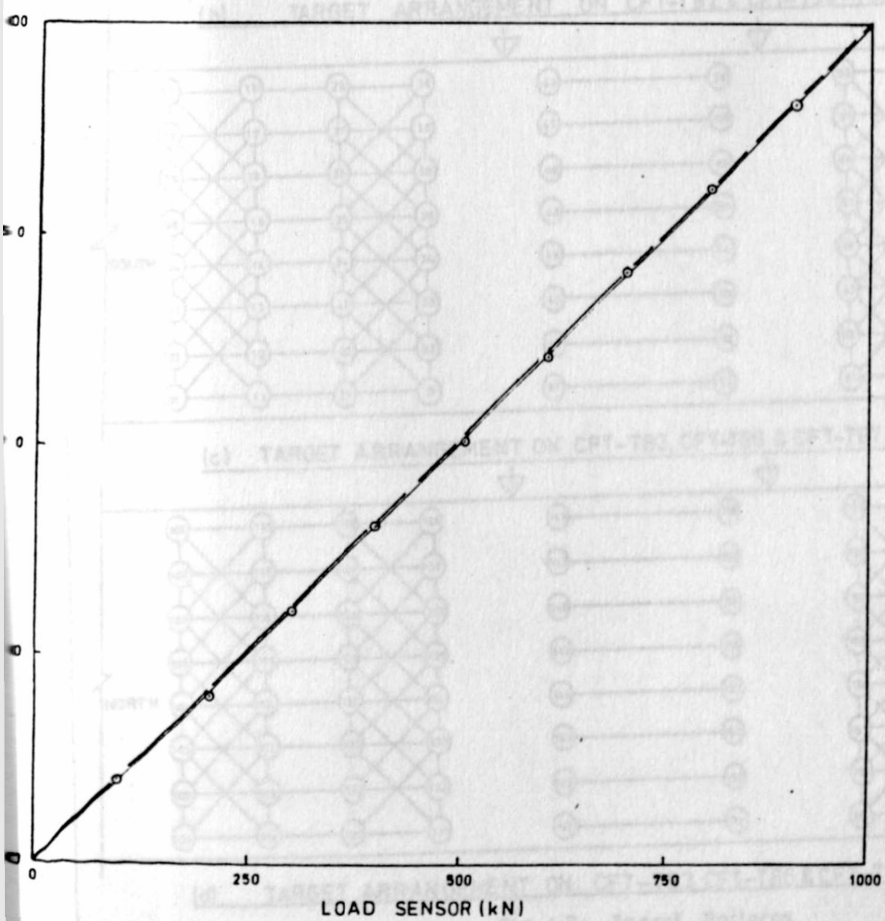
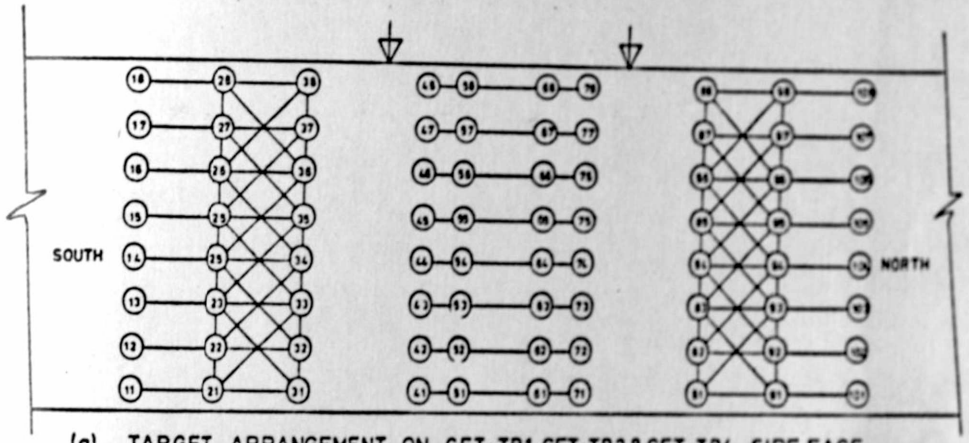
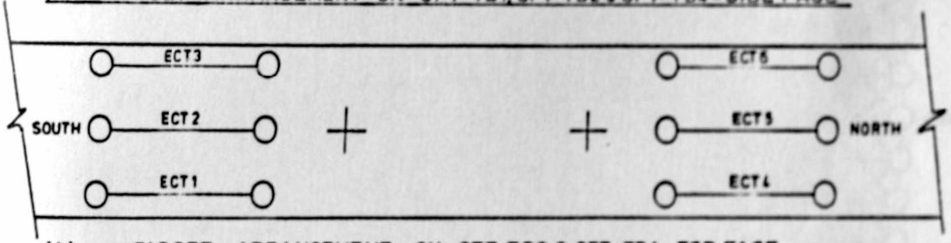


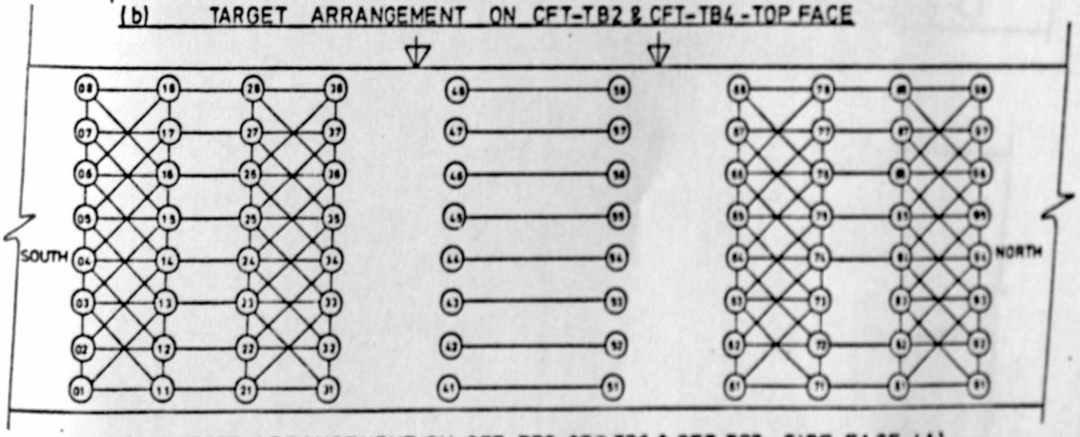
Fig. 4.6 Calibration of cylinder crushing Machine



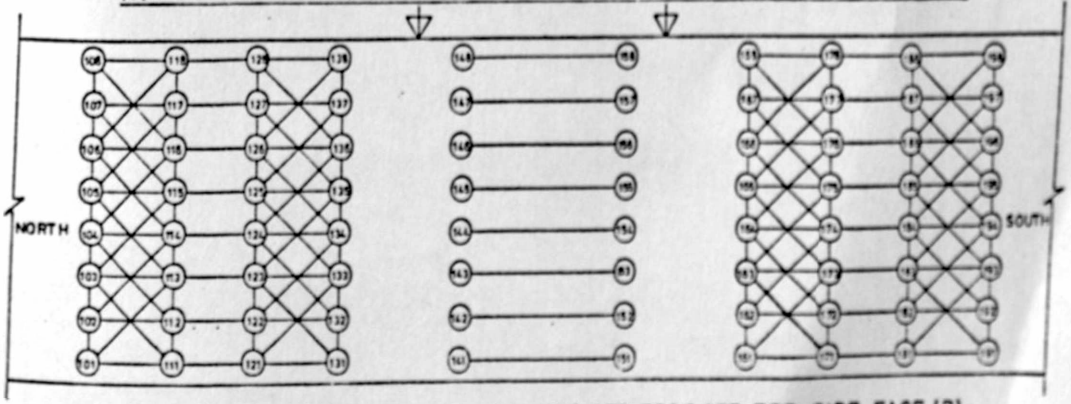
(a) TARGET ARRANGEMENT ON CFT-TB1, CFT-TB2 & CFT-TB4 - SIDE FACE



(b) TARGET ARRANGEMENT ON CFT-TB2 & CFT-TB4 - TOP FACE

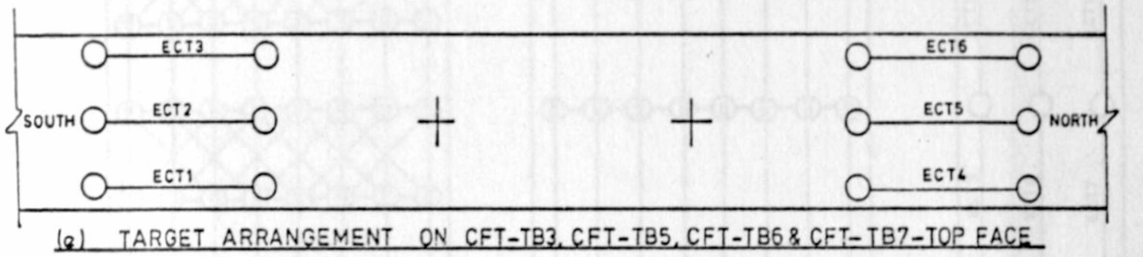


(c) TARGET ARRANGEMENT ON CFT-TB3, CFT-TB6 & CFT-TB7 - SIDE FACE (A)

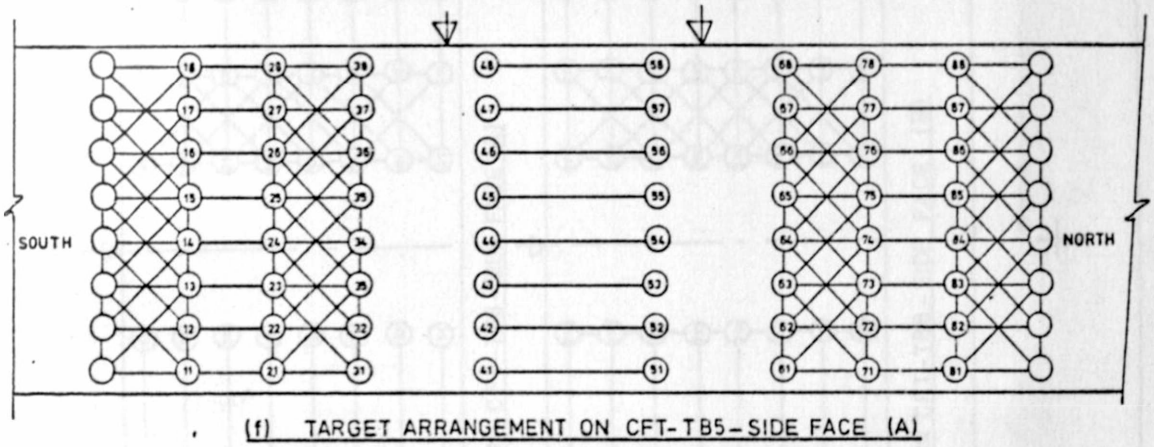


(d) TARGET ARRANGEMENT ON CFT-TB3, CFT-TB6 & CFT-TB7 - SIDE FACE (B)

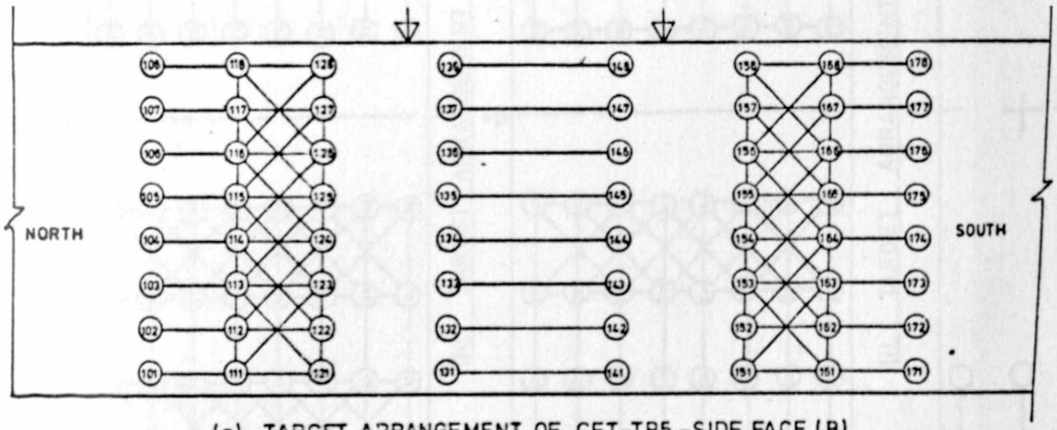
Fig. 4.7 : Target Patterns



(e) TARGET ARRANGEMENT ON CFT-TB3, CFT-TB5, CFT-TB6 & CFT-TB7-TOP FACE

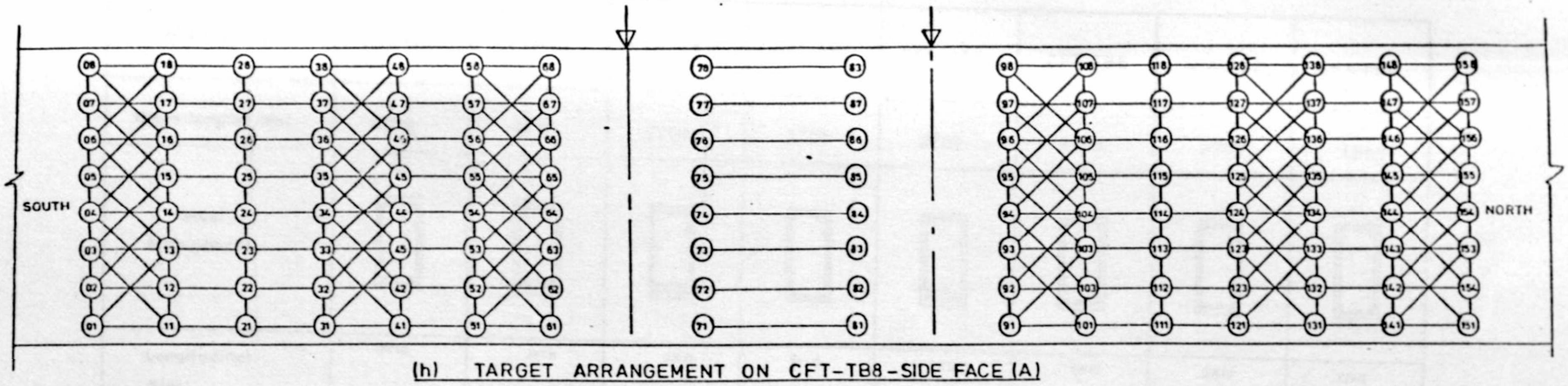


(f) TARGET ARRANGEMENT ON CFT-TB5-SIDE FACE (A)

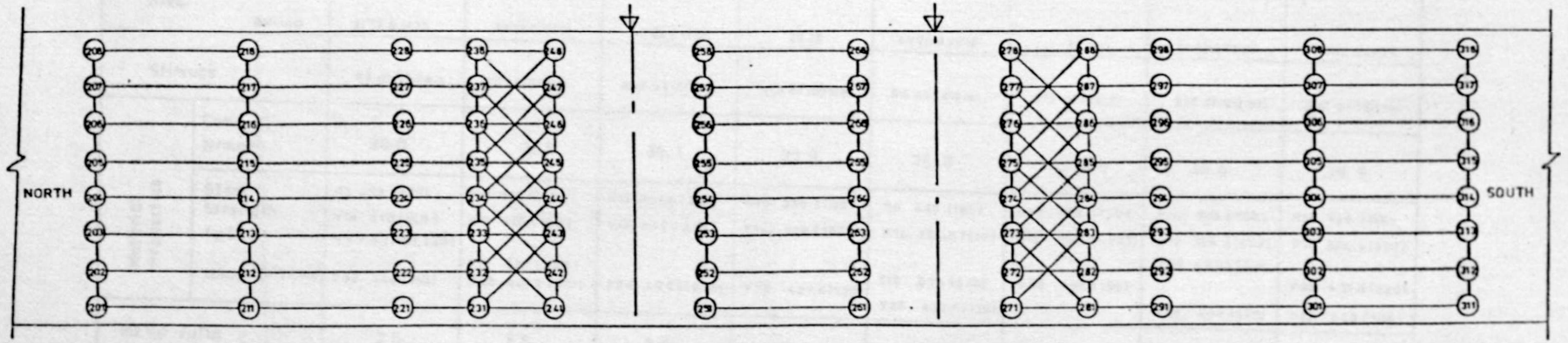


(g) TARGET ARRANGEMENT OF CFT-TB5-SIDE FACE (B)

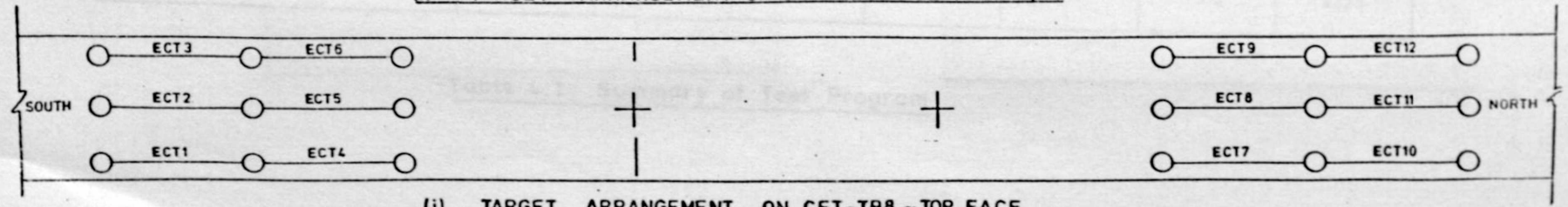
Fig. 4.7 : Target Patterns



(h) TARGET ARRANGEMENT ON CFT-TB8-SIDE FACE (A)



(i) TARGET ARRANGEMENT ON CFT-TB8-SIDE FACE (B)



(j) TARGET ARRANGEMENT ON CFT-TB8-TOP FACE

Fig. 4.7 : Target Patterns

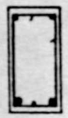
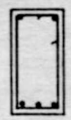
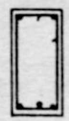
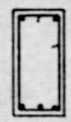
BEAM NAME		CFT-TB1	CFT-TB2	CFT-TB3	CFT-TB4	CFT-TB5	CFT-TB6	CFT-TB7	CFT-TB8
Beam length (mm)		2600	2700	2700	2700	2700	2700	2700	4000
Steel Arrangement									
Longitudinal Steel	Top	2Y10	2Y10	2R12	2Y10	2R12	2R12	2R12	2R12
	Bottom	2Y32 & 1Y25	4Y25 & 1Y12	4Y25 & 1Y12	2Y25	4Y25 & 1Y12	3Y32	2Y32 & 1Y25	2Y32 & 1Y25
Stirrups		R8 at 100mm	R10 at 100mm	R12 at 100mm	R10 at 100mm	R6 at 50mm	R10 at 100 m	R10 at 100mm	R10 at 100mm
Material Properties	Conc. f_c N/mm^2	30.0	26.6	39.1	22.9	38.8	19.8	36.6	28.9
	Steel Strength fy (E) N/mm^2(kN/mm^2)	R8 495 (200) Y10 410 (160) Y25 427.5 (220) Y32 340 (145)	R10 330 (190) Y10 410 (160) Y12 522 (230) Y25 427.5 (220)	R12 304.8 (220) Y12 522 (230) Y25 427.5 (220)	R10 330 (190) Y10 410 (160) Y25 427.5 (220)	R6 445 (185) R12 304.8 (220) Y12 522 (230) Y25 427.5 (220)	R10 330 (190) R12 304.8 (220) Y32 405 (190)	R10 330 (190) R12 304.8 (220) Y25 427.5 (220) Y32 405 (190)	R10 330 (190) R12 304.8 (220) Y25 427.5 (220) Y32 405 (190)
M/Vd ratio		2.5	2.5	2.5	2.5	2.5	2.5	2.5	4.125

Table 4.1: Summary of Test Program

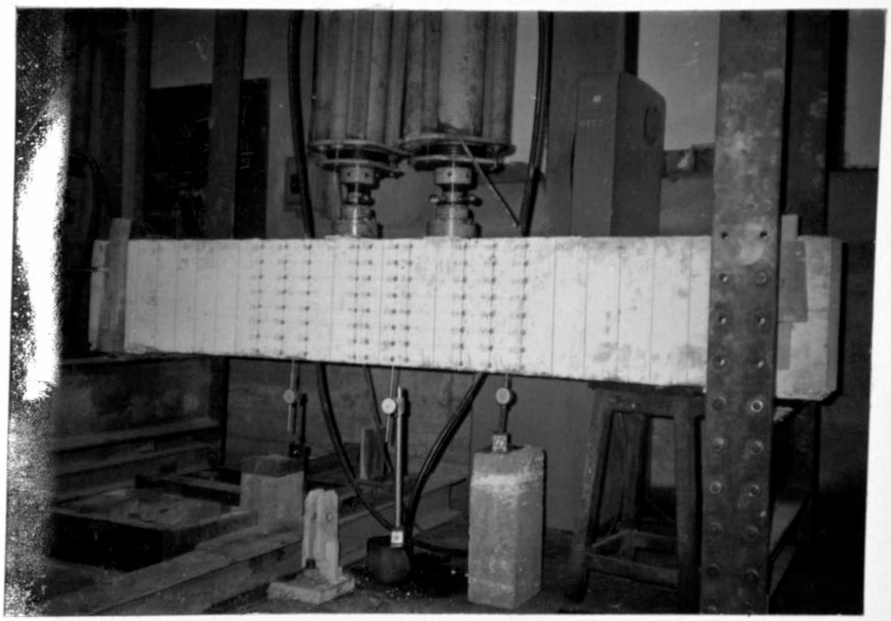


Plate 4.1: Initial Set up of Test Rig
(Notice the packing against
left hand side support)

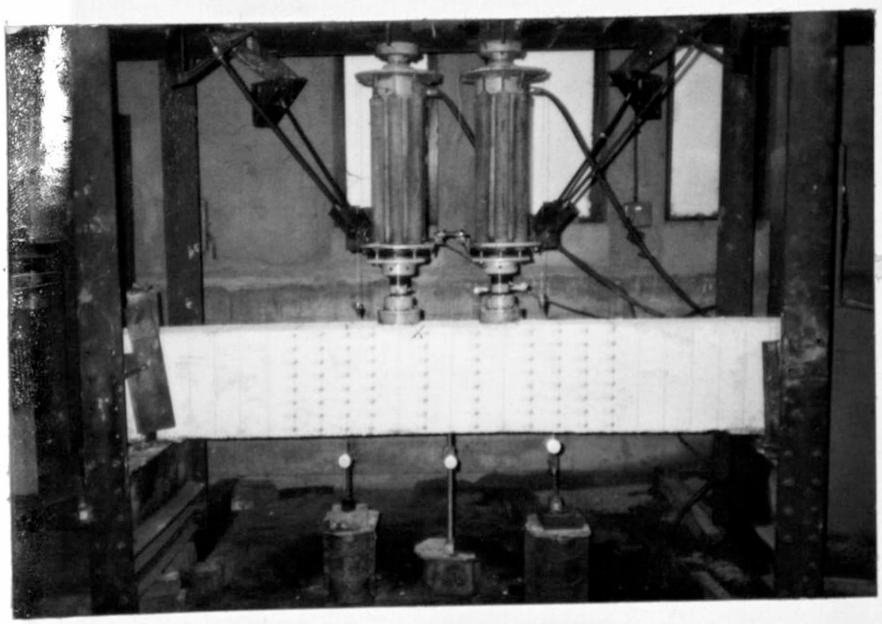


Plate 4.2: Revised Set up of Test Rig
(Notice introduced anchorage on jacks and
see revised proping of left hand side support
in plate 4.3)
(Notice also the plumb bobs)

Plate 4.3 : Anchorage of Support

(Notice the trussed square twisted bar)

CHAPTER 5

ANALYSIS AND DISCUSSION

A comparative study of the predictions of the theoretical model developed in Chapter 3 and the results of the experimental program reported in Chapter 4 is presented in this chapter. It is recalled that the parameters of the test program were the longitudinal steel content, the transverse steel content, the concrete strength and the $\frac{M}{Vd}$ ratio. These were chosen so as to test the validity of the trends indicated in Figures 3.7 to 3.9. In addition to these trends, other profiles involving the measured strains are studied. Where transverse and principal compression strains are plotted, the theory is plotted only in the region below the neutral axis since the model assumes that it is this region which is cracked.

To enable easy comparison of behavioral trends, the experimental results and the theoretical predictions are plotted side by side on suitable graphs. Before these comparisons are made, the observed behaviour of test specimens and the limitations of the test specimens and testing equipment are presented.

5.1 Behaviour of Test Specimens

All the test specimens, except beams CFT-TB1 and

CFT-TB6 failed by crushing of concrete in flexure in the region between the loads. The tests for all these beams failing in flexure were completed within a day except for beams CFT-TB5 which was unloaded at a load stage of 249.7kN after the rods used in anchoring the test rig bent. The testing for this beam was resumed seven days later after the test rig was upgraded to the state described in chapter 4. Plates 5.1 to 5.6 show the typical trend for beams which failed in flexure.

Beam CFT-TB1 had a typical shear failure. On the first day of the test, testing was stopped after spalling occured at one of the supports premature to the beam failure. The spalled end was reclaimed by means of concrete mortar and in addition, 300mm x 300mm x 12mm seating plates were used at each of the supports. The beam was tested to failure seven days later. Some of the stages of loading are shown in plates 5.7 to 5.11.

As shown in plate 5.12, beam CFT-TB6 had bond failure.

The mode of cracking was observed to be generally the same for all the test specimens. Flexural cracks, which are practically vertical, formed first. As the load was increased, these developed into inclined cracks. The spacing of the cracks in the longitudinal direction varied from about 100mm in the regions near the load to more than 200mm towards the supports.

Vertical stirrups rarely had more than three inclined cracks crossing them and most of the cracks did not extend beyond the surface 150mm from the top face. These crack patterns can be observed in plates 5.1 to 5.3

5.2 Limitations of Test Specimens and Testing Equipment

It is assumed, in the development of theory that the model is uniformly cracked and that the cracks are closely spaced in the region below the neutral axis. The description of the test specimens in the last section shows that uniform cracking assumed in the theoretical model did not take place for the specimens tested. With only very few cracks some of the gauge lengths for measurement of strains did not cross any cracks. However, for analysis, average strains evaluated in a manner shown in Appendix C were used. The averaging of strains was assumed to minimise the local effects due to the sparse cracking.

The stress picture of the prediction model is assumed to be free from any localised stress concentration effects which occur at and around loading and reaction points. According to Saint Venant's Principle the complex stress condition resulting at such load transfer points can be considered to be confined to the region within a radius equal to the effective depth of the beam as illustrated in Figure 5.1. Due to the

size of the test specimens, which was limited by the available testing facilities, some of the gauge lengths extended into such regions. However, these localised effects are more severe at the load transfer point and less severe towards the boundaries of these described regions and it is assumed that in the chosen gauge lengths (see Figure 4.7) extreme effects of stress concentrations are avoided. Moreover, it was of interest to find out how well the response of a specimen with stress concentrations is predicted by the compression field theory.

The strains were obtained by means of mechanical demec meters. These were calibrated in inches per division with one division equivalent to 0.0001 inches. Readings were taken to the nearest one division. The possible error in readings due to these meters was computed based on repeated readings over a given gauge length using the meters. These readings showed that an error of ± 2 divisions could occur when the meter is held steadily on the target points. This means an error in the measured strains of upto $\pm 0.05 \times 10^{-3}$ for the 4 inch gauge lengths $\pm 0.025 \times 10^{-3}$ for the 8 inch gauge lengths and $\pm 0.044 \times 10^{-3}$ for the 4.56 inch gauge lengths is possible. For a beam with bottom longitudinal steel yield strain value of 2.3×10^{-3} the respective errors that can occur at yield expressed as percentages are ± 2.2%, ± 1.1% and ± 1.9%. These percentages are larger at lower strains.

The loading jacks were calibrated as explained in Chapter 4. The loads were read to the nearest 5psi (0.45KN) in units of pressure and the equivalent load in metric units obtained from the calibration curve. The final load used is subject to errors that arise from determining the calibration curve and reading the loads. Using the graph of Figure 4.5, an average error of about ± 3.75% is estimated.

5.3 Transverse Strains Profiles and Principal Compression Strains Profiles.

The experimental average transverse strains at six levels in the section were obtained from the measured strains as illustrated in Appendix C. The six levels were 50mm apart, the first and the sixth being 75mm clear of the edges. As already noted, theoretical predictions for transverse and principal diagonal strains were restricted to the region below the neutral axis. Typical transverse strains profiles are plotted in Figure 5.2.

The experimental average principal compression strains are computed based on Mohr's circle of compatibility of strains by a method developed by Onsongo (1978) and included in Appendix C. Average values of the measured strains are used and plots similar to those for average transverse strains profiles are given in Figure 5.3.

As expected, it is observed from Figures 5.2 and 5.3 that for both theoretical and experimental trends, the strains increased with load. For transverse strains, the increase was greatly accelerated after the yield of transverse steel. However, although theory predicts that for a given load the strains are consistently largest at the bottom of the section decreasing towards the neutral axis, the experimental plots do not exhibit a similar pattern. In the later case, higher strains at rows other than the bottom level are observed.

Observation of the test specimens revealed that the variation of strains was related to the crack patterns. Rows with high strains were those in gauge lengths crossed by cracks. As shown in Figure 5.2, the transverse strain values in the uncracked region above the neutral axis are low. Although a complete picture requires observation of both faces of the beam, due to the process of averaging, this effect of the crack distribution can also be studied by observation of Plates 5.1 to 5.12 and also Plates C.1 to C.5

The trend of low transverse strains in uncracked concrete is expected. It is likely that the experimental strain profiles were affected by the distribution of cracks and that these differed from the theoretical predictions because specimens were not uniformly cracked.

However, looking at Figures 5.2 and 5.3, for any given load, it is observed that the maximum strains in the section predicted by theory is comparable to the maximum average strain from experiment with the predictions being generally higher than the measured values.

5.4 Longitudinal Strains Profiles

Using the assumed linear variation, prediction of longitudinal strains is possible over the entire section given the extreme compression fibre strain and the depth to the neutral surface. The experimental and theoretical plots are presented in Figures 5.4 and 5.5, average longitudinal strains having been obtained from measured strains as shown in Appendix C.

In Figure 5.4, the profiles from experiment from a region of combined flexure and shear are compared to those from a region in pure flexure. A linear regression analysis of the experimental data plotted in Figures 5.4 and 5.5 yields correlation coefficients close to 1 which are denoted r in the figures. The comparable nature of plots in Figure 5.4(a) and (b) and computed correlation coefficients show that the assumption plane sections remain plane provides a good approximation of the strain profiles.

In most of the plots in Figures 5.4 and 5.5, the experimental strains tended to be higher than the

predicted strains. However, the difference hardly exceeds 5% of the predicted values.Considering the limitations of the test specimens and the testing equipment already discussed, in particular local effects and errors due to testing equipment, the strains obtained from experiment and theory are quite comparable. It is also noted that near failure, where errors due to equipment tend to be minimised and the cracking is more, the theory predicts larger strains than measured over most of the sections.

5.5 Shear Force - Shear Strain Relationships

Typical shear force - shear strain relationships are plotted in Figure 5.6. The maximum shear strains were obtained by use of equation (3.18). The experimental response corresponds to average strains at row 2 of Target Patterns given in Figure 4.7 while the theoretical prediction is done at the bottom longitudinal steel level which gives the maximum value of maximum shear strain. Row 2 was chosen because it gives maximum values of the maximum shear strain in most cases; (see Figure 5.7). Although row 4 gives the maximum values in some cases, they do not differ very much from those given by row 2 (see typical plots of shear strain variation in Appendix C).

Figure 5.6 shows that the predicted and the experimental trends of shear force - shear strain

are the same. For any given load, the predicted shear strains are generally greater than those obtained from experiment showing that the theory predicts shear strains conservatively.

5.6. Shear Force-Angles of Principal Compression Relationships

The experimental angles of principal compression were deduced from measured strains using Mohr's circle (see Appendix C). Typical relationships are plotted together with the theoretical predictions in Figure 5.8

There is good agreement between the trends exhibited by predictions from theory and those deduced from experiment; angles decrease as we move from the bottom level up the section. Comparing experimental and predicted angles at the bottom level, the experimental angles are found to be greater than the predicted ones (Figure 5.8 (a))by as large a factor as 1.5 in most cases. However, there was comparable agreement in a few cases (Figure 5.8 (b)). One possible explanation of the results of Figure 5.8 (a) may be that the angles were deduced from the longitudinal strains, transverse strains and principal compression strains using equation (3.16) which is non linear. The effect of non uniform cracking on the individual strains has been noted. Combination of these strains in the equation mentioned above is likely to have

affected the angles of principal compression strains to cause the observed difference. The plots of Figure 5.8 (b) were obtained from beam CFT-TB8 in a region that had inclined cracks and considered free from local effects as defined by Figure 5.1. The capability of the theory in predicting trends is, however, shown.

5.7 Moment-Curvature Relationships

Some of the moment-curvature relationships determined for the test specimens are compared with theoretical predictions in Figure 5.9. The trends for theory and experiment are observed to be similar.

It is noted that the moment-curvature relationships were plotted for a given section on the beam. The theory assumes that the section under prediction is loaded to ultimate capacity. This was not the condition on the test specimens as failure occurred in one region only, typically in the central region with pure flexure. However, with the exception of the plot for beam CFT-TB6 in Figure 5.9 (d), the typical plots of Figure 5.9 show that the theory predicts ultimate loads well and conservatively. As has been noted in section 5.1, beam CFT-TB6 had local bond failure before the expected capacity load was reached.

5.8 Response with Varying Material Properties and Loading Condition

Figures 3.7 to 3.9 were obtained by varying

material properties and loading conditions for a chosen beam section. Similar plots for the test specimens are presented in Figure 5.10. It is, however, noted that a strict control on concrete strength could not be achieved for the test specimens. Table 4.1 also reveals that the modulus of elasticity and the stress at yield varied from one bar size to another for both mild and square twisted steel. This is a factor not considered in the development of Figures 3.7 to 3.9 where steel contents were varied with the modulus of elasticity and the stress at yield assumed constant.

Figure 5.10(a) presents the trends for varying longitudinal steel content, other parameters being nearly constant. The general trend of curves from experiment and theory are in agreement.

Comparing the plot of beam CFT-TB2 in Figure 5.10(a) and that of beam CFT-TB8 in Figure 5.10(b), it is seen that the predicted relationship is confirmed; there is an increase in moment capacity for an increase in $\frac{M}{Vd}$ ratio, other parameters being held constant.

In Figure 5.10(c) variation of transverse steel content is considered. The general trends are observed to agree well. The displacement of beam CFT-TB5 above CFT-TB3 at ultimate is likely due to the fact that the test for beam CFT-TB5 was done on two

separate days leading to a change in concrete strength.

Figure 5.10(d) shows good agreement in predicted and experimental trends for varying concrete strength, other parameters being held constant.

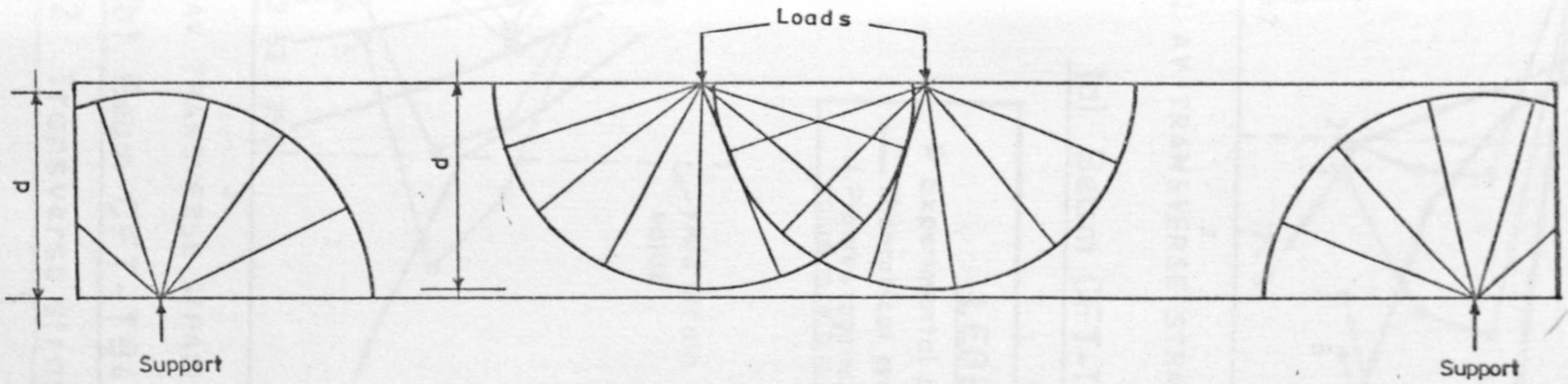
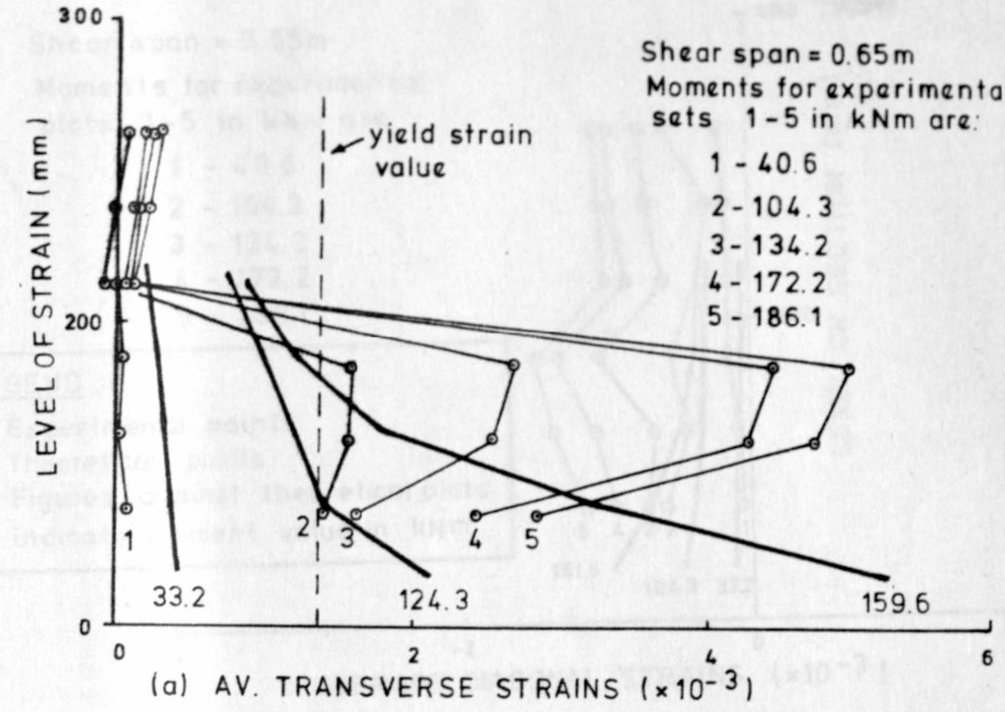
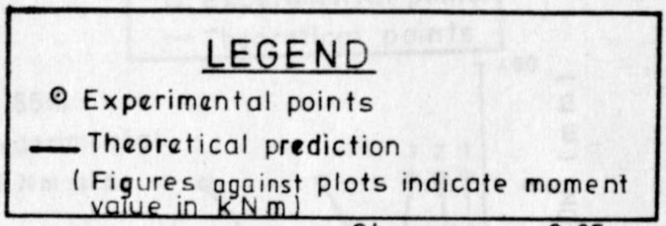
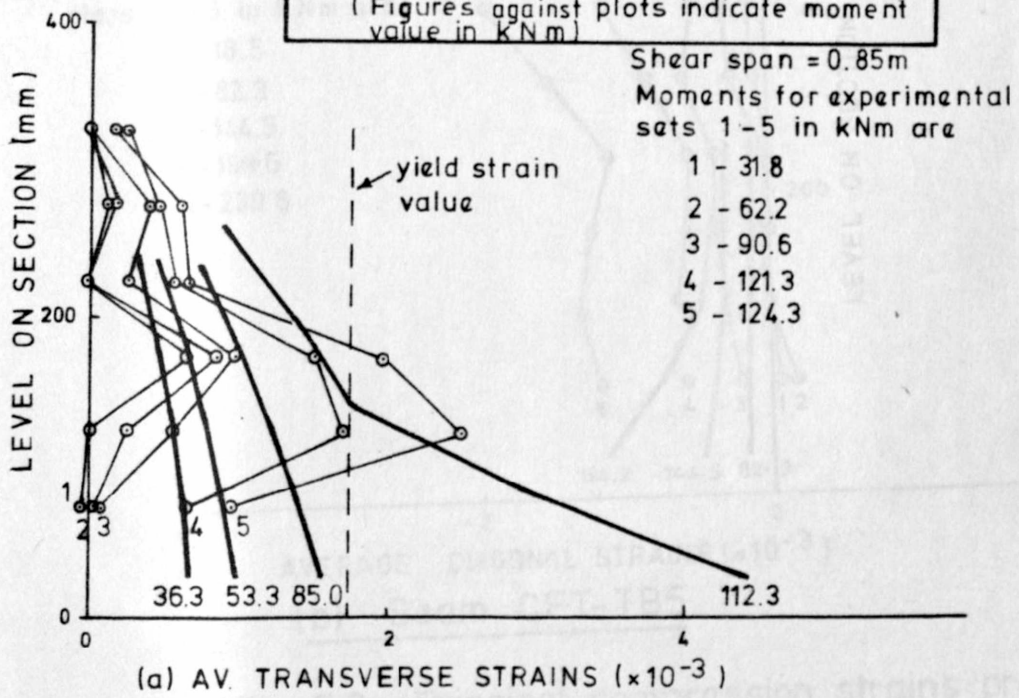


Fig. 5.1 : Stress concentrations
(Shaded regions indicate areas affected by local effects)



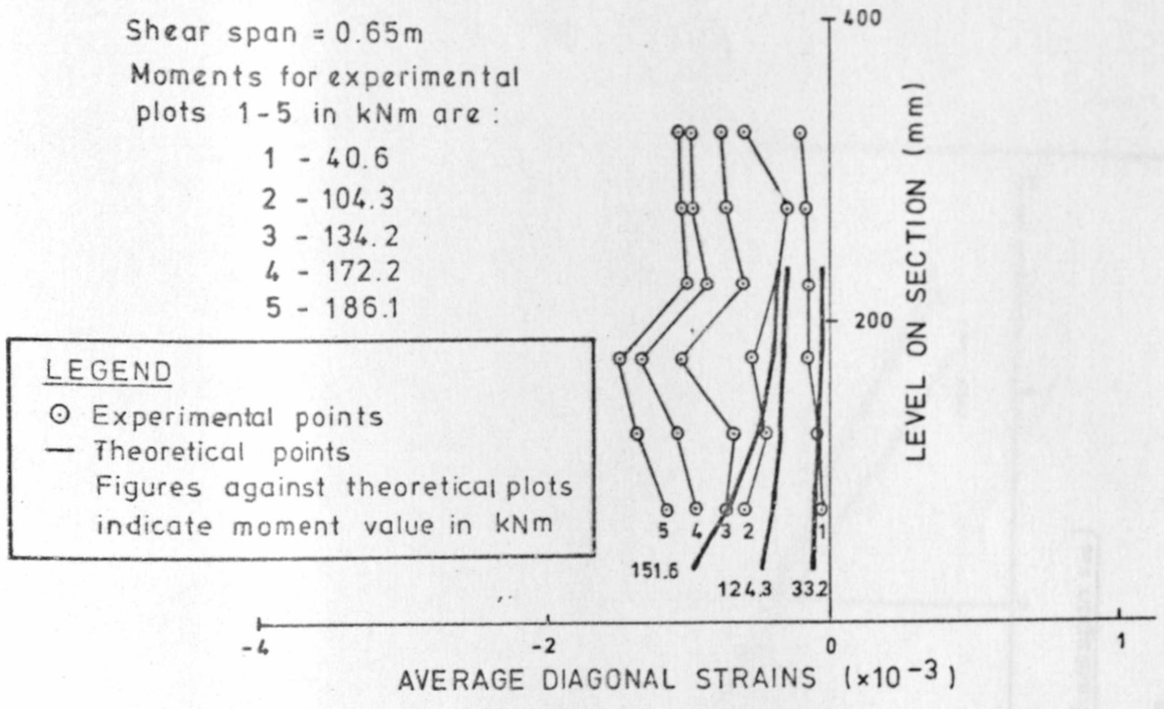
(a) Beam CFT-TB3



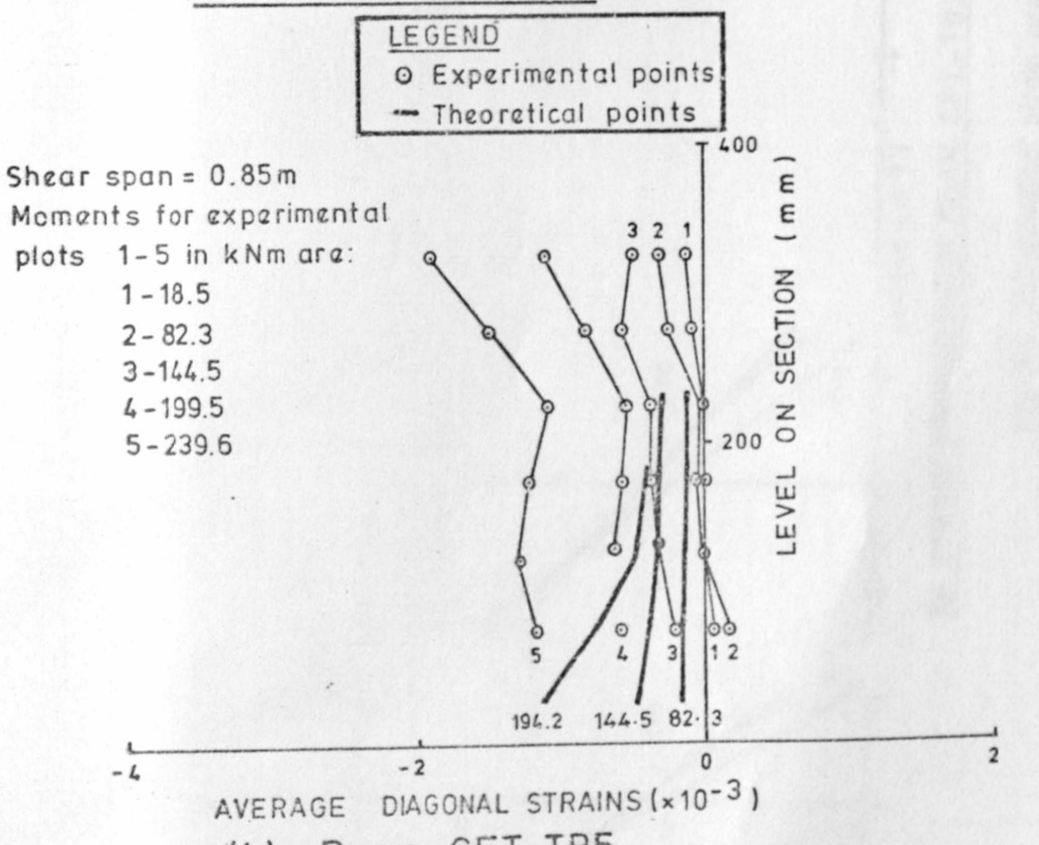


(b) Beam CFT-TB4

Fig. 5.2 : Transverse strains profiles



(a) Beam CFT-TB3



(b) Beam CFT-TB5

Fig. 5.3 : Principal compression strains profiles

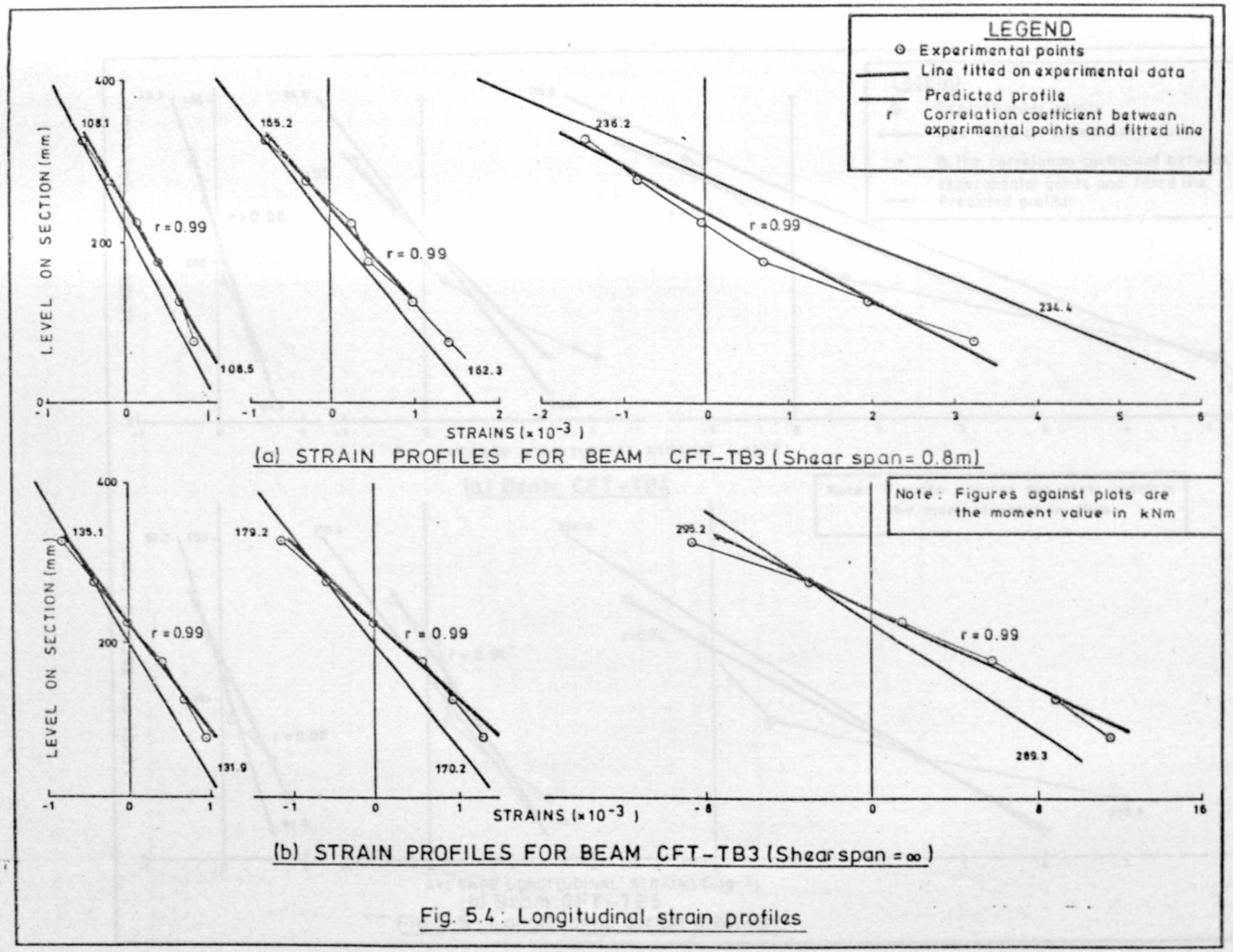


Fig. 5.4: Longitudinal strain profiles

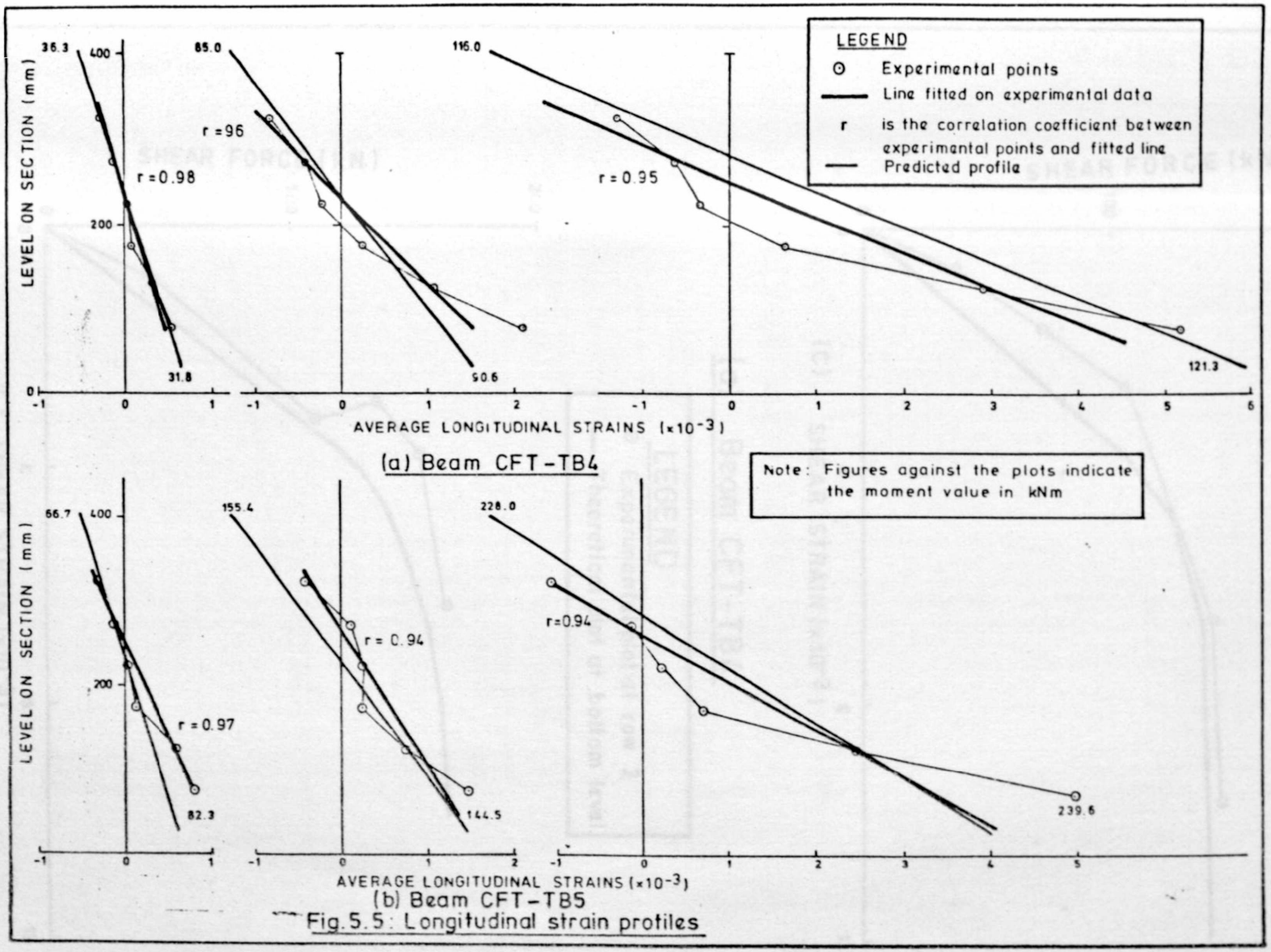
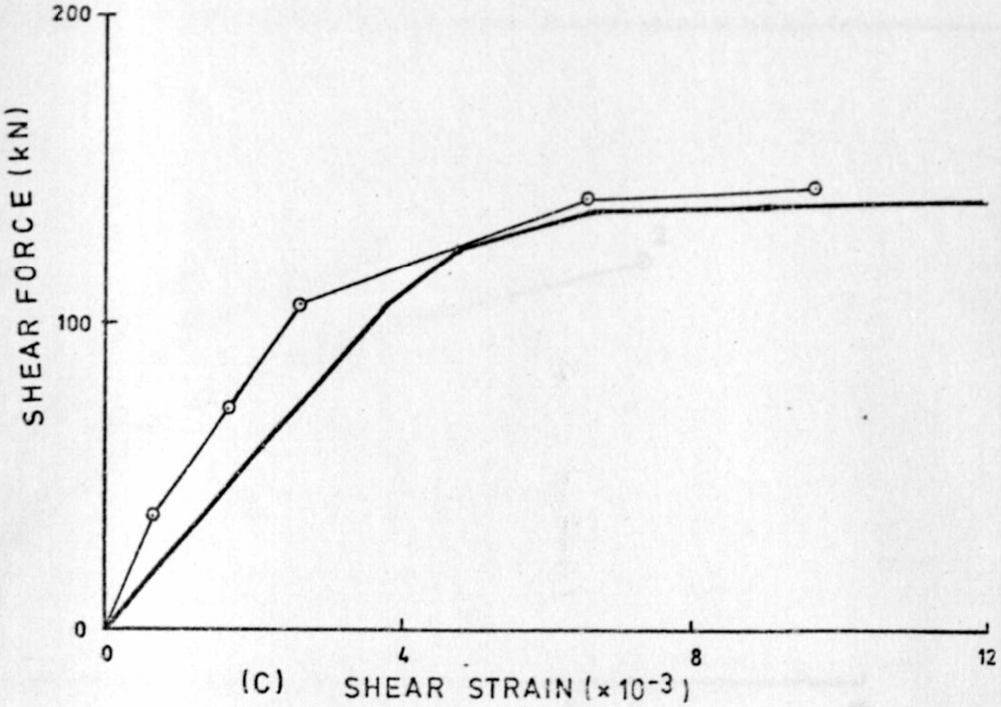
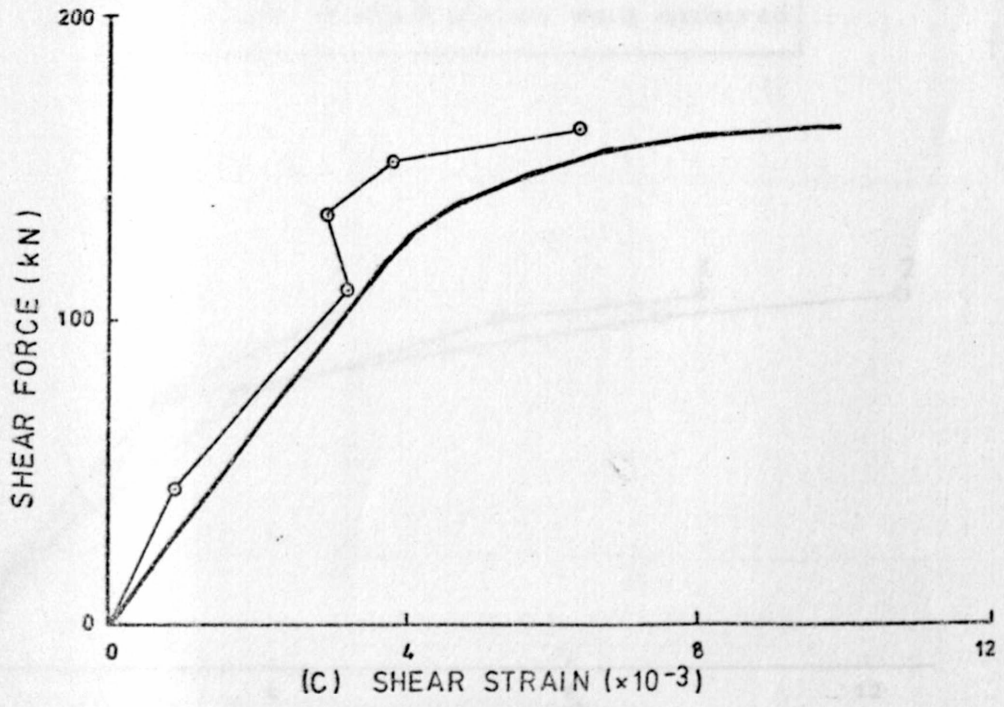


Fig. 5.5: Longitudinal strain profiles



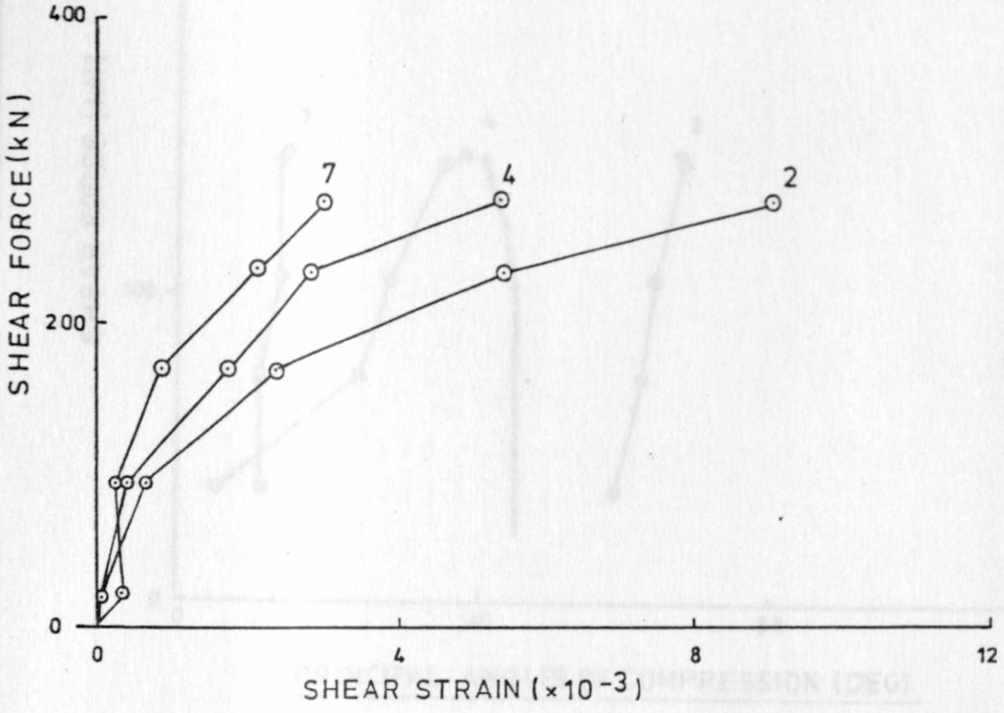
(a) Beam CFT-TB4

LEGEND
⊙ Experimental plot at row 2
— Theoretical plot at bottom level



(b) Beam CFT-TB8

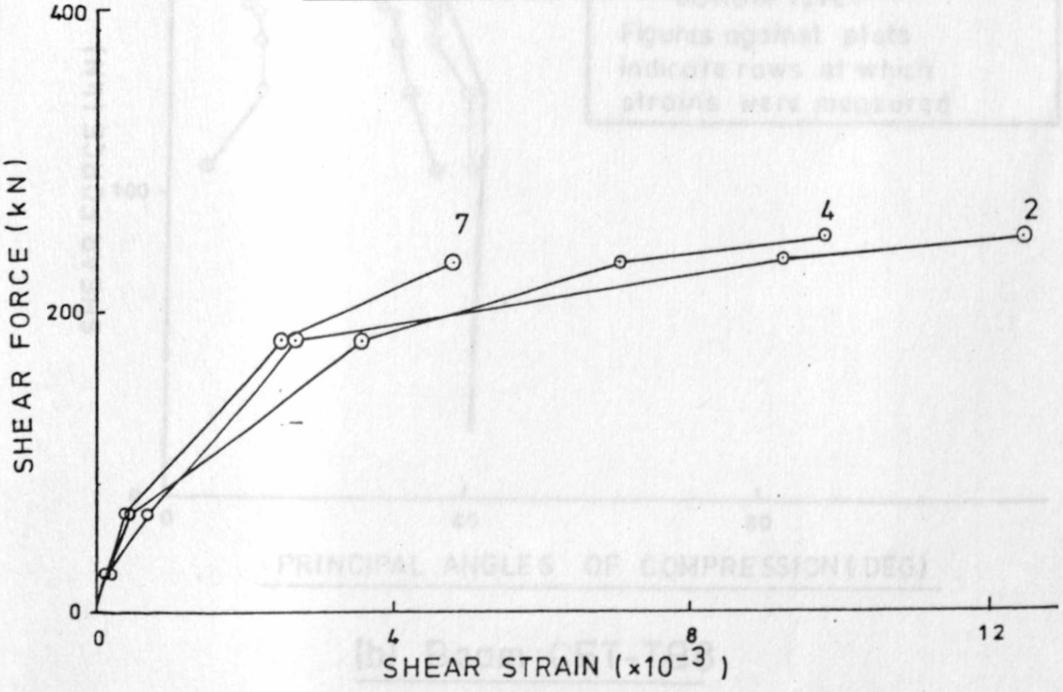
Fig. 5.6 : Shear Force - Shear Strain Relationships



(a) Beam CFT-TB5

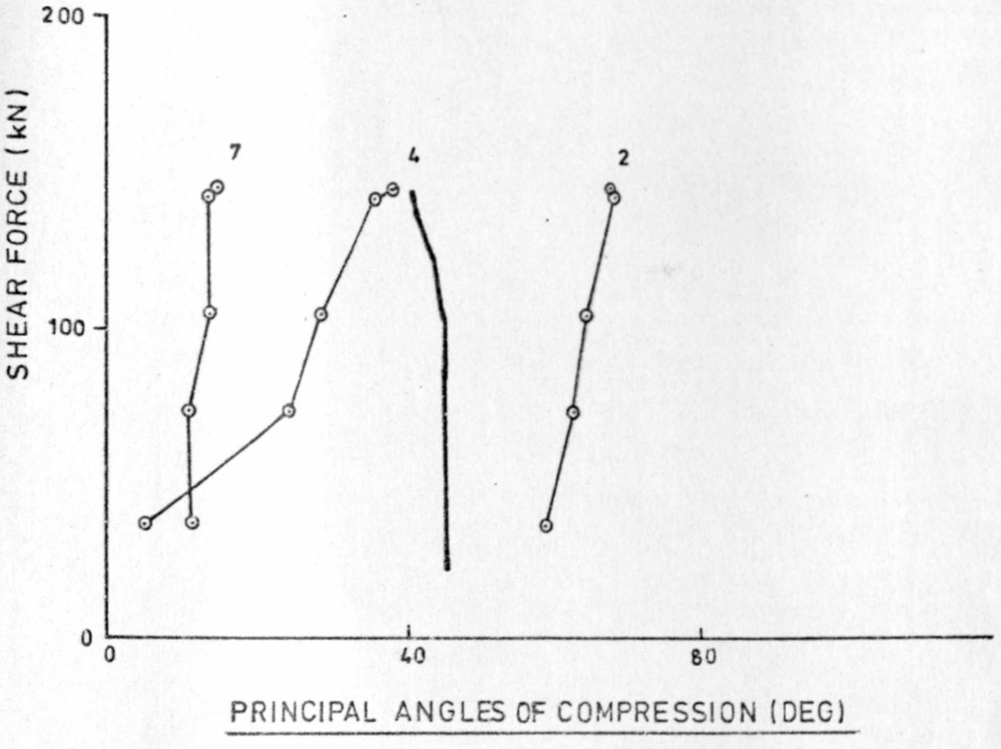
LEGEND

Figures against the plots indicate rows at which strains were measured

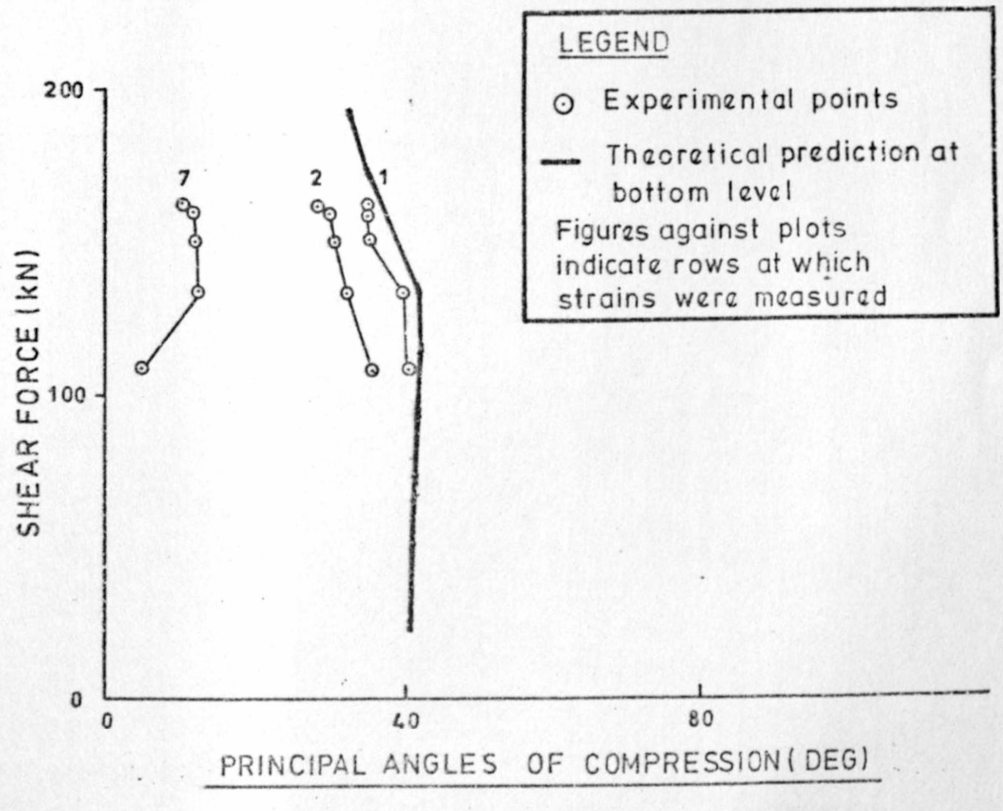


(b) Beam CFT-TB6

Fig. 5.7 : Variation shear force

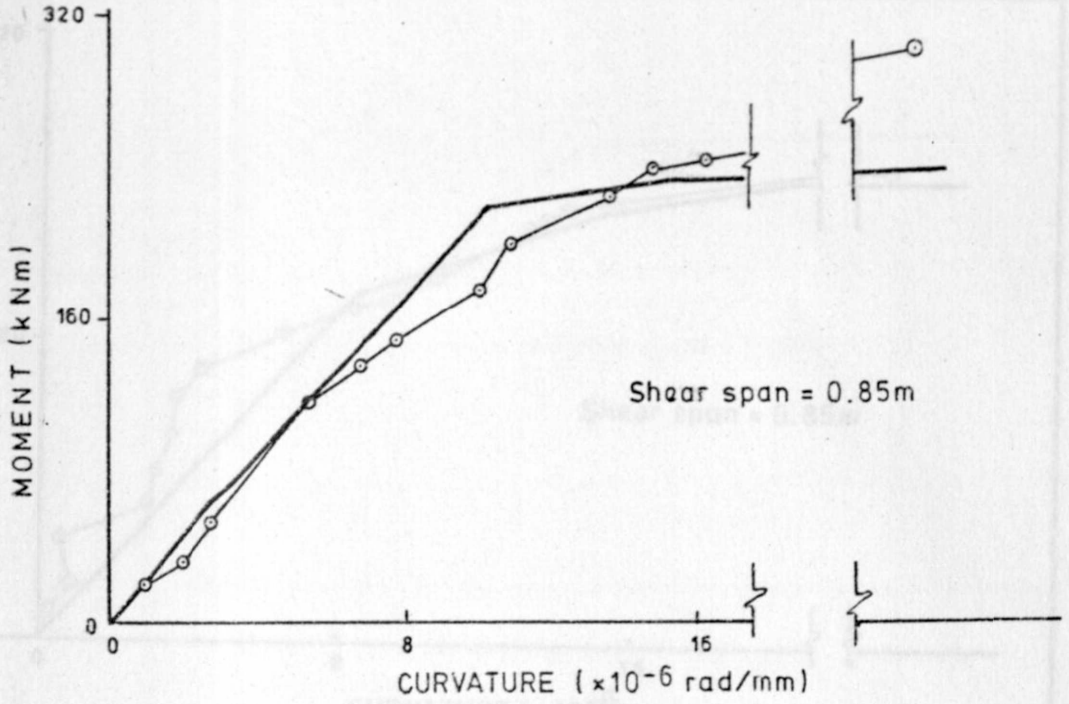


(a) Beam CFT-TB4

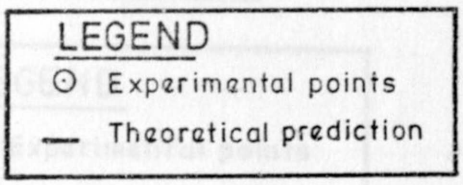


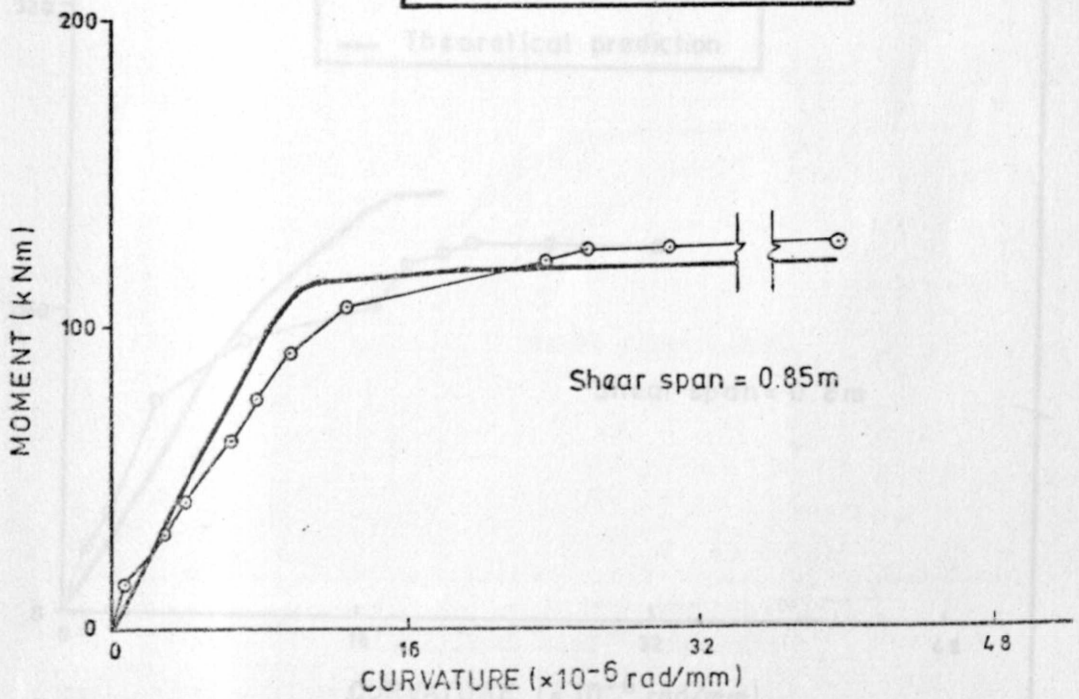
(b) Beam CFT-TB8

Fig. 5.8: Shear Force - Principal Angles of compression Relationships



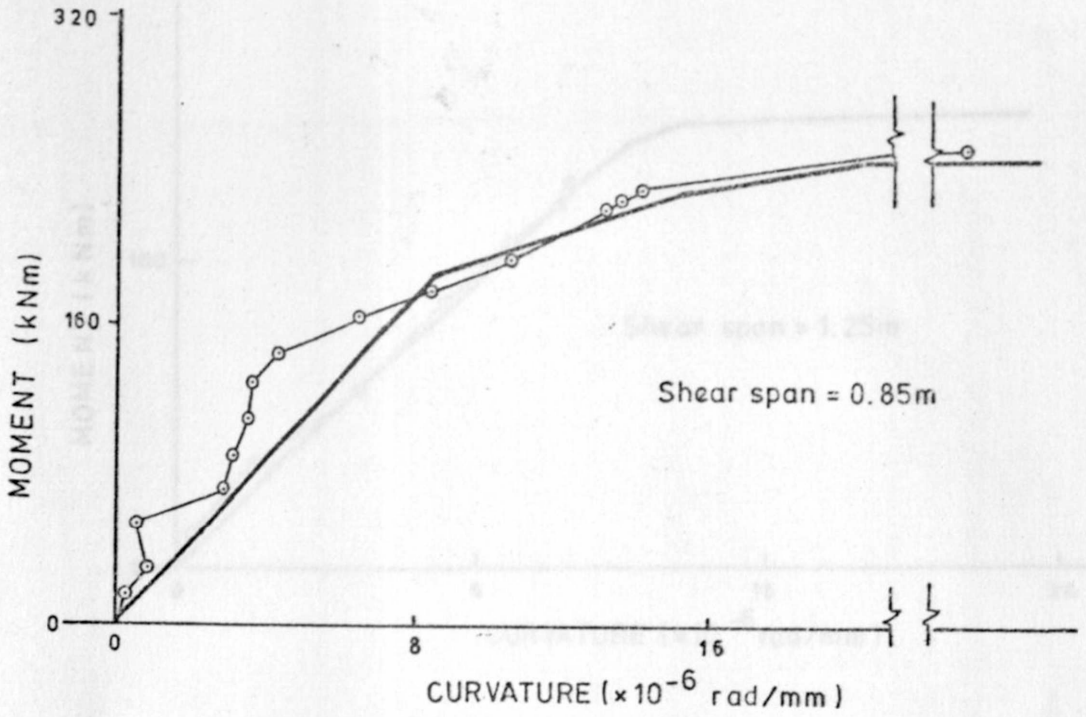
(a) Beam CFT-TB3



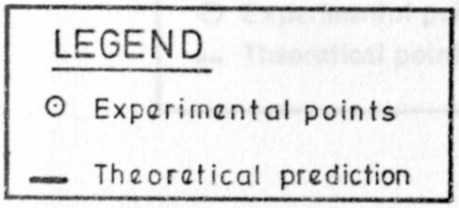


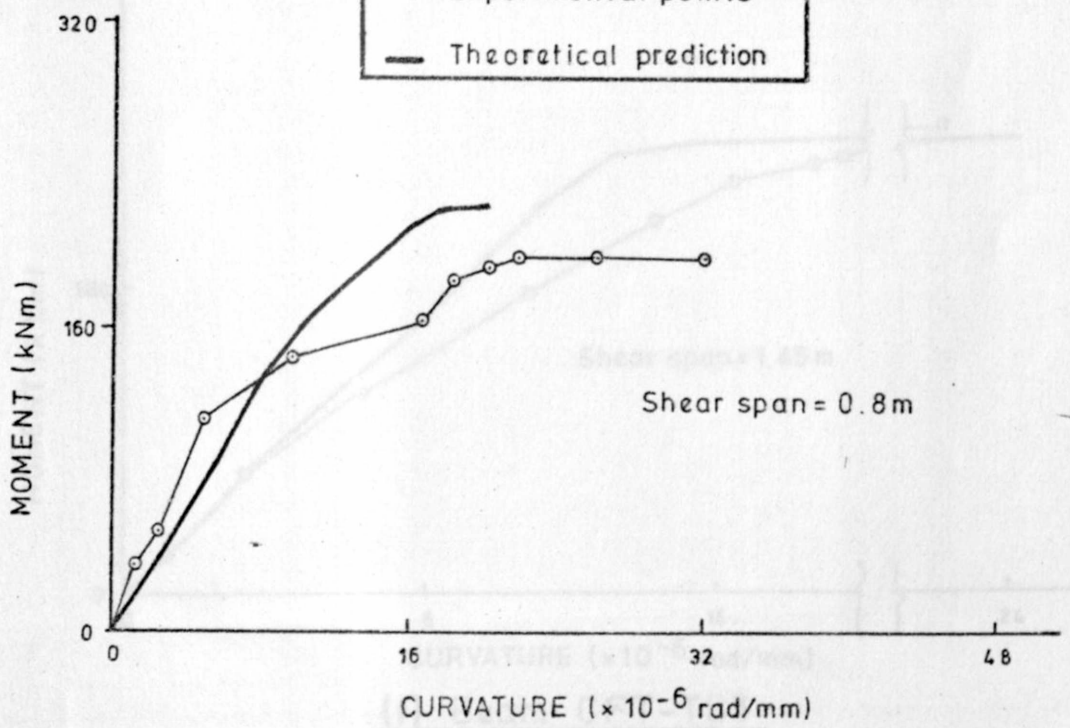
(b) Beam CFT-TB4

Fig. 5.9 : Moment-curvature Relationships



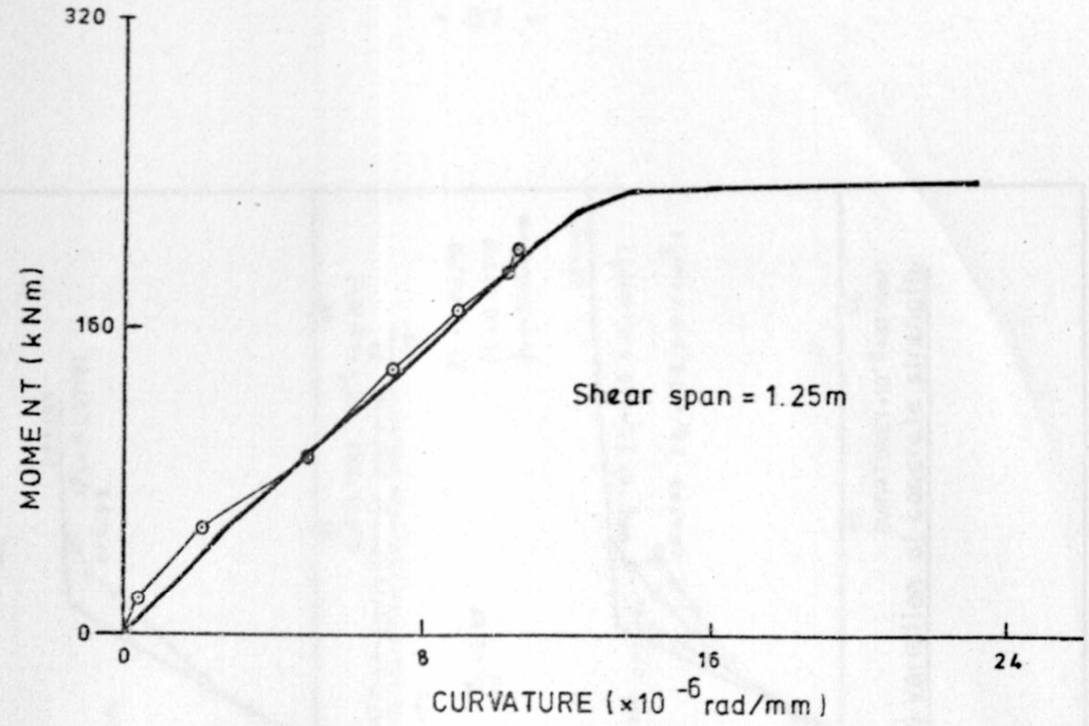
(c) Beam CFT-TB5



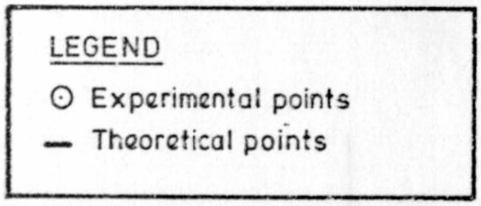


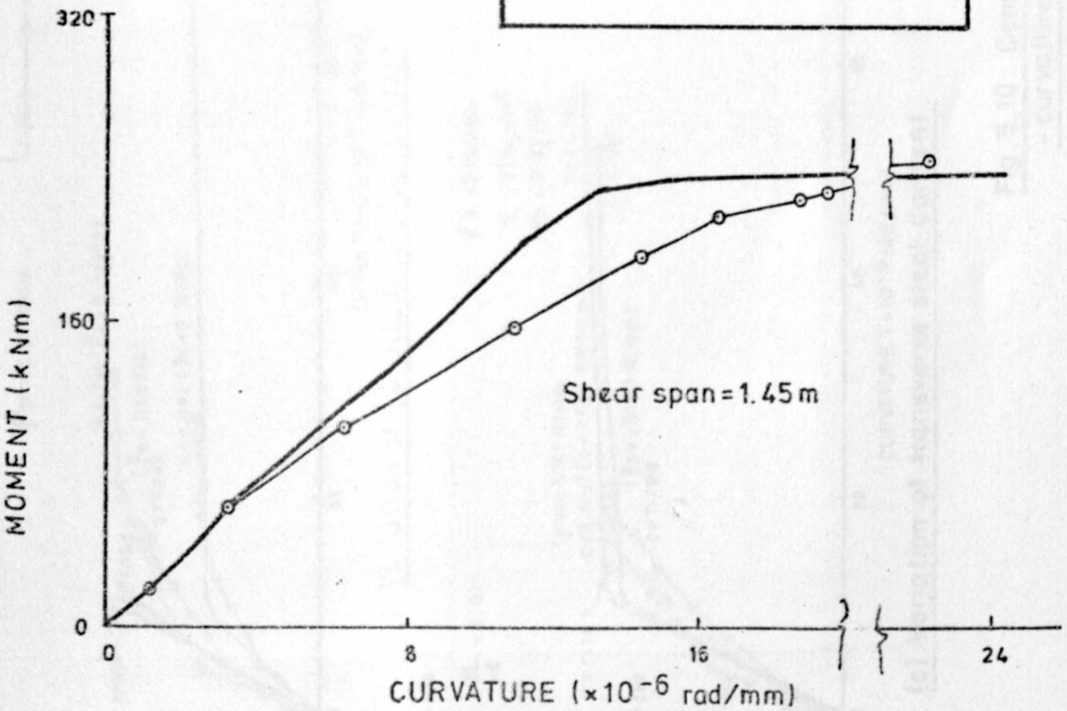
(d) Beam CFT-TB6

Fig. 5.9 : Moment - curvature Relationships



(e) Beam CFT-TB8





(f) Beam CFT-TB8

Fig. 5.9: Moment - curvature Relationships

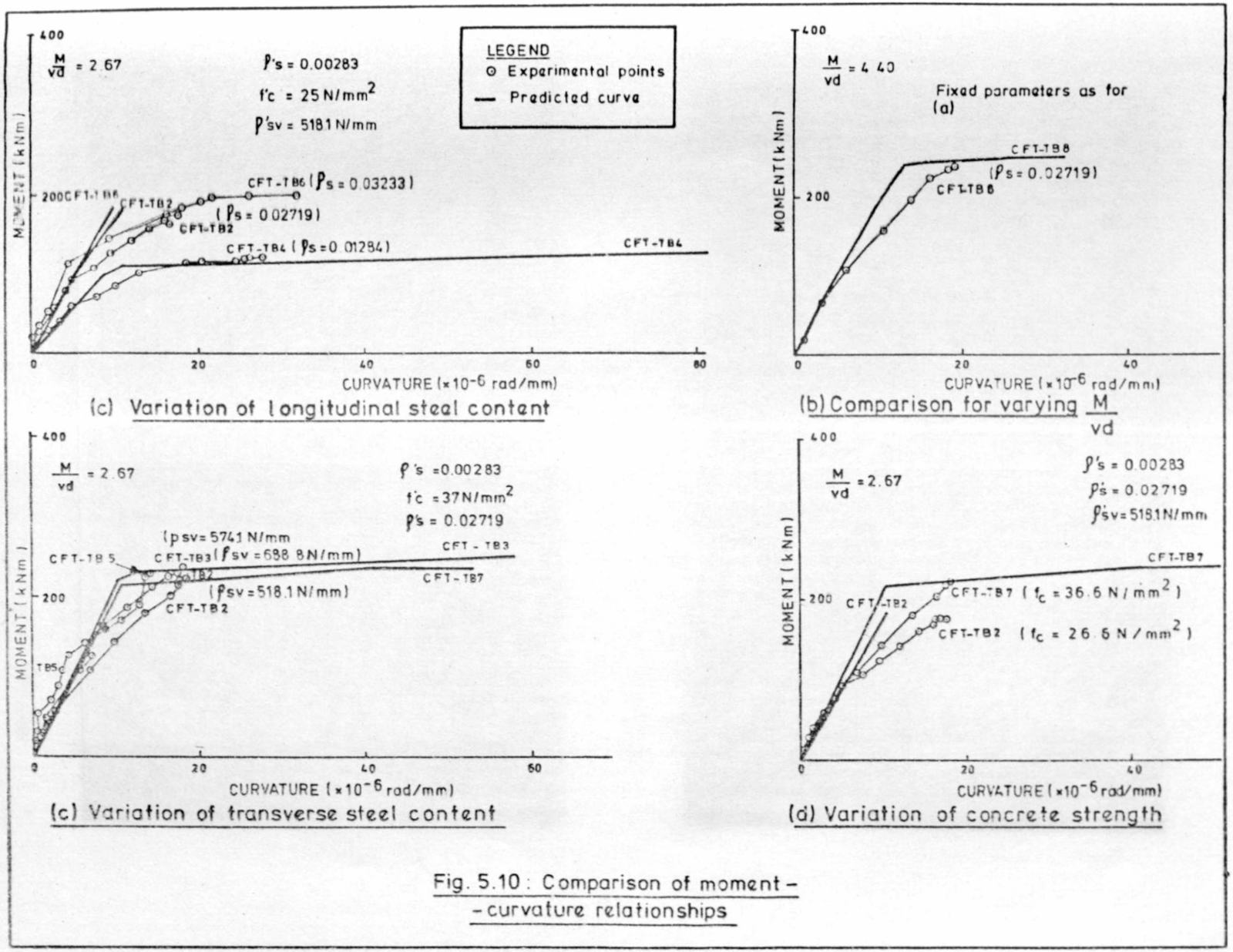


Fig. 5.10 : Comparison of moment – curvature relationships

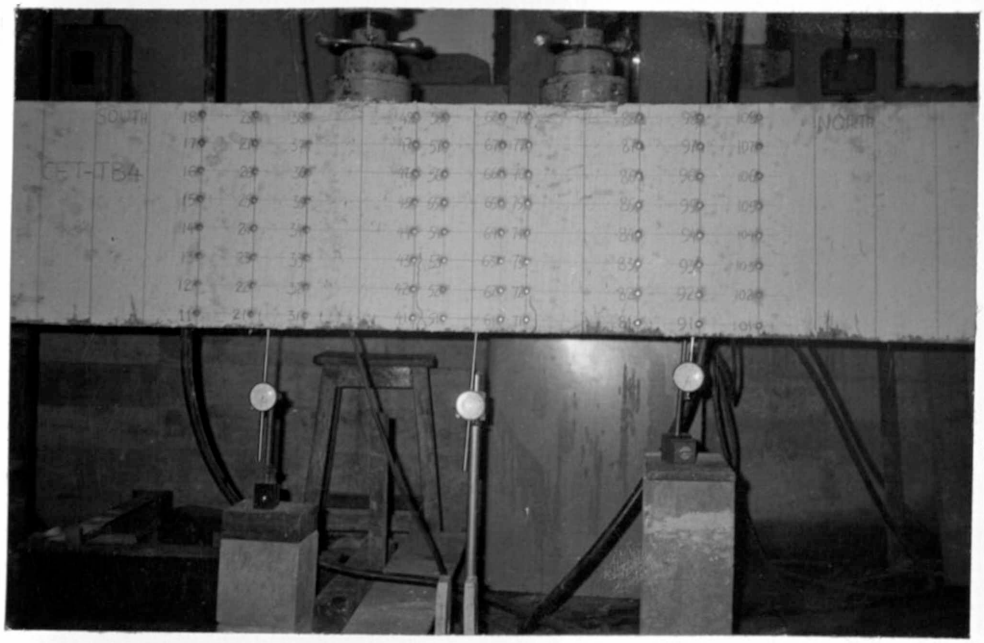


Plate 5.1 : Beam CFT-TB4 at Flexural Cracking Capacity

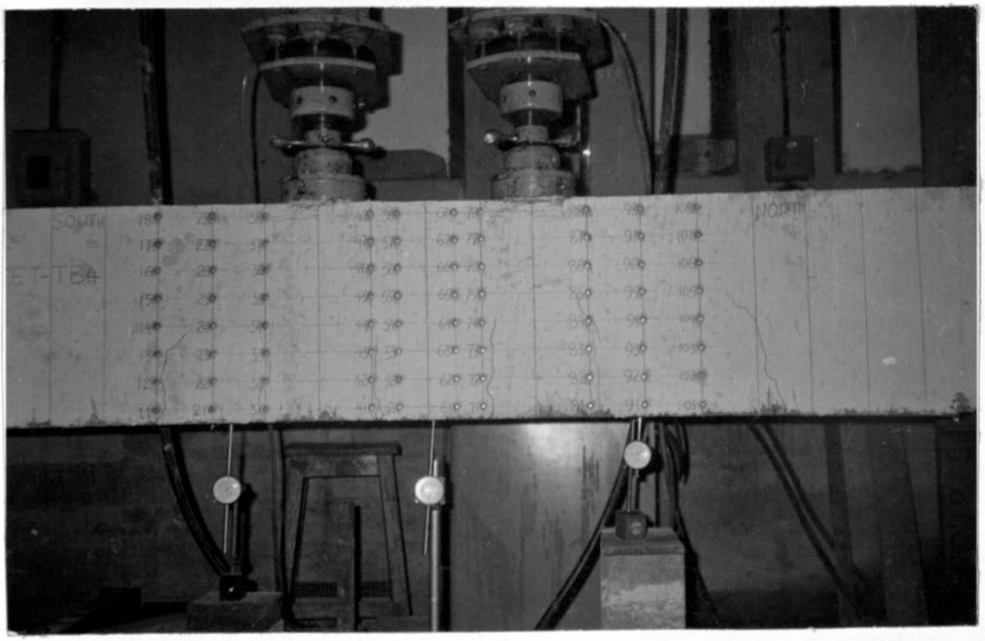


Plate 5.2 : Beam CFT-TB4 at Start of Inclined Cracks

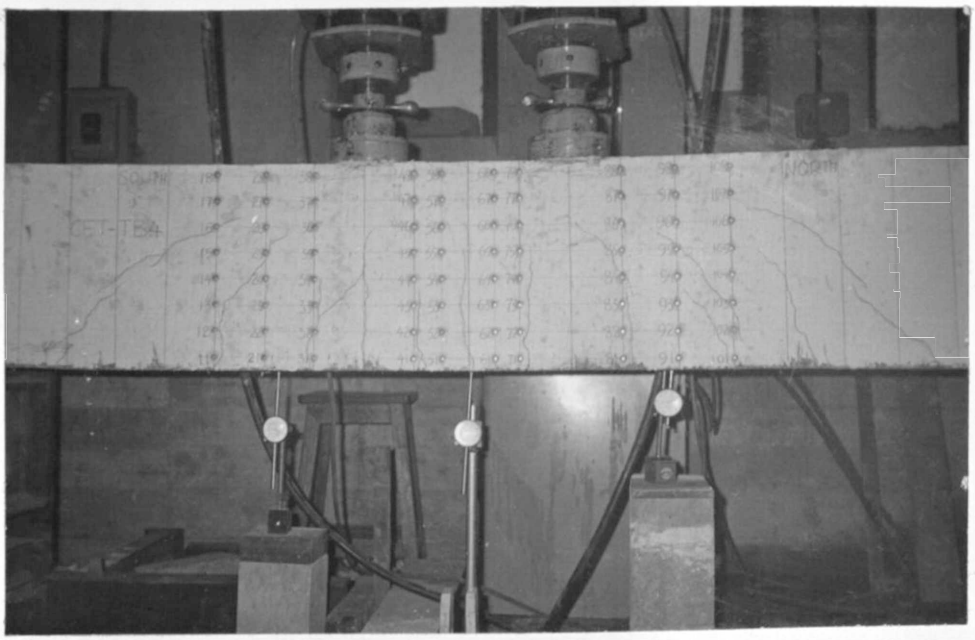


Plate 5·3 : Beam CFT-TB4 at about 3/4 Capacity

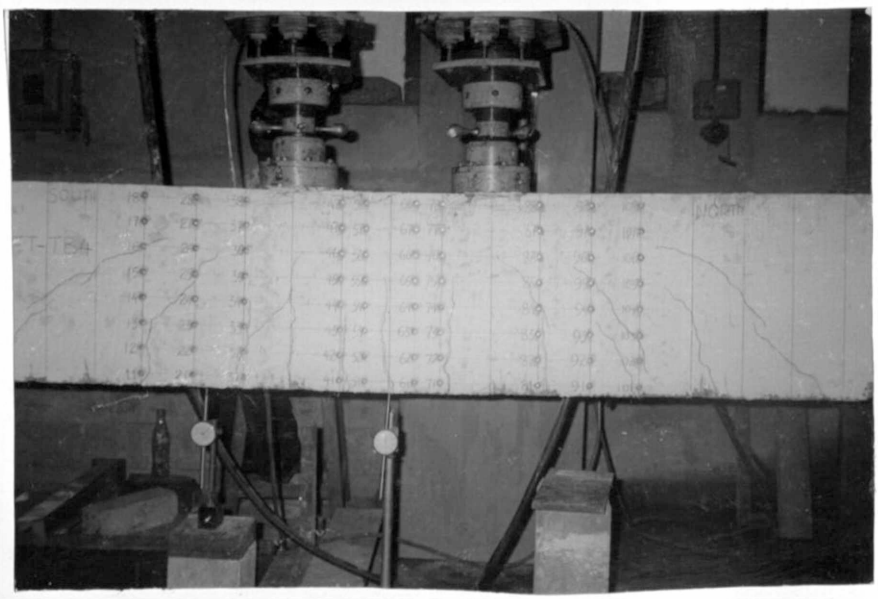


Plate 5.4 : Beam CFT TB4 Near Capacity Loading

(Notice start of crushing in concrete
at the top between loads)

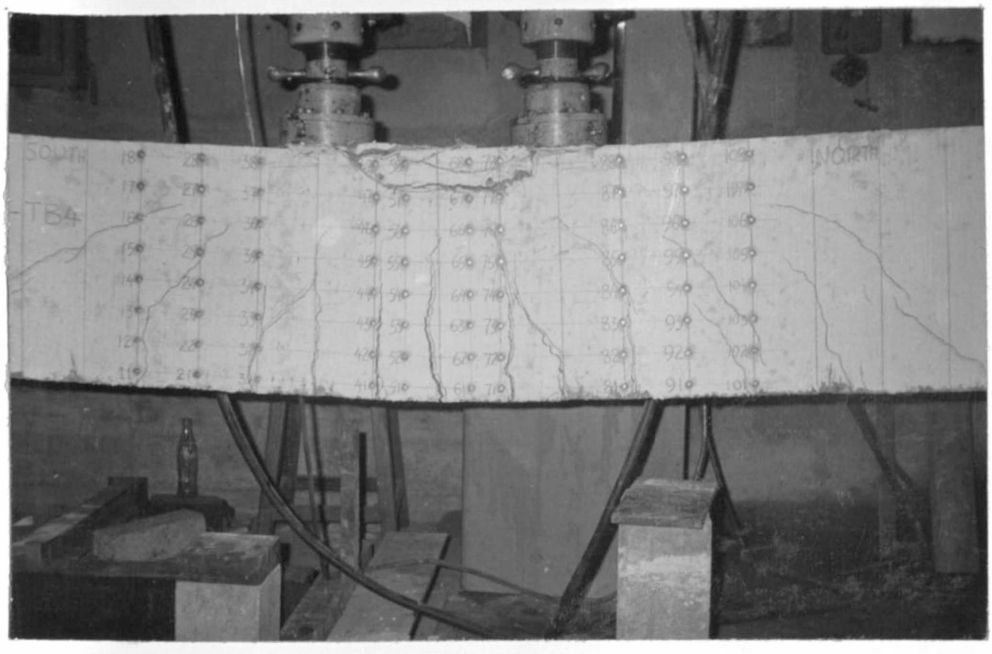


Plate 5 5: Beam CFT-TB4 at Capacity Loading

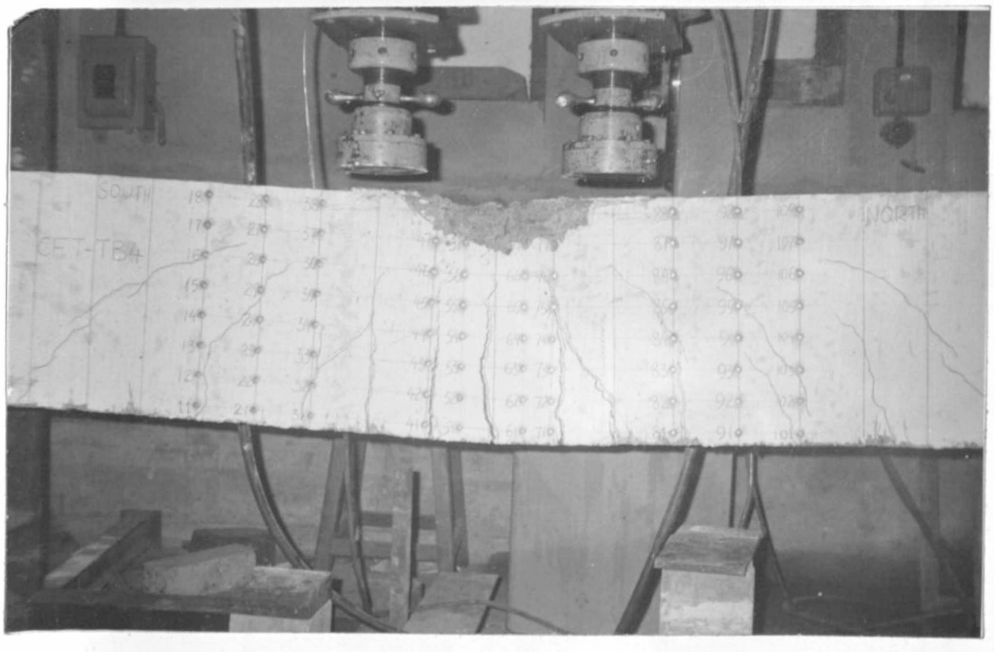


Plate 5.6 : Beam CFT-TB4 at Failure (Sequence of Beam CFT-TB4 was typical of Beam CFT-TB2, CFT-TB3 CFT-TB7 and CFT-TB 8)

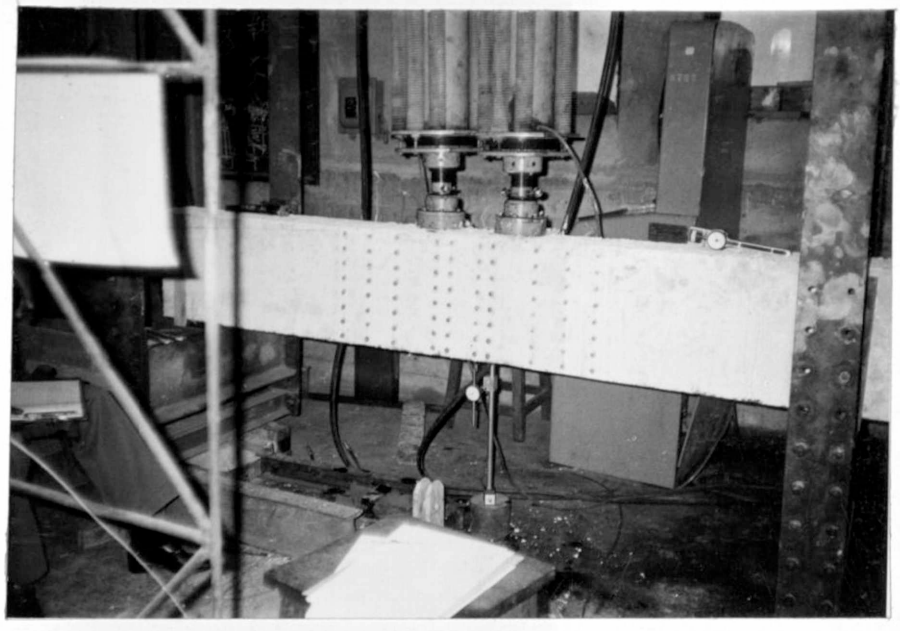


Plate 5.7 : Beam CFT-TB1 in Test Rig (front side)

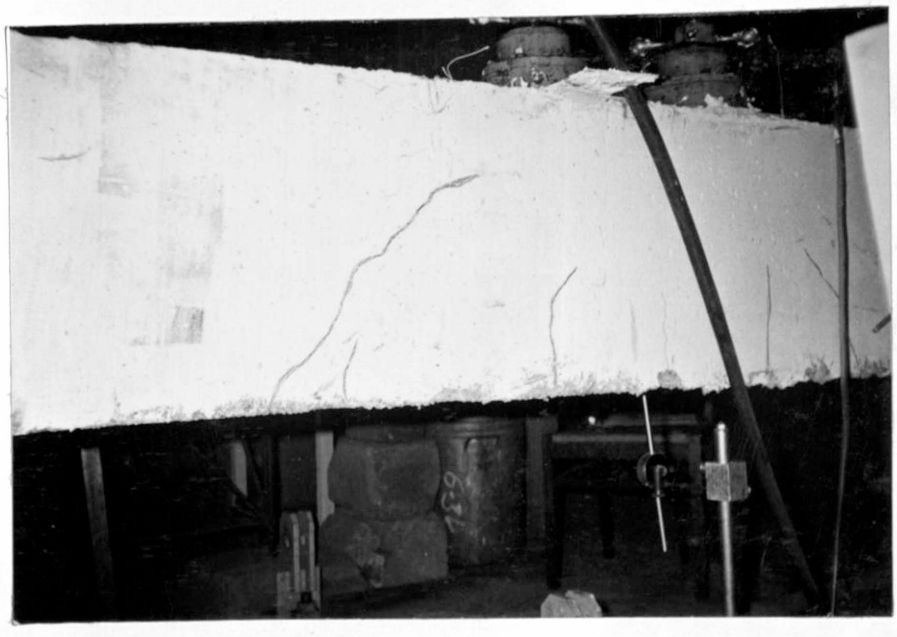


Plate 5.8 : Beam CFT TB1 at about Half Capacity (rear side)

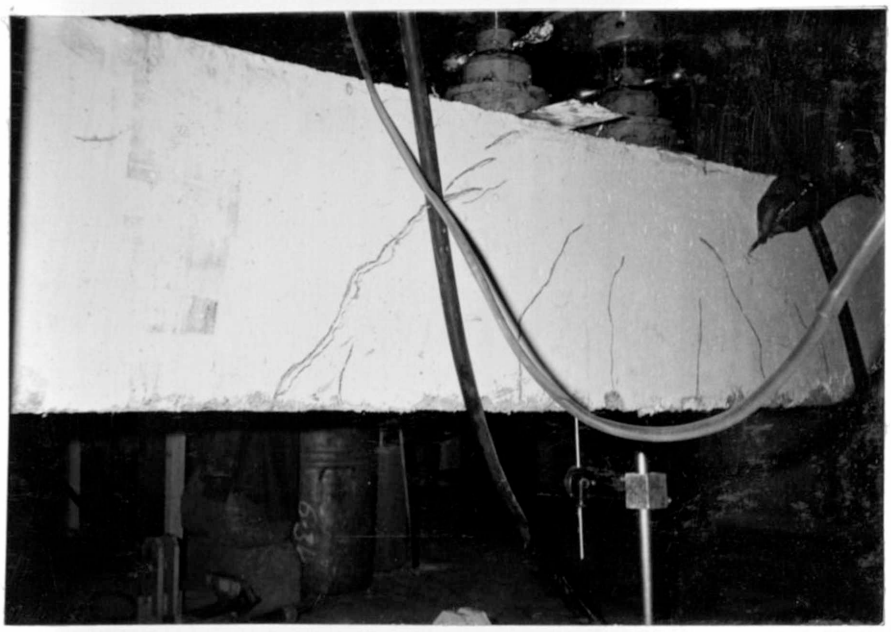


Plate 5.9 : Beam CFT-TB1 at Near Full Capcity
(rear side)

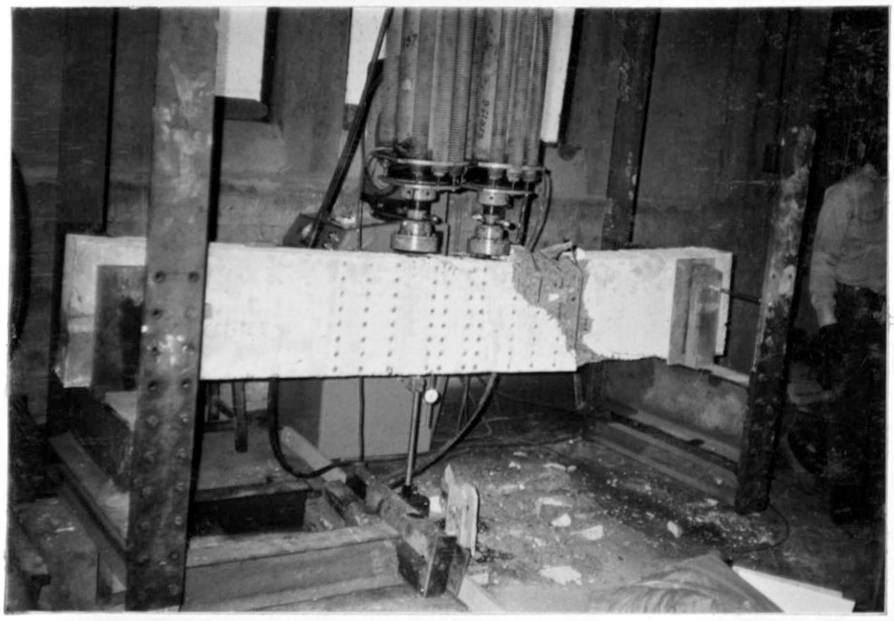


Plate 5.10 : Beam CFT-TB1 at Failure (front side)
(Notice failure is in the shear span)

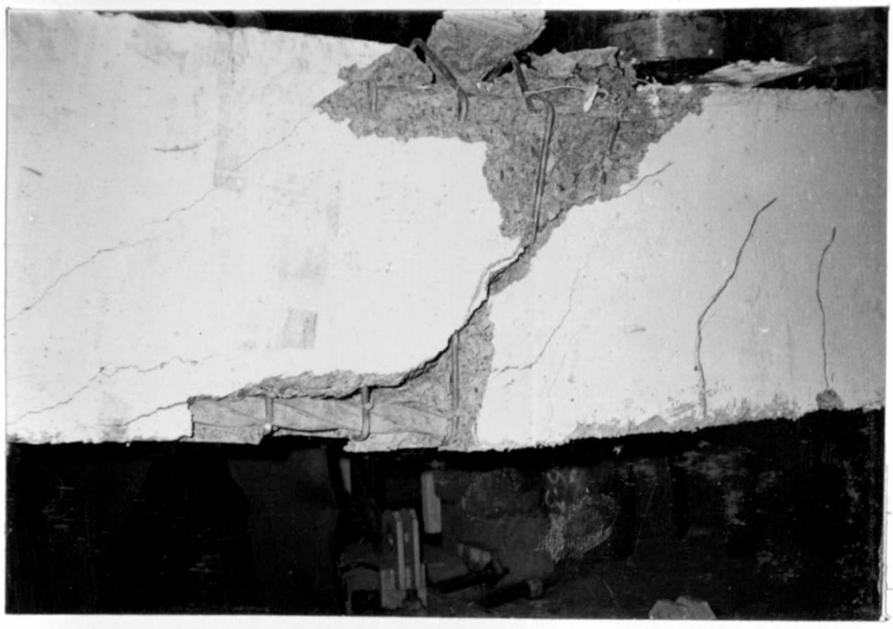


Plate 5.11: Beam CFT-TB1 at Failure (rear side)

Plat 5.12 : Beam CFT-TB6 at Failure (front side)

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

From the study of predictions using the compression field theory and the data from the experimental specimens tested, the following conclusions may be made about structural concrete beams loaded in flexure and shear:-

(i) Due to non-uniform cracking of test specimens, the transverse strains and the principal compression strains profiles obtained from experiment differ from those obtained from theory. However, the maximum average transverse strains and the average principal compression strains obtained from experiment are generally comparable to those obtained from theoretical predictions.

(ii) Application of the Bernoulli-Navier hypothesis which states that longitudinal strains along any line in a section vary linearly, is reasonable.

(iii) The plots for the maximum shear strain from experimental data and from theoretical model are in good agreement.

(iv) The moment-curvature response for the test specimens is predicted well by the compression field theory.

(v) The compression field theory predicts the ultimate loadswell and conservatively.

(vi) The predicted and the experimental trends as material properties and loading conditions are varied, are generally in agreement.

6.2 Recommendations

The following recommendations are made for further research on present work.

(i) It is recognized that the experimental program was restricted to only rectangular solid beam sections. It is recommended that tests be extended to other types of beam sections as further investigation of application of theory.

(ii) Tests should be carried out on many identical specimens in order to yield statistically more significant data.

(iii) As a further development of the theoretical model, the tensile strength of concrete should be taken into account.

REFERENCES

1. Collins, M.P., and Mitchell, D. (1980), "Shear and Torsion Design of Prestressed and Non-Prestressed Concrete Beams", Journal of the Prestressed Concrete Institute, Vol.25, No.5 September - October 1980, pp 32-100

2. Mitchell, D., and Collins, M.P. (1974), "Diagonal Compression Field Theory - A Rational Model for Structural Concrete in Pure Torsion", American Concrete Institute Journal, Vol. 71, Aug., 1974, pp. 396 - 408

3. Onsongo, W.M. (1978), "The Diagonal Compression Field Theory for Reinforced Concrete Beams Subjected to Combined Torsion, Flexure and Axial Load", PhD Thesis, University of Toronto, Canada, 1978, 246 pp.

4. Joint ASCE-ACI Task Committee 426 (1973), "The Shear Strength of Reinforced Concrete Members", Journal of the Structural Division, ASCE, Vol 99, No. ST6, Proc. Paper, June, 1973, pp 1091-1187.

5. Joint ASCE-ACI Task Committee 426 (1974), "The Shear Strength of Reinforced Concrete Members-Slabs", Journal of the Structural Division, ASCE, Vol.100, No. ST8, Proc. Paper 10733, August, 1974, pp 1543 - 1591.

6. Leonhardt, F. and Walther, R. (1964), "The Stuttgart Shear Tests, 1961, "Translation No. 111, Cement and Concrete Association, London, England, 1964.

7. Leonhardt, F. (1965), "Reducing the Shear Reinforcement in Reinforced Concrete Beams and Slabs", Magazine of Concrete Research, Vol. 17, No. 53, Dec.1965, pp 187 - 194.

8. Fenwick, R.C. and Paulay, T. (1968), "Mechanisms of Shear Resistance of Concrete Beams", Journal of the Structural Division, ASCE, Vol.94, No. ST10, Proc. Paper 2325, Oct. 1968, pp. 2325 - 2350.

9. Gergely, P. (1969), "Splitting Cracks Along the Main Reinforcement in Concrete Members", Report to Bureau of Public Roads, U.S. Department of Transportation, Cornell University, Ithaca, N.Y., Apr. 1969

10. Hofbeck, J.A., Ibrahim, I.A. and Mattock, A.H. (1969), "Shear Transfer in Reinforced Concrete", Journal of the American Concrete Institute, Vol. 66, No. 2, Feb., 1969, pp 119 - 128.

11. Jimenez, R., White, R.N., and Gergely, P. (1982), "Cyclic Shear and Dowel Action Models in Reinforced Concrete", Journal of the Structural Division, Proc. ASCE Vol. 108 No. ST5, May 1982, pp 1106 - 1123.

12. Bresler, B. and MacGregor, J.G. (1967), "Review of Concrete Beams Failing in Shear", Journal of the Structural Division, ASCE, Vol 93, No. ST1, Proc. Paper 5106, Feb. 1967, pp 343 - 372.

13. Collins, M.P. (1978), "Towards a Rational Theory for RC Members in Shear", Journal of the Structural Division, ASCE, Vol. 104 No. ST4, Proc. Paper 13697, April, 1978, pp 649 - 666.

14. Vecchio, F. and Collins M.P. (1982) "The Response of Reinforced Concrete to In-Plane Shear and Normal Stresses", University of Toronto, Dept. of Civil Engineering, Publication No. 82 - 03, March 1982, 332 pp.

15. Collins, M.P. (1983), "Prestressed Concrete Structures", A Post-Graduate Course at the University of Stellenbosch, March 1983.

16. Neville, A.M. (1973), "Properties of Concrete".

17. Road Note No.4 (1969), TRRL Publication.

APPENDIX A

EQUATIONS FOR USE IN SOLUTION TECHNIQUE AND EXAMPLE CALCULATIONS

A.1 Further Details on Solution Technique to Reinforced Concrete Beams

Steps of the solution procedure were outlined in Section 3.6. The pure flexure and the combined flexure-shear cases are examined here with further detail.

Referring to Figure 3.1, for a known top face strain ε_{ct}, the following relationships can be deduced from the pure flexure theory.

$$\alpha\beta = \Omega_{ct} - \frac{1}{3}\Omega_{ct}^2 \quad \text{.....(A.1)}$$

$$\beta = \frac{4 - \Omega_{ct}}{6 - 2\Omega ct} \quad \text{.....(A.2)}$$

If y is the depth to the neutral axis,

$$\phi = \frac{\varepsilon_{ct}}{y} \quad \text{.....(A.3)}$$

$y = y_p$ for pure flexure case and

$y = y_n$ for combined flexure and shear case.

From the geometry of the diagram for strains (Figure 3.1 (c)) the following relationships are deduced:-

$$\varepsilon'_{\ell} = \frac{y - d'}{y}\,\varepsilon_{ct} \quad \text{..... (A.4)}$$

$$\varepsilon_{\ell} = \frac{d - y}{y}\,\varepsilon_{ct} \quad \text{..... (A.5)}$$

A.1.1 Pure Flexure Case

Given the extreme compression fibre strain, ε_{ct}, for a rectangular section the pure flexure case is solved if the correct neutral surface depth y_p is known so as to define the correct strain profile. Using the well known equivalent rectangular compression stress block theory, the following cases are possible for y_p.

(i) For both top and bottom steel yielding, equilibrium of forces requires that

$$\alpha\beta f'_c b y_p + A'_\ell f'_{\ell y} = A_\ell f_{\ell y}$$

hence $$y_p = \frac{A_\ell f_{\ell y} - A'_\ell f'_{\ell y}}{\alpha\beta f'_c b} \quad \text{.....(A.6)}$$

(ii) For only bottom steel yielding, equilibrium of forces requires that

$$\alpha\beta f'_c b y_p + A'_\ell f'_\ell = A_\ell f_{\ell y}$$

and by using equation (A.4) the neutral surface depth can be shown to be:

$$y_p = -\left(\frac{\varepsilon_{ct} E A'_\ell - A_\ell f_{\ell y}}{2\alpha\beta f'_c b}\right) + \sqrt{\left(\frac{\varepsilon_{ct} E A'_\ell - A_\ell f_{\ell y}}{2\alpha\beta f'_c b}\right)^2 + \frac{A'_\ell d' \varepsilon_{ct} E}{\alpha\beta f'_c b}}$$

..... (A.7)

(iii) For all steel in elastic range, equilibrium of forces gives

$$\alpha\beta f'_c b y_p + A'_\ell \varepsilon_{ct} E \left(\frac{y_p - d'}{y_p}\right) - A_\ell \varepsilon_{ct} E \left(\frac{d - y_p}{y_p}\right) = o$$

If the modulus of elasticity for bottom and top longitudinal steel are assumed equal then the neutral surface depth for this case is given by:-

$$y_p = -\frac{\varepsilon_{ct} E \ (A'_\ell + A_\ell)}{2\alpha\beta f'_c b} + \sqrt{\left(\frac{\varepsilon_{ct} E \ (A'_\ell + A_\ell)}{2\alpha\beta f'_c b}\right)^2 + \frac{\varepsilon_{ct} E \ (A'_\ell d' + A_\ell d)}{\alpha\beta f'_c b}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (A.8)$$

(iv) For only top steel yielding equilibrium of forces yields

$$\alpha\beta f'_c b y_p + A'_\ell f'_{\ell y} = A_\ell f_{\ell y}$$

and y_p is given by:-

$$y_p = -\frac{A'_\ell f'_{\ell y} + \varepsilon_{ct} E \ A_\ell}{2\alpha\beta f'_c b} + \sqrt{\left(\frac{A'_\ell f'_{\ell y} + \varepsilon_{ct} E \ A_\ell}{2\alpha\beta f'_c b}\right)^2 + \frac{\varepsilon_{ct} E \ A_\ell d}{\alpha\beta f'_c b}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (A.9)$$

Having determined y_p, the flexural moment, M_p, can be evaluated as:-

$$M_p = A'_\ell f'_\ell h_\ell + \alpha\beta f'_c b y_p \left(d - \frac{\beta y_p}{2}\right) \quad \ldots\ldots (A.10)$$

A.1.2 Combined Loading Case

The shear force in the section is given by

$$V = \frac{M}{a} \quad \text{.....(A.11)}$$

and the lever arm, jd, by

$$jd = \frac{M}{A_\ell f_\ell} \quad \text{.....(A.12)}$$

As a start of the iteration process the depth to the neutral axis is estimated to some value less than the known pure flexure value. A strain profile is thus established from which internal forces are calculated such that the section is in equilibrium. From the internal forces, the moment, M, and the lever arm, jd, are computed. The value of jd is used to determine q_b (see equation (3.6)) which in turn is used to determine q_n (see equation (3.7)). These define the shear flow distribution.

A.1.2.1 Evaluation of Angles and Strains

With the known shear flow distribution, the angles and strains at any level in the cracked concrete can be evaluated through an iterative process similar to that developed by Onsongo (1978) for the case of combined moment and torsion.

Equation (3.20) can be rewritten as:

$$q = \frac{bf_{cp}\tan\theta}{1 + \tan^2\theta} \quad \text{.....(A.13)}$$

For any given level, j, in the cracked concrete the strains and the principal angle of compression can be evaluated from the following relationships.

(i) Case of Transverse Steel Yielding

If q_j is the shear flow and θ_j the principal angle at the level j, equation (3.9) takes the form:-

$$\tan \theta_j = \frac{A_v f_{vy}}{q_j s_v}$$

Define $$t_v = \frac{A_v}{S_v} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (A.14)$$

and let $$c = \frac{t_v f_{vy}}{q_j} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (A.15)$$

then $$f_{cp} = \frac{q_j (1+c^2)}{bc} \ldots\ldots\ldots\ldots\ldots\ldots \quad (A.16)$$

(see equation A.13)

The value of f_{cp} is then used to calculate the principal compression strain, ε_{cp}, from equation (3.21). By a systematic evaluation of response from low values of ε_{ct}, it is possible to choose which of the two roots of equation (3.21) is applicable. By calculating the longitudinal strain, ε_s, from the strain profile, the transverse strain is deduced from equation (3.16) as:-

$$\varepsilon_v = \frac{\varepsilon_{cp} (1 - c^2) + \varepsilon_\ell}{c^2} \geq \varepsilon_{vy}$$

(ii) Case of Transverse Steel in Elastic Range

Let $\varepsilon_v = \eta\varepsilon_{vy}$

Then, using equation (3.16) the following expression is deduced:-

$$\Omega_{cp} = \frac{\eta^3 c^2 \Omega_{vy} - \Omega_\ell}{1 - \eta^2 c^2} \quad \text{.....(A.17)}$$

For $\Omega_{cp} \geq$ o the following boundaries for Ω are recognised.

$$\left[\frac{\Omega_\ell}{\Omega_{vy}} \cdot \frac{1}{c^2}\right]^{\frac{1}{3}} \leq \eta \leq \frac{1}{c}$$

or $$\frac{1}{c} < \eta < \left[\frac{\Omega_\ell}{\Omega_{vy}} \frac{1}{c^2}\right]^{\frac{1}{3}}$$

Equation (A.13) can be rewritten in terms of η as:

$$q_i = \frac{b\lambda\ (2\Omega_{cp} - \Omega_{cp}^2)\ \eta c}{1 + \eta^2 c^2}$$

leading to the function

$$f(\eta) = \frac{\eta c}{1+\eta^2 c^2}\ (2\Omega_{cp} - \Omega_{cp}^2) - \frac{q_i}{b\lambda} \quad \text{.... (A.18)}$$

This function is conveniently differentiated to allow use of the recursion formula for obtaining a solution for η . The first differential takes the form:-

$$f'(\eta)=\frac{\eta^3c^3\Omega_{vy}-c\Omega_\ell}{(1+\eta^2c^2)^2}(2-\Omega_{cp})+\frac{2(\eta^3c^3\Omega_{vy}\left((3-\eta^2c^2)-2\eta^2\right)-2\eta^2c^3\Omega_\ell)(1-\Omega_{cp})}{(1+\eta^2c^2)\ (1-\eta^2c^2\ )^2} \quad \ldots\ldots\ldots\ldots (A.19$$

A value of η is first guessed within suitable limits established. Subsequent iteration steps are then obtained using the recursion formula.

$$\eta_{i+1} = \eta_i - \frac{f(\eta_i)}{f'(\eta_i)} \quad \ldots\ldots\ldots\ldots\ldots\ldots (A.20)$$

This gives quadratic convergence close to the root of $f(\eta) = o$. Once a solution is found, the transverse strain and the angle of principal strain are calculated. The principal tensile strain in concrete, ε_t, is then computed as:-

$$\varepsilon_t = \varepsilon_{cp} + \varepsilon_v + \varepsilon_\ell$$

This enables determination of the effective peak concrete stress, λ . The effective peak concrete stress is calculated in an iterative scheme. Initially, λ is assumed equal to f'_c. Subsequent values for λ are calculated from:-

$$\lambda_{i+1} = \frac{\lambda_i}{0.8 + 0.34\Omega_t}$$

For every new value of λ, if there is no satisfactory convergence (between λ_i and λ_{i+1}), a new set of strains is computed using the latest value of λ as the effective peak concrete stress until convergence is obtained.

The evaluation of angles and strains is done at all chosen levels in the section to enable use of Simpson's integration formulae. This in turn enables the evaluation of new values for the moment and shear. These are compared with the previous values. If the difference is significant, the whole process is repeated until acceptable convergence is obtained. A sample calculation to show how the iterative process works is presented in the following section.

A.2 Sample Calculation

Consider the beam section shown in Figure 3.1 Given:

A_ℓ	= 1905mm^2	ε_{co}	= 0.002
A'_ℓ	= 226mm^2	f'_c	= 36.8N/mm^2
b	= 200mm	fy	= 462N/mm^2
h_ℓ	= 345.8mm	f'y	= 282N/mm^2
d	= 368.8mm	E	= 200kN/mm^2
d'	= 23mm	ε'_ℓ	= 1.41 x 10^{-3}
h	= 400mm	ε_ℓ	= 2.31 x 10^{-3}
Ω_{vy}	= 0.705		

Consider a case loading with top face strain ε_{ct} = 0.001.

Then Ω_{ct} = 0.5

β = 0.7

$\alpha\beta$ = 0.417

Step 1

Assume both top and bottom longitudinal steel are yielding for pure flexure loading.

equation (A.6) , $y_p = 271.91\text{mm}$

equation (A.4) $\varepsilon'_\ell = 0.915\text{x}10^{-3} < \varepsilon'_{\ell y}$ Not O.K.

equation (A.5) $\varepsilon_\ell = 0.356\text{x}10^{-3} < \varepsilon_{\ell y}$ Not O.K.

Hence try both steels in elastic range.

equation (A.8) gives $y_p = 157.46\text{mm}$

Check values of ε'_ℓ and ε_ℓ

equation (A.4) $\varepsilon'_\ell = 0.854\text{x}10^{-3} < \varepsilon'_{\ell y}$ O.K.

equation (A.5) $\varepsilon_\ell = 1.342\text{x}10^{-3} < \varepsilon_{\ell y}$ O.K.

Hence $C_S = A'_\ell E\varepsilon'_\ell = 38.60\text{kN}$

$T = A_\ell E\varepsilon_\ell = 511.30\text{kN}$

$C_1 = \alpha\beta f'_c b y_p = 472.76\text{kN}$

Using equation (A.10), find the pure moment value, M_p as: $M_p = 160.96\text{kNm}$

Step 2

For the combined flexure - shear case, we start by guessing a value for y_n.

Guess A: $y_n = 120\text{mm}$

Equation (A.4) $\varepsilon'_\ell = 0.808 \times 10^{-3}$ hence $C_s = 36.54kN$

Equation (A.5) $\varepsilon_\ell = 2.073 \times 10^{-3}$ hence $T = 789.94kN$

$C_1 = \alpha\beta f'_c b y_n$ hence $C_1 = 360.29kN$

Take $C_2 = T - C_s - C_1$ $C_2 = 398.11kN$

Take $\bar{x}_2 = \frac{d - y_n}{2}$ $\bar{x}_2 = 129.17mm$

Step 3

Taking moments about bottom longitudinal steel, new moment, M, is deduced as:

$M = 181.16kNm$

and $jd = 229.33mm$

hence for a = 1m, V = 181.16kN

Equation (3.6) $q_b = 0.7899kN/mm$

Equation (3.7) $q_n = 0.4495kN/mm$

hence $q_m = 0.6197kN/mm$

Step 4

Evaluate θ_n

Equation (A.15) $c = 0.94523$; $0 < \eta < \frac{1}{c}$

$$\frac{1}{c} = 1.079$$

$$c^2 = 0.89346$$

Try $\eta_1 = 0.50$

Equation (A.17) $\Omega_{cp} = 0.10138$

Equation (A.18) $f(\eta) = 0.01193$

Equation (A.19) $f'(\eta) = 0.59776$

Hence using the recursion formula (equation A.20)

$$\eta_2 = 0.48004$$

Repeat step 4 until convergence in η is obtained and then deduce θ_n from

$$\tan \theta_n = \eta c$$

From the strains, work out λ, the effective peak concrete stress. If the difference from the previous value of λ is significant, repeat step 4 with the new value of λ until satisfactory convergence is obtained. Further progress of the iteration process is shown in Table A.1.

Consider the evaluation of θ_b

$$c = 0.53789 \qquad 0 < \eta < \frac{1}{c}$$

$$\frac{1}{c} = 1.8591$$

$$c^2 = 0.28933$$

Assume transverse steel yielding

Equation (A.16) $f_{cp} = 9.467$

Equation (3.21) $\Omega_{cp} = 0.14151$

Hence $\varepsilon_{cp} = 0.283 \times 10^{-3}$

and $\varepsilon_v = 7.860 \times 10^{-3} > \varepsilon_{vy}$

Transverse steel yielding and hence

$$\tan\theta_b = c = 0.53789$$

The above procedures are repeated at all the chosen levels depending on whether or not the transverse steel is yielding. On obtaining the full set, a new value for C_2, the compression in cracked concrete below the neutral axis is determined together with its point of action.

Step 5

With the new value of C_2 check the equilibrium of the section. If equilibrium does not exist, repeat steps 2,3 and 4 with new values for y_n until equilibrium is established. See Table A.1.

Note that in Table A.1, the effective peak concrete stress was not revised and so the results

represent only one step of iteration with respect to the peak concrete stress, λ.

y_n (mm)	Level	q N/mm	ε	Links yield? NO / YES	Links elastic: Iterations for η					Principal angle of compression	Initial value of C_2	Final value of C_2	REMARKS
					1	2	3	4	5				
120	1	449.5	0.945		0.500	0.480	0.478			24.35	393.11	252.19	Guess another y_n
	2	619.7	0.686	YES	-	-	-			34.44			
	3	789.9	0.538	YES	-	-	-			28.28			
80	1	284.4	1.494	NO	0.400	0.335	0.285	0.303	0.302	24.26	607.92	389.74	Guess another y_n
	2	582.3	0.730	YES	-	-	-	-	-	36.12			
	3	880.1	0.483	YES	-	-	-	-	-	25.77			
148.9	1	555.1	0.765	NO	0.500	0.622	0.595	0.592		24.40	77.39	259.59	Guess another y_n
	2	558.9	0.760	NO	0.980	0.399	0.998			37.19			
	3	562.7	0.755	YES	-	-	-	-		37.24			
132.6	1	526.5	0.807	NO	0.560	0.502				24.39	243.19	223.30	Guess another y_n
	2	602.6	0.705	YES	-	-	-	-	-	35.19			
	3	676.7	0.626	YES	-	-	-	-	-	32.06			
134.2	1	513.5	0.827	NO	0.547	0.548	-	-	-	24.38	225.64	213.48	Guess another y_n
	2	589.8	0.720	YES	-	-	-	-	-	35.77			
	3	606.0	0.650	YES	-	-	-	-	-	32.54			
136.7	1	514.2	0.826	NO	0.548	0.549	-	-	-	24.38	198.83	205.07	Guess another y_n
	2	580.6	0.732	YES	-	-	-	-	-	36.20			
	3	646.9	0.657	YES	-	-	-	-	-	33.30			
135.9	1	507.2	0.838	NO	0.541	0.541	-	-	-	24.38	207.36	205.94	Satisfactory Convergence
	2	580.1	0.732	YES	-	-	-	-	-	36.22			
	3	652.9	0.651	YES	-	-	-	-	-	33.05			

Table A1 : Iteration Process

APPENDIX B

COMPUTER PROGRAM

B.1 Program Capabilities

The program is capable of solving the response of solid rectangular reinforced concrete section whose material and geometrical properties and the ratio of moment to shear are known. It will also handle prestressed concrete sections for certain values of prestressing force.

B.2 Input of data

The following symbols are used in the program for input of data. Their respective descriptions are included here.

NLCB	Number of different sections to be analysed
NSPECIMEN	Beam number (for example 1 for CFT-TB1)
SMSR	Ratio of moment to shear in section
ACS	Area of top longitudinal steel
YSH	Yield strain of transverse steel
YST	Yield strain of bottom longitudinal steel
YHS	Yield stress of transverse steel
MES	Modulus of elasticity of bottom longitudinal steel
YTS	Yield stress of bottom longitudinal steel
BRS	Width of section
EPZERO	Concrete strain at peak concrete stress

YSC	Yield strain of top longitudinal steel
DP	Depth to centre of mass of prestress steel
AHS	Area of transverse steel
ATS	Area of bottom longitudinal steel
PCS	Peak concrete stress
SPACING	Spacing of transverse steel
D1	Depth to centre of mass of bottom longitudinal steel
D2	Depth to centre of mass of top longitudinal steel
MESC	Modulus of elasticity of top longitudinal steel
MESH	Modulus of elasticity of transverse steel
APS	Area of prestressing steel
YPS	Yield stress of prestressing steel
YSP	Yield strain of prestressing steel

The input data is accessed by READ statements in the program. In Appendix B.6, the input data for the eight test beams is presented. The data is in six separate subfiles as shown separated by the horizontal lines. At the beginning of each subfile, the number of different sections to be analysed is entered. On the next line the beam number and ratio of moment to shear in the section under consideration are entered. Material and section properties are then entered on the next two lines. Hereafter, other sections can be

considered upto the maximum number specified, by repeating operation of lines 2 to 4. Note that the data is entered in the order in which the symbols have been described above.

B. 3 Steps of the Program

The program carries out an iterative scheme as discussed in the theory presented in Chapter 3. The working of the program is summarised by the flow charts presented in figures B.1 (a) - (j). In this program, Simpson's Integration rule has been applied for five ordinates instead of the three considered in the theory. Equations (3.11) and 3.12) are therefore revised to:-

$$C_2 = \frac{d-y_n}{12}(q_n \cot\theta_n + 4q_u \cot\theta_u + 2q_m \cot\theta_m + 4q_\ell \cot\theta_\ell + q_b \cot\theta_b)$$

and

$$\bar{x}_2 = d-y_n \left(\frac{q_n \cot\theta_n + 3q_u \cot\theta_u + q_m \cot\theta_m + q_\ell \cot\theta_\ell}{q_n \cot\theta_n + 4q_u \cot\theta_u + 2q_m \cot\theta_m 4q_\ell \cot\theta_\ell + q_b \cot\theta_b}\right).$$

Where u and ℓ are new positions at the mid-points of the top half and bottom half, respectively of the region below the neutral axis (see Figure 3.1). The other symbols are as defined before. Further information about the steps of the program is available from the program listing given in Appencix B.5 by means of comment statements.

B.4 Output of Results

The notation used in the input of data is also used in the printout of the input data except where specified. The required convergence parameters for a chosen top face strain value are output in a suitable tabular form as shown in Table B.1. The new symbols used are as defined below:-

SHS	Spacing of transverse steel
PMOMENT	Pure moment value from consideration of pure flexure theory
PCUR	Curvature due to the pure moment
MOMENT	Moment for the combined moment and shear loading consideration
CUR	Curvature due to the above moment
SHEAR	Shear force in section
ANGLES	The angles of principal compression at each of the five levels considered
SHEAR FLOW	Corresponding shear flow values
LSTR	Corresponding longitudinal strains
TRST	Corresponding transverse strains
DIAGST	Corresponding principal compression strains
FCP	Corresponding principal compressive stresses
FCD	Corresponding effective peak concrete stresses
COUNTERS	Number of iterations to convergence: the first five corresponding respectively to convergence in strains at each of the chosen levels and the last representing the overall number for convergence of the forces on section

B.5 Program Listing

```
FORTRAN COMPILATION BY \XFAT MK 6A    DATE  21/01/84  TIME  11/00/07


0005                  SEND TO (20,SEMICOMPILED)
0006                  LIST
0007                  ADD DUMP (20,PROGRAM HTXX)
0008                  LIBRARY(SUBGROUPSRF7)
0009                  LIBRARY(SUBGROUPSRGP)
0010                  LIBRARY(SUBGROUPFSCD)
0011                  LIBRARY(SUBGROUPS-RS)
0012                  PROGRAM (MIMI)
0013                  COMPRESS INTEGER AND LOGICAL
0014                  EXTENDED DATA
0015                  TRACE 2
0016                  INPUT 100 =CRJ
0017                  OUTPUT 200 =LPO
0018                  END



0019                  MASTER CLAS
0020                  WRITE(2,101)
0021                  WRITE(2,101)
0022                  WRITE(2,102)
0023                  COMMON /BLK1/ D1,D2,T3,T1,PRODUCT,XBAR,YST,YTS,C2
0024                  COMMON /BLK2/ YN,PUREMOMENT,IND3
0025                  COMMON /BLK4/ PCS,BRS,EPZERO,PCUR,ETA,I,IF,MA1,MA2,MA3,MA4,MA5
0026                  COMMON /BLK5/ MES,YSC,ATS,B2,YCS,ACS,SMSR
0027                  COMMON /BLK6/ Q3,QN,AM,W0,RL,RM,V,YSH,YHS,AHS,SPACING,L
0028                  COMMON /BLK7/ RATIO2,RATIO3,K,X
0029                  COMMON /BLK9/ ANGLES(5),A(5),B(5),C2(5)
0030                  COMMON /BLK11/ RLOS(5),TRST(5),DIAG(5)
0031                  COMMON /BLK12/ VA(5),CST(5),FRACTION(1000),DD(100)
0032                  COMMON /BLK14/ M1,M2,M3,M4,M5,KC1,KC2,KC3,KC4,KC5,KC6
0033                  COMMON /BLK15/ APS,YPS,YSP,MESP,DEP,DP,KA,KE,KI,RNVC,RNSC,RCH
0034                  DIMENSION IC(50,5)
0035                  READ(1,5000) NLCB
0036            5000  FORMAT(I2)
0037                  IPAGE=1
0038                  DO 600 N=1,NLCB
0039                  IF=0
0040                  ILINE=0
0041                  IPAGE=IPAGE+1
0042                  READ(1,5005) NSPECIMEN,SMSR
0043            5005  FORMAT(I2,F5.0)
0044                  WRITE(2,200) NSPECIMEN
0045            200   FORMAT('1',////////////////////,12X,'PREDICTIONS FOR BEAM CFT-TB',
0046                 1 1,10X,'SOURCES SHITOTE UNIVERSITY OF NAIROBI(1983)')
0047                  WRITE(2,300)
0048            300   FORMAT(//,30X,'TABLE OF INPUT MATERIAL AND SECTION PROPERTIES')
0049                  WRITE(2,400)
0050            400   FORMAT(10X,'BRS',9X,'DTS',9X,'DCS',9X,'ATS',9X,'ACS',9X,'AHS'
0051                 1,9X,'SHS')
0052                  READ(1,500) ACS,YSH,YST,YHS,MCS,YTS,BRS,EPZERO,YSC,YCS,DP
0053            500   FORMAT(4F10.0,10,6F10.0)
0054                  READ(1,700) AHS,ATS,PCS,SPACING,D1,D2,MESC,MCSP,APS,YPS,YSP,
0055                 1 DP
0056            700   FORMAT(6F10.0,2I0,4F10.0)
0057                  WRITE(2,800) BRS,D1,D2,ATS,ACS,AHS,SPACING
0058            800   FORMAT(10X,7(2X,E10.4))
0059                  WRITE(2,900)
0060            900   FORMAT(//,10X,'YTS',9X,'YCS',9X,'YHS',9X,'PCS',9X,'YST',9X,'YSC',
0061                 1 9X,'YSH')
0062                  WRITE(2,1000) YTS,YCS,YHS,PCS,YST,YSC,YSH
0063            1000  FORMAT(10X,7(2X,E10.4))
0064                  WRITE(2,1003) EPZERO
0065                  WRITE(2,5010) SMSR
0066            5010  FORMAT(///,40X,'MOMENT-SHEAR RATIO=',F5.1)
0067                  WRITE(2,5015) IPAGE
0068            5015  FORMAT('1',////////////,113X,'PAGE',I4)
0069            C     VARY WRITE STATEMENTS ACCORDINGLY IF RC OR PC IS BEING
0070            C     ANALYSED
0071            C     BRS-BREADTH OF SECTION
```

```
0072            C       DTS=DEPTH TO TENSION STEEL
0073            C       DCS=DEPTH TO COMPRESSION STEEL
0074            C       ATS=AREA OF TENSION STEEL
0075            C       ACS=AREA OF COMPRESSION STEEL
0076            C       AHS=AREA OF HOOP STEEL
0077            C       SHS=SPACING OF HOOP STEEL
0078            C       YTS=YIELD STRESS OF TENSION STEEL
0079            C       YCS=YIELD STRESS OF COMPRESSION STEEL
0080            C       YHS=YIELD STRESS OF HOOP STEEL
0081            C       PCS=PEAK CONCRETE STRESS
0082            C       YST=YIELD STRAIN OF TENSION STEEL
0083            C       YSC=YIELD STRAIN OF COMPRESSION STEEL
0084            C       YSH=YIELD STRAIN OF HOOP STEEL
0085            C       MES=MODULUS OF ELASTICITY OF STEEL
0086            C       B1=STRESS BLOCK FACTOR FOR ULTIMATE STRENGTH
0087            C       B2=STRESS BLOCK FACTOR FOR DEPTH TO NEUTRAL AXIS
0088            C       APS=AREA OF PRESTRESS STEEL
0089            C       YSP=YIELD STRAIN OF PRESTRESS STEEL
0090            C       YPS=YIELD STRESS OF PRESTRESS STEEL
0091            C       DEP=STRAIN DIFFERENCE DUE TO PRESTRESSING OPERATION
0092            C       DP=DEPTH TO PRESTRESS STEEL
0093            C       MESP=MODULUS OF ELASTICITY OF PRESTRESS STEEL
0094            C       MESC=MODULUS OF ELASTICITY OF COMPRESSION STEEL
0095            C       T1=CHOSEN TOP FACE STRAIN
0096                    CZ(1),CZ(2),CZ(3),CZ(4),CZ(5)=PCS
0097                    CST(1),CST(2),CST(3),CST(4),CST(5)=0.
0098                    M1,M2,M3,M4,M5,M6=0
0099                    T1=0.0
0100                    KC=0
0101                    DO 1100 NSTRAINLOOP=1,21
0102                    KC1,KC2,KC3,KC4,KC5,KC6=0
0103                    T1=T1+0.0002
0104                    MA1,MA2,MA3,MA4,MA5=0
0105                    B2=(4-(T1/EPZERO))/(6-(2*T1/EPZERO))
0106                    PRODUCT=(T1/EPZERO)-((T1**2)/(3*(EPZERO**2)))
0107                    CALL PURE
0108                    X=YN
0109            7000    YN=0.75*YN
0110                    CALL TRAPEZ
0111                    XCAR=(D1-YN)/2
0112                    CALL UPDATE
0113                    IF(IF.EQ.1) GO TO 601
0114                    IF(AN.LT.0.0) YN=SP
0115                    IF(AN.LT.0.0) GO TO 7000
0116                    K=0
0117                    CALL SOLUTION
0118                    IF(ABS(RATIO2).GT.0.01) GO TO 1020
0119                    IF(ABS(RATIO3).LT.0.01) GO TO 1030
0120            1020    YN=0.75*YN
0121                    CALL TRAPEZ
0122                    CALL UPDATE
0123                    IF(IF.EQ.1) GO TO 1100
0124                    IF(AN.LT.0.0) YN=SP
0125                    IF(AN.LT.0.0) GO TO 7000
0126                    CALL SOLUTION
0127                    IF(ABS(RATIO2).GT.0.01) GO TO 1040
0128                    IF(ABS(RATIO3).LT.0.01) GO TO 1030
0129            1040    CALL LINEARFIT
0130                    CALL TRAPEZ
0131                    CALL UPDATE
0132                    IF(IF.EQ.1) GO TO 601
0133                    IF(AN.LT.0.0) YN=SP
0134                    IF(AN.LT.0.0) GO TO 7000
0135                    CALL SOLUTION
0136                    IF(ABS(RATIO2).GT.0.01) GO TO 1050
0137                    IF(ABS(RATIO3).LT.0.01) GO TO 1030
0138            1050    IF(K.GT.15) WRITE(2,105) T1
0139            105     FORMAT(10X,'TOP FACE STRAIN=',F7.5,//,10X,'NO CONVERGENCE AFTER 15
0140                1   MAJOR LOOPS',//,15X,'-ITERATIONS ABANDONED')
0141                    IF(K.GT.15) GO TO 1100
0142                    GO TO 1040
0143            1030    PCON=T1/A
0144                    IF(VA(5).LT.CST(5)) M5=5
0145                    IF(VA(4).LT.CST(4).AND.M5.EQ.5) M4=4
0146                    IF(VA(3).LT.CST(3).AND.M5.EQ.5) M3=3
0147                    IF(VA(2).LT.CST(2).AND.M5.EQ.5) M2=2
0148                    IF(VA(1).LT.CST(1).AND.M5.EQ.5) M1=1
0149                    JN=NSTRAINLOOP+KC
```

```
      IC(JN,1)=M1
      IC(JN,2)=M2
      IC(JN,3)=M3
      IC(JN,4)=M4
      IC(JN,5)=M5
      IF(JN.GT.1) GO TO 1001
      GO TO 1002
 1001 IF(IC(JN,1).GT.IC((JN-1),1).OR.IC(JN,2).GT.IC((JN-1),2).OR.
     1IC(JN,3).GT.IC((JN-1),3).OR.IC(JN,4).LT.IC((JN-1),4).OR.
     2IC(JN,5).GT.IC((JN-1),5)) GO TO 1003
 1002 COR=T1/FM
      SP=FM
      DO 15 M=1,5
      ANGLES(M)=ANGLES(M)*180.0/3.1415926
   15 CONTINUE
      WRITE(2,1005) T1
      IF(RNVC.EQ.1) WRITE(2,4015) RNVC,RNSC
      IF(RCH.EQ.1) WRITE(2,4016) RCH
      IF(KILL.EQ.1) WRITE(2,4017)
      WRITE(2,2000)
      WRITE(2,2010) PURMOMENT,PCUR,RM,CUR,V
      WRITE(2,2020)
      WRITE(2,2030)
      WRITE(2,2035) ANGLES(1),ANGLES(2),ANGLES(3),ANGLES(4),ANGLES(5)
      WRITE(2,2036) QN,QQ,QM,QL,QQ
      WRITE(2,2040) RLOS(1),RLOS(2),RLOS(3),RLOS(4),RLOS(5)
      WRITE(2,2042) TRST(1),TRST(2),TRST(3),TRST(4),TRST(5)
      WRITE(2,2043) DIAG(1),DIAG(2),DIAG(3),DIAG(4),DIAG(5)
      WRITE(2,2041) A(1),A(2),A(3),A(4),A(5)
      WRITE(2,2042) B(1),B(2),B(3),B(4),B(5)
      WRITE(2,2045) KC1,KC2,KC3,KC4,KC5,KC6
      WRITE(2,2070)
  100 FORMAT(30X,'BEHAVIORAL RESPONSE PREDICTION FOR STRUCTURAL')
  101 FORMAT(32X,'CONCRETE BEAM IN COMBINED MOMENT AND SHEAR')
  102 FORMAT(29X,'LOADING USING COMPRESSION FIELD THEORY ANALYSIS')
  105 FORMAT(//,32X,'CONCRETE STRAIN AT PEAK STRESS=',E10.4)
 1005 FORMAT(11X,'TOP FACE STRAIN=',F7.3)
 2000 FORMAT(//,19X,'PMOMENT',7X,'PCUR',6X,'MOMENT',6X,'CUR',8X,'SHEAR')
 2010 FORMAT(17X,E10.4,4(2X,E10.4))
 2020 FORMAT(//,23X,'ANGLES,SHEAR FLOWS,LSTR,TRST,DIAGST AT LEVELS SHOWN
     1')
 2030 FORMAT(24X,'1',11X,'2',11X,'3',11X,'4',11X,'5')
 2035 FORMAT(20X,F7.2,4(5X,F7.2))
 2040 FORMAT(14X,5(4X,E9.3))
 2041 FORMAT(11X,'FCP',5(4X,E9.3))
 2042 FORMAT(11X,'FCD',5(4X,E9.3))
 2045 FORMAT(5X,'COUNTERS',1X,6(6X,I4))
 2070 FORMAT(10X,'----------------------------------------------------
     1----------')
 4015 FORMAT(10X,'SHEAR EQUILIBRIUM WITHIN SET ACCURACY NOT POSSIBLE',//,
     1 20X,'RNVC=',F6.3,5X,'RNSC=',F6.3)
 4016 FORMAT(10X,'EFFECTIVE PEAK CONCRETE STRESS WITHIN SET ACCURACY NOT
     1 POSSIBLE',//,'RCH=',F6.3)
 4017 FORMAT(10X,'SOME ANGLES NOT WITHIN SET ACCURACY-BUT SATISFACTORILY
     1 CLOSE')
      CST(1)=VA(1)
      CST(2)=VA(2)
      CST(3)=VA(3)
      CST(4)=VA(4)
      CST(5)=VA(5)
      CZ(1)=B(1)
      CZ(2)=B(2)
      CZ(3)=B(3)
      CZ(4)=B(4)
      CZ(5)=B(5)
      ILINE=ILINE+1
      IF(ILINE.GT.2.AND.NSTRAINLOOP.LT.21) GO TO 805
      GO TO 1100
  805 ILINE=0
      IPAGE=IPAGE+1
      WRITE(2,803) IPAGE
      GO TO 1100
 1003 NSTRAINLOOP=NSTRAINLOOP-1
      T1=T1-.00025
      KC=KC+1
 1100 CONTINUE
  601 CALL FIRSTCRACKS
  803 FORMAT('1',////////,113X,'PAGE',I3)
```

```
0228          600   CONTINUE
0229                STOP
0230                END

END OF SEGMENT, LENGTH  1577, NAME  CLA3



0231                SUBROUTINE PURE
0232          C     SEGMENT COMPUTES PURE MOMENT VALUE FOR SECTION USING PURE
0233          C     FLEXURE THEORY
0234          C     YN IS THE DEPTH TO THE NEUTRAL AXIS
0235          C     T2=TOP STEEL STRAIN
0236          C     T3=BOTTOM STEEL STRAIN
0237                COMMON /BLK1/ D1,D2,T3,T1,PRODUCT,XBAR,YST,YTS,C2
0238                COMMON /BLK2/ YN,PUREMOMENT,IND3
0239                COMMON /BLK3/ T2,CONFORCE
0240                COMMON /BLK4/ PCS,BRS,EPZERO,PCUR,ETA,I,IF,MA1,MA2,MA3,MA4,MA5
0241                COMMON /BLK5/ MES,YSC,ATS,BC,YCS,ACS,SMOR
0242                COMMON /BLK15/ APS,YPS,YSP,MESP,DEP,DP,KA,KE,KI,RNVC,RNSC,RCH
0243                PPB=PRODUCT*PCS*BRS
0244                YN=((ATS*YTS)+(APS*YPS)-(ACS*YCS))/(PRODUCT*PCS*BRS)
0245                CALL TRIPLE
0246                IF((T2.GT.YSC.OR.T2.EQ.YSC).AND.(T3.GT.YST.OR.T3.EQ.YST)
0247               1.AND.(T4.GT.YSP.OR.T4.EQ.YSP.OR.YSP.EQ.0.)) GO TO 1
0248                TERM1=((ACS*T1*MESC)-(ATS*YTS)+(APS*MESP*T1))/(2*PPB)
0249                TERM2=((ACS*D2*T1*MESC)+(APS*MESP*DP*T1))/PPB
0250                TERM3=TERM1**2
0251                YN=SQRT(TERM3+TERM2)-TERM1
0252                CALL TRIPLE
0253                IF((T3.GT.YST.OR.T3.EQ.YST).AND.T2.LT.YSC.AND.(T4.LT.
0254               1YSP.OR.YSP.EQ.0.)) GO TO 2
0255                TERM1=((ACS*YCS)+(ATS*MES*T1)+(APS*MESP*T1))/(2*PPB)
0256                TERM2=((ATS*MES*D1*T1)-(APS*MESP*DP*T1))/PPB
0257                TERM3=TERM1**2
0258                YN=SQRT(TERM3+TERM2)-TERM1
0259                CALL TRIPLE
0260                IF((T2.GT.YSC.OR.T2.EQ.YSC).AND.T3.LT.YST.AND.(T4.LT.
0261               1YSP.OR.YSP.EQ.0.)) GO TO 3
0262                TERM1=((ACS*T1*MESC)-(APS*YPS)+(ATS*MES*T1))/(2*PPB)
0263                TERM2=((ACS*D2*T1*MESC)+(ATS*MES*D1*T1))/PPB
0264                TERM3=TERM1**2
0265                YN=SQRT(TERM3+TERM2)-TERM1
0266                CALL TRIPLE
0267                IF((T4.GT.YSP.OR.T4.EQ.YSP.OR.YSP.EQ.0.).AND.T2.LT.YSC
0268               1.AND.T3.LT.YST) GO TO 4
0269                TERM1=((ACS*YCS)-(ATS*YTS)+(APS*MESP*T1))/(2*PPB)
0270                TERM2=(APS*MESP*DP*T1)/PPB
0271                TERM3=TERM1**2
0272                YN=SQRT(TERM3+TERM2)-TERM1
0273                CALL TRIPLE
0274                IF((T4.LT.YSP.OR.T4.EQ.YSP.EQ.0.).AND.(T2.GT.YSC.OR.T2.EQ.YSC
0275               1).AND.(T3.GT.YST.OR.T3.EQ.YST)) GO TO 5
0276                TERM1=((ACS*YCS)-(APS*YPS)+(ATS*MES*T1))/(2*PPB)
0277                TERM2=(ATS*MES*D1*T1)/PPB
0278                TERM3=TERM1**2
0279                YN=SQRT(TERM3+TERM2)-TERM1
0280                CALL TRIPLE
0281                IF((T3.LT.YST).AND.(T2.GT.YSC.OR.T2.EQ.YSC).AND.
0282               1(T4.GT.YSP.OR.T4.EQ.YSP.OR.YSP.EQ.0.)) GO TO 1
0283                TERM1=((ACS*MESC*T1)-(ATS*YTS)-(APS*YPS))/(2*PPB)
0284                TERM2=(ACS*MESC*D2*T1)/PPB
0285                TERM3=TERM1**2
0286                YN=SQRT(TERM3+TERM2)-TERM1
0287                CALL TRIPLE
0288                IF((T2.LT.YSC).AND.(T3.GT.YST.OR.T3.EQ.YST).AND.
0289               1(T4.GT.YSP.OR.T4.EQ.YSP.OR.YSP.EQ.0.)) GO TO 4
0290                TERM1=((ACS*MESC*T1)+(ATS*MES*T1)+(APS*MESP*T1))/(2*PPB)
0291                TERM2=((ACS*MESC*D2*T1)-(ATS*MES*D1*T1)-(APS*MESP*DP*T1))/PPB
0292                TERM3=TERM1**2
0293                YN=SQRT(TERM3+TERM2)-TERM1
0294                CALL TRIPLE
0295          2           PUREMOMENT=(ACS*MESC*T2*(D1-D2))+CONFORCE*(D1-((D2*YN)/2))
0296               1-(APS*MESP*T4*(D1-DP))
0297                RETURN
0298          1     PUREMOMENT=(ACS*YCS*(D1-D2))+CONFORCE*(D1-((D2*YN)/2))
```

```
0327                SUBROUTINE UPDATE
0328          C     SEGMENT UPDATES MAJOR VARIABLES DURING ITERATIONS
0329          C     RM,V ARE THE MOMENT AND SHEAR RESPECTIVELY
0330          C     RLEVER IS THE LEVER ARM
0331          C     QN,QU,QM,QL,QB ARE THE SHEAR FLOWS
0332          C     SEGMENT ENSURES SHEAR EQUILIBRIUM ON SECTION
0333                COMMON /BLK1/ D1,D2,T3,T1,PRODUCT,XBAR,YST,YTS,C2
0334                COMMON /BLK2/ YN,PURE MOMENT,IND3
0335                COMMON /BLK3/ T2,CONFORCE
0336                COMMON /BLK4/ PCS,BRS,EPZERO,PCUR,ETA,I,IF,MA1,MA2,MA3,MA4,MA5
0337                COMMON /BLK5/ MES,YSC,ATS,BC,YCS,ACS,SMSR
0338                COMMON /BLK6/ QB,QN,QM,QU,QL,RM,V,YSH,YHS,AHS,SPACING,L
0339                COMMON /BLK9/ ANGLES(5),A(5),B(5),CZ(5)
0340                COMMON /BLK10/ FORCE(2),DIST(2)
0341                COMMON /BLK11/ RLOS(5),TRST(5),DIAG(5)
0342                COMMON /BLK13/ FCD,FCP,ECP,EV,RLS,C
0343                COMMON /BLK14/ M1,M2,M3,M4,M5,KC1,KC2,KC3,KC4,KC5,KC6
0344                COMMON /BLK15/ APS,YPS,YSP,MESP,DEP,DP,KA,KE,KI,RNVC,RNSC,RCH
0345                KAI=0
0346                IND3=0
0347                KA,KE=0
0348                CS=ACS*MES*T2
0349                IF(T2.GT.YSC.OR.T2.EQ.YSC) CS=ACS*YCS
0350                T=ATS*MES*T3
0351                IF(T3.GT.YST.OR.T3.EQ.YST) T=ATS*YTS
0352                TP=APS*MESP*T4
0353                IF(T4.GT.YSP.OR.T4.EQ.YSP) TP=APS*YPS
0354                C2=T+TP-CS-CONFORCE
0355                RLEVER=(((CS*(D1-D2))+CONFORCE*(D1-((D2*YN)/2))+(C2*XBAR)
0356               1-(TP*(D1-DP)))/T
0357                FORCE(1)=C2
0358                DIST(1)=XBAR
0359                RM=T*RLEVER
0360                V=RM/SMSR
0361                QB=V/RLEVER
0362          15    QN=(C2*V/D1)*(1-((D1-YN)/(2*RLEVER)))
0363          14    QM=(QB+QN)/2
```

```
0299                1-(APS*YPS*(D1-DP))
0300                 RETURN
0301          3      PUREMOMENT=(ACS*YCS*(D1-D2))+CONFORCE*(D1-((D2*YN)/2))
0302                1-(APS*MESP*T4*(D1-DP))
0303                 RETURN
0304          4      PUREMOMENT=(ACS*MESC*T2*(D1-D2))+CONFORCE*(D1-((D2*YN)/2))
0305                1-(APS*YPS*(D1-DP))
0306                 RETURN
0307          5      PUREMOMENT=(ACS*YCS*(D1-D2))+CONFORCE*(D1-((D2*YN)/2))
0308                1-(APS*MESP*T4*(D1-DP))
0309                 RETURN
0310                 END

END OF SEGMENT, LENGTH  1129, NAME  PURE


0311                 SUBROUTINE TRIPLE
0312           C     SEGMENT COMPUTES STRAIN PROFILE FOR GIVEN TOP FACE STRAIN
0313           C     AND DEPTH TO N.A
0314           C     CONFORCE IS THE T.F.W. CONCRETE FORCE ABOVE THE N.A
0315                 COMMON /BLK1/ D1,D2,T3,T1,PRODUCT,XBAR,YST,YTS,C2
0316                 COMMON /BLK2/ YN,PUREMOMENT,ICD
0317                 COMMON /BLK3/ T2,CONFORCE
0318                 COMMON /BLK4/ PCS,BRS,EPZERO,PCUR,ETA,I,LF,MA1,MA2,MA3,MA4,MA5
0319                 COMMON /BLK15/ APS,YPS,YSP,MESP,DEP,DP,KA,KE,KI,RNVC,RNSC,RCH
0320                 T2=((YN-D2)*T1)/YN
0321                 T3=((D1-YN)*T1)/YN
0322                 CONFORCE=PRODUCT*PCS*BRS*YN
0323                 E S=((D1-YN)*T1)/YN
0324                 T4=ECS+DEP
0325                 RETURN
0326                 END

END OF SEGMENT, LENGTH    68, NAME  TRIPLE
```

```
0364                GU=AN+((AU-2N)/4)
0365                GL=AN+(2.*(AB-AN)/4)
0366                IF(AN.LT.0.0) RETURN
0367                RNEV=GU
0368                RNES=AN
0369                DO 10 NL=1,3
0370                L=NL-1
0371                IND10,IND11,IND12,IND13=0
0372                FCO=CZ(L+1)
0373           5    CALL ALLRNGLES
0374                IF(IFAIL.EQ.1) RETURN
0375                OME=ACP=CCP/EPZERO
0376                ECT=EV+CCP+RLS
0377                FCE=PCS/(.6+(.34*ECT/EPZERO))
0378                RCH=(FCO-FCE)/FCO
0379                FCO=FCE
0380                IF(ABS(RCH).LT..001) GO TO 10
0381                IND3=1
0382                IF(MA1.GT.200.AND.L.EQ.0) GO TO 10
0383                IF(MA2.GT.200.AND.L.EQ.1) GO TO 10
0384                IF(MA3.GT.200.AND.L.EQ.2) GO TO 10
0385                IF(MA4.GT.200.AND.L.EQ.3) GO TO 10
0386                IF(MA5.GT.200.AND.L.EQ.4) GO TO 10
0387                IND3=0
0388                GO TO 5
0389           10   CONTINUE
0390                MA1,MA2,MA3,MA4,MA5=0
0391                KAI=KAI+1
0392                RNVC=(RNEV-QU)/QU
0393                RNSC=(RNES-QN)/QN
0394                IF(ABS(RNVC).LT..001.AND.ABS(RNSC).LT..001) GO TO 20
0395                IF(ABS(RNVC).LT..001.AND.ABS(RNSC).GT..001) GO TO 25
0396                IF(KAI.GT.15) GO TO 20
0397                RLEVER=V/QU
0398                GO TO 15
0399           25   IF(KAI.GT.15) GO TO 20
0400                V=AN*D1*RLEVER/((2*RLEVER)-D1-YN)
0401                RM=V*SMOR
0402                QU=V/RLEVER
0403                GO TO 14
0404           20   CALL EVALUATION
0405                IF(KAI.GT.15) KA=1
0406                IF(IND3.EQ.1) KL=1
0407                RETURN
0408                END

END OF SEGMENT, LENGTH   399, NAME  UPDATE



0409                SUBROUTINE LINKSYIELDING
0410           C    SEGMENT COMPUTES STRAINS FOR A CASE OF TRANSVERSE STEEL
0411           C   1YIELDING
0412           C    KC1,KC2,KC3,KC4,KC5 ARE LOOP COUNTERS FOR ITERATIONS AT
0413           C    RESPECTIVE LEVELS
0414           C    CCP-PRINCIPAL DIAGONAL CONCRETE STRAIN
0415           C    EV-TRANSVERSE STRAIN
0416                COMMON /BLK4/ PCS,BRS,EPZERO,PCUR,ETA,I,IF,MA1,MA2,MA3,MA4,MA5
0417                COMMON /BLK6/ QB,QN,QM,QU,QL,RM,V,YSH,YHS,AHS,SPACING,L
0418                COMMON /BLK13/ FCO,FCP,CCP,EV,RLS,C
0419                COMMON /BLK14/ M1,M2,M3,M4,M5,KC1,KC2,KC3,KC4,KC5,KC6
0420                IF(L.EQ.0) KC1=KC1+1
0421                IF(L.EQ.1) KC2=KC2+1
0422                IF(L.EQ.2) KC3=KC3+1
0423                IF(L.EQ.3) KC4=KC4+1
0424                IF(L.EQ.4) KC5=KC5+1
0425                IF(L.EQ.0) MA1=MA1+1
0426                IF(L.EQ.1) MA2=MA2+1
0427                IF(L.EQ.2) MA3=MA3+1
0428                IF(L.EQ.3) MA4=MA4+1
0429                IF(L.EQ.4) MA5=MA5+1
0430                IF(L.EQ.0.AND.M1.EQ.1) GO TO 2
0431                IF(L.EQ.1.AND.M2.EQ.2) GO TO 2
0432                IF(L.EQ.2.AND.M3.EQ.3) GO TO 2
0433                IF(L.EQ.3.AND.M4.EQ.4) GO TO 2
0434                IF(L.EQ.4.AND.M5.EQ.5) GO TO 2
```

```
0435                OMEGACP=1-SQRT(1-(FCP/FCO))
0436                GO TO 1
0437          2     OMEGACP=1+SQRT(1-(FCP/FCO))
0438          1     ECP=OMEGACP*EPZERO
0439                EV=(((ECP*(1-(C**2)))+RLS)/(C**2)
0440                ETA=EV/YSH
0441                RETURN
0442                END

END OF SEGMENT, LENGTH   340, NAME  LINKSYIELDING



0443                SUBROUTINE ALLANGLES
0444          C     SEGMENT COMPUTES ANGLES AT ALL LEVELS
0445          C     AND STRAINS FOR A CASE OF TRANSVERSE STEEL IN ELASTIC RANGE
0446          C     ETA IS ASSUMED TRANSVERSE STRAIN FACTOR
0447          C     FN,FNBAR1,FNBAR2 ARE TERMS FOR USE IN THE RECURSION
0448          C     FORMULA
0449                COMMON /BLK1/ D1,D2,T3,T1,PRODUCT,XBAR,YST,YTS,C2
0450                COMMON /BLK4/ FCO,BRS,EPZERO,FCUR,ETA,I,IF,MA1,MA2,MA3,MA4,MA5
0451                COMMON /BLK6/ XS,XN,XM,XU,XL,XM,V,YSH,YHS,ANS,SPACING,L
0452                COMMON /BLK9/ ANGLES(5),A(5),B(5),C2(5)
0453                COMMON /BLK11/ RLS(5),TRST(5),DIAG(5)
0454                COMMON /BLK12/ VA(5),CST(5),FRACTION(1000),DD(100)
0455                COMMON /BLK13/ FCO,FCP,ECP,EV,RLS,C
0456                COMMON /BLK14/ M1,M2,M3,M4,M5,KC1,KC2,KC3,KC4,KC5,KC6
0457                DIMENSION BBB(100)
0458                ME=0
0459                KI=0
0460                IF(L.EQ.0) Q=XN
0461                IF(L.EQ.1) Q=XU
0462                IF(L.EQ.2) Q=XM
0463                IF(L.EQ.3) Q=XL
0464                IF(L.EQ.4) Q=XB
0465                OMEGAS=T3/EPZERO
0466                OMEGAVY=YSH/EPZERO
0467                C=(ANS*YHS)/(SPACING*2)
0468                RLS=T3*L/4.
0469                FCP=(Q*(1+(C**2)))/(BRS*C)
0470                IF(FCP.GT.FCO) GO TO 641
0471                CALL LINKSYIELDING
0472                GO TO 642
0473          641   Q=.9*Q
0474                ME=ME+1
0475                C=(ANS*YHS)/(SPACING*2)
0476                FCP=(Q*(1+(C**2)))/(BRS*C)
0477                IF(Q.LT.1E-11.OR.FCO.LT.0.0.OR.FCP.LT.0.0) IF=1
0478                IF(IF.EQ.1) WRITE(2,1000) T1
0479                D=1-(FCP/FCO)
0480                IF(ME.GT.100) WRITE(2,1000) T1
0481          1000  FORMAT(10X,'TOP FACE STRAIN=',F5.4,///,10X,'FOR GREATER DEFORMATION
                   1S CALCULATED CONCRETE STRESSES CONSISTENTLY EXCEED CALCULATED PEAK
                   2',//,10X,'CONCRETE STRESSES-FURTHER ITERATIONS ABANDONED')
0484                IF(ME.GT.100.OR.IF.EQ.1) RETURN
0485                IF(D.LE.0.0) GO TO 641
0486                ME=0
0487                CALL LINKSYIELDING
0488          642   IF(EV.GT.YSH.OR.EV.EQ.YSH) GO TO 6
0489                DDUMD1=1/C
0490                DDUMD2=(OMEGAS*L/(4*OMEGAVY*(C**2)))**(1.0/3)
0491                IND2=0
0492                IF(DDUMD1.LT.DDUMD2) IND2=1
0493                IF(DDUMD1.GT.DDUMD2) IND2=2
0494                IF(DDUMD2.LT.0.0) DDUMD2=0.0
0495          95    ETA=(DDUMD1+DDUMD2)/2.0
0496                KI=0
0497                FRACTION(1)=ETA
0498                I=1
0499          20    X1=ETA*C
0500                IF(L.EQ.0) KC1=KC1+1
0501                IF(L.EQ.1) KC2=KC2+1
0502                IF(L.EQ.2) KC3=KC3+1
0503                IF(L.EQ.3) KC4=KC4+1
0504                IF(L.EQ.4) KC5=KC5+1
0505                IF(L.EQ.0) MA1=MA1+1
```

```
0506                IF(L.EQ.1) MA2=MA2+1
0507                IF(L.EQ.2) MA3=MA3+1
0508                IF(L.EQ.3) MA4=MA4+1
0509                IF(L.EQ.4) MA5=MA5+1
0510                X2=A1**2
0511                A3=A2*ETA
0512                X4=A2**2
0513                A5=A1*A2
0514                X6=(1+A2)**2
0515                A7=1-A2
0516                X8=A7**2
0517                X9=1-A2
0518                A10=A3*ETA
0519                A12=A7**3
0520                FCP=(6*(1+((ETA*C)**2)))/(BRS*ETA*C)
0521                OMEGACP=((A3*OMEGAVY)-(OMEGAS*L/4))/A7
0522                IF(L.EQ.0.AND.M1.EQ.1) GO TO 50
0523                IF(L.EQ.1.AND.M2.EQ.2) GO TO 50
0524                IF(L.EQ.2.AND.M3.EQ.3) GO TO 50
0525                IF(L.EQ.3.AND.M4.EQ.4) GO TO 50
0526                IF(L.EQ.4.AND.M5.EQ.5) GO TO 50
0527                IF(OMEGACP.GT.1.0) GO TO 91
0528                GO TO 92
0529          91    I=I+1
0530                KI=1
0531                IF(I.GT.3) GO TO 7
0532                BOUND1=ETA
0533                GO TO 95
0534          50    IF(OMEGACP.GT.1.0) GO TO 92
0535                I=I+1
0536                KI=1
0537                IF(I.GT.3) GO TO 7
0538                BOUND2=ETA
0539                GO TO 95
0540          92    I=I+1
0541          100   X10=(2*OMEGACP)-(OMEGACP**2)
0542                X11=2-OMEGACP
0543                X12=1-OMEGACP
0544                Y1=4/(BRS*FCD)
0545                FN=((X1*X10)/(1+X2))-Y1
0546                FNDASH1=(((X3*OMEGAVY)-(C*OMEGAS*L/4.))*X11)/X6
0547                FNDASH2=((2.0*X12)/((1+X2)*X8))*((X5*OMEGAVY*X9)-(X4*
0548               1OMEGAS*L/2.0))
0549                FNDASH=FNDASH1+FNDASH2
0550                ETA=ETA-(FN/FNDASH)
0551                IF(IND2.EQ.1) GO TO 645
0552                IF(ETA.LT.BOUND1.AND.ETA.GT.BOUND2) GO TO 646
0553                IF(ETA.GT.BOUND1) IND10=1
0554                IF(ETA.GT.BOUND1) ETA=(BOUND1+FRACTION(I-1))/2.0
0555                IF(ETA.LT.BOUND2) IND11=1
0556                IF(ETA.LT.BOUND2) ETA=(BOUND2+FRACTION(I-1))/2.0
0557                GO TO 646
0558          645   IF(ETA.LT.BOUND1) IND12=1
0559                IF(ETA.LT.BOUND1) ETA=(BOUND1+FRACTION(I-1))/2.0
0560                IF(ETA.GT.BOUND2) IND13=1
0561                IF(ETA.GT.BOUND2) ETA=(BOUND2+FRACTION(I-1))/2.0
0562          646   FRACTION(I)=ETA
0563                RATIO1=(FRACTION(I)-FRACTION(I-1))/FRACTION(I)
0564                IF(ETA.LT.0.0) ETA=0.5
0565                IF(ABS(RATIO1).LT.0.01) GO TO 7
0566                GO TO 20
0567          7     ANGLES(L+1)=ATAN(ETA*C)
0568                EV=ETA*YBH
0569                X1=ETA*C
0570                X2=A1**2
0571                X3=A2*ETA
0572                X7=1-A2
0573                OMEGACP=((X3*OMEGAVY)-(OMEGAS*L/4.))/X7
0574                ECP=OMEGACP*EPZERO
0575                RLO(L+1)=RLS
0576                TRST(L+1)=EV
0577                DIAG(L+1)=ECP
0578                VA(L+1)=W
0579                IF(L.EQ.0) QN=Q
0580                IF(L.EQ.1) QO=Q
0581                IF(L.EQ.2) QM=Q
0582                IF(L.EQ.3) QL=Q
0583                IF(L.EQ.4) QS=Q
```

```
0534                  A(L+1)=FLP
0535                  B(L+1)=FLB
0536                  RETURN
0537            6     FLP=(B*(1+(C**2)))/(BRS*C)
0538                  ANGLES(L+1)=ATAN(C)
0539                  RLDS(L+1)=RLS
0540                  TRST(L+1)=SV
0541                  DIAS(L+1)=SDP
0542                  VA(L+1)=W
0543                  IF(L.EQ.0) QN=Q
0544                  IF(L.EQ.1) QU=Q
0545                  IF(L.EQ.2) QM=Q
0546                  IF(L.EQ.3) QL=Q
0547                  IF(L.EQ.4) QD=Q
0548                  A(L+1)=FLP
0549                  B(L+1)=FLB
0550                  RETURN
0551                  END
```

END OF SEGMENT, LENGTH 1051, NAME ALLANGLES

```
0552                  SUBROUTINE EVALUATION
0553            C     SEGMENT EVALUATES NEW VALUES OF C2 AND XBAR
0554                  COMMON /BLK1/ D1,D2,T3,T1,PRODUCT,XBAR,YST,YTS,C2
0555                  COMMON /BLK2/ YN,PUREMOMENT,IND3
0556                  COMMON /BLK6/ QB,QN,QM,QU,QL,RM,V,YSH,YHS,AHS,SPACING,L
0557                  COMMON /BLK9/ ANGLES(5),A(5),B(5),CZ(5)
0558                  COMMON /BLK10/ FORCE(2),DIST(2)
0559                  COTN=1/TAN(ANGLES(1))
0560                  COTU=1/TAN(ANGLES(2))
0561                  COTM=1/TAN(ANGLES(3))
0562                  COTL=1/TAN(ANGLES(4))
0563                  COTB=1/TAN(ANGLES(5))
0564                  C2=((D1-YN)/12)*((3N*COTN)+(4*QU*COTU)+(2*QM*COTM)+
0565                 1(4*QL*COTL)+(QB*COTB))
0566                  XBAR=((D1-YN)*((2N*COTN)+(3*QU*COTU)+(QM*COTM)+(QL*COTL)))
0567                 1/((4N*COTN)+(4*QU*COTU)+(2*QM*COTM)+(4*QL*COTL)+(QD*COTB))
0568                  FORCE(2)=C2
0569                  DIST(2)=XBAR
0570                  RETURN
0571                  END
```

END OF SEGMENT, LENGTH 201, NAME EVALUATION

```
0572                  SUBROUTINE SOLUTION
0573            C     SEGMENT FINDS RATIOS FOR TESTING CONVERGENCE
0574            C     K,KCO ARE LOOP COUNTERS
0575                  COMMON /BLK2/ YN,PUREMOMENT,IND3
0576                  COMMON /BLK7/ RATIO2,RATIO3,K,X
0577                  COMMON /BLK8/ DELTA(100),DEPTH(100)
0578                  COMMON /BLK10/ FORCE(2),DIST(2)
0579                  COMMON /BLK14/ M1,M2,M3,M4,M5,KC1,KC2,KC3,KC4,KC5,KC6
0580                  RATIO2=(FORCE(2)-FORCE(1))/FORCE(2)
0581                  RATIO3=(DIST(2)-DIST(1))/DIST(2)
0582                  K=K+1
0583                  KC6=KC6+1
0584                  DELTA(K)=FORCE(1)-FORCE(2)
0585                  DEPTH(K)=YN
0586                  RETURN
0587                  END
```

END OF SEGMENT, LENGTH 95, NAME SOLUTION

```
0588                  SUBROUTINE LINEARFIT
0589            C     SEGMENT APPROXIMATES NEXT DEPTH USING A LINEARFIT
0590                  COMMON /BLK1/ D1,D2,T3,T1,PRODUCT,XBAR,YST,YTS,C2
0591                  COMMON /BLK2/ YN,PUREMOMENT,IND3
```

```
0642                COMMON /BLK7/ RATIO2,RATIO3,K,X
0643                COMMON /BLK8/ DELTA(100),DEPTH(100)
0644                DIFF1=DEPTH(K)-DEPTH(K-1)
0645                DIFF2=DELTA(K)-DELTA(K-1)
0646                IF(DIFF1.EQ.0.0.OR.DIFF2.EQ.0.0) GO TO 701
0647                SLOPE=DIFF1/DIFF2
0648                YN=DEPTH(K)-(SLOPE*DELTA(K))
0649                IF(YN.LT.0.0) YN=DEPTH(K)/2.0
0650                IF(YN.GT.X) YN=X
0651                RETURN
0652          701   YN=0.75*YN
0653                I=0
0654                RETURN
0655                END

END OF SEGMENT, LENGTH   150, NAME  LINEARFIT



0656                SUBROUTINE FIRSTCRACK
0657          C     SEGMENT COMPUTES MOMENT AT FIRST CRACKING
0658          C     TS-BOTTOM FACE STRAIN
0659          C     CC-COMPRESSIVE FORCE IN CONCRETE ABOVE N.A
0660          C     CS-COMPRESSIVE FORCE IN TOP STEEL
0661          C     TC-TENSILE FORCE IN CONCRETE BELOW N.A
0662          C     TS-TOTAL TENSILE FORCE FROM STEEL BELOW N.A
0663                COMMON /BLK1/ D1,D2,T3,T1,PRODUCT,XBAR,YST,YTS,C2
0664                COMMON /BLK2/ YN,PUREMOMENT,IND3
0665                COMMON /BLK3/ T2,CONFORCE
0666                COMMON /BLK4/ PCS,BRS,EPZERO,PCUR,ETA,I,IF,MA1,MA2,MA3,MA4,MA5
0667                COMMON /BLK5/ MES,YSC,ATS,B2,YCS,ACS,SMSR
0668                COMMON /BLK7/ RATIO2,RATIO3,K,X
0669                COMMON /BLK8/ DELTA(100),DEPTH(100)
0670                COMMON /BLK15/ APS,YPS,YSP,MESP,DEP,DP,KA,KE,KI,RNVC,RNSC,RCH
0671                DIMENSION CRACK(1000)
0672                T3=0.00001
0673                YN=X
0674                I=1
0675                CRACK(I)=YN
0676                T1=(YN*T3)/(400.0-YN)
0677                B2=(4-(T1/EPZERO))/(6-(2*T1/EPZERO))
0678                PRODUCT=(T1/EPZERO)-((T1**2)/(3*(EPZERO**2)))
0679                T2=(YN-D2)*T1/YN
0680                CC=PRODUCT*PCS*BRS*YN
0681                CS=ACS*MES*T2
0682                IF(T2.GT.YSC) CS=ACS*YCS
0683                TC=((BRS*(400.0-YN))-ATS)*34500.0*T3/2.0
0684                TS=(ATS*MES*(D1-YN)*T3/(400.0-YN))+APS*MESP*(((DP-YN)
0685               1*T3)/(400.-YN)+DEP)
0686                CF=CC+CS
0687                TF=TC+TS
0688                DELTA(I)=CF-TF
0689                YN=0.75*X
0690          350   I=I+1
0691                CRACK(I)=YN
0692                T1=(YN*T3)/(400.0-YN)
0693                D2=(4-(T1/EPZERO))/(6-(2*T1/EPZERO))
0694                PRODUCT=(T1/EPZERO)-((T1**2)/(3*(EPZERO**2)))
0695                T2=(YN-D2)*T1/YN
0696                CC=PRODUCT*PCS*BRS*YN
0697                CS=ACS*MES*T2
0698                IF(T2.GT.YSC) CS=ACS*YCS
0699                TC=((BRS*(400.0-YN))-ATS)*34500.0*T3/2.0
0700                TS=(ATS*MES*(D1-YN)*T3/(400.0-YN)+APS*MESP*(((DP-YN)
0701               1*T3)/(400.-YN))+DEP)
0702                CF=CC+CS
0703                TF=TC+TS
0704                DELTA(I)=CF-TF
0705                RATIO4=DELTA(I)/TF
0706                IF(ABS(RATIO4).LT.0.01) GO TO 375
0707                SLOPE2=(CRACK(I)-CRACK(I-1))/(DELTA(I)-DELTA(I-1))
0708                YN=CRACK(I)-(SLOPE2*DELTA(I))
0709                IF(YN.GT.400.0) YN=(CRACK(I)+400.0)/2.0
0710                GO TO 350
0711          375   PUREMOMENT=(TS*D1)+(TC*(YN+((400.0-YN)*2.0/3)))-
0712               1(CC*D2*YN/2.0)-(CS*D2)
0713                IF(YN.LT.D2.AND.YN.GT.0.0) PUREMOMENT=(CS*D2)+(TS*D1)+
```

```
0714                1(TC*(YN+((D1-YN)*2.0/3)))-(CC*DC*YN/2.0)
0715                 IF(YN.GT.0.0) PCUR=T1/YN
0716                 WRITE(2,885)
0717          885    FORMAT(/,44X,'AT FIRST CRACKING:')
0718                 WRITE(2,890) PUREMOMENT,PCUR
0719          890    FORMAT(33X,'MOMENT=',E10.4,3X,'CURVATURE=',E10.4)
0720                 RETURN
0721                 END

END OF SEGMENT, LENGTH   039, NAME  FIRSTCRACKS


0722                 FINISH

END OF COMPILATION -  NO ERRORS

S/C SUBFILE:           158 BUCKETS USED

**** END OF STREAM HTOO          795
```

B.6 Input Data

```
2
1 800.
196. .00248 .0022 495. 166060 364.6 200. .0035 .00256 410. 0.
90.7 1828.2 30. 100. 368.4 23.2 160000 0 0. 0. 0. 0.
2 800.
196. .00174 .00196 330. 220560 432.8 200. .0035 .00256 410. 0.
143. 2175.4 26.6 100. 365.9 25.1 160000 0 0. 0. 0. 0.
```

```
2
3 800.
210.6 .00139 .00196 304.8 220560 432.8 200. .0035 .00139 304.8 0.
210.6 2175.4 39.1 100. 363.9 27.4 220000 0 0. 0. 0. 0.
3 850.
210.6 .00139 .00196 304.8 220560 432.8 200. .0035 .00139 304.8 0.
210.6 2175.4 39.1 100. 363.9 27.4 220000 0 0. 0. 0. 0.
```

```
4
4 800.
196. .00174 .00194 330. 220000 427.5 200. .0035 .00256 410. 0.
143. 1027. 22.9 100. 367.7 25.1 160000 0 0. 0. 0. 0.
4 850.
196. .00174 .00194 330. 220000 427.5 200. .0035 .00256 410. 0.
143. 1027. 22.9 100. 367.7 25.1 160000 0 0. 0. 0. 0.
```

```
2
5 800.
210.6 .00241 .00196 445. 220560 432.8 200. .0035 .00139 304.8 0.
48.2 2175.4 38.8 50. 369.9 21.3 220000 0 0. 0. 0. 0.
5 850.
210.6 .00241 .00196 445. 220560 432.8 200. .0035 .00139 304.8 0.
48.2 2175.4 38.8 50. 369.9 21.3 220000 0 0. 0. 0. 0.
```

```
3
6 800.
210.6 .00174 .00213 330. 190000 405. 200. .0035 .00139 304.8 0.
143. 2587.8 25.8 100. 363.9 25.3 220000 0 0. 0. 0. 0.
6 850.
210.6 .00174 .00213 330. 190000 405. 200. .0035 .00139 304.8 0.
143. 2587.8 25.8 100. 363.9 25.3 220000 0 0. 0. 0. 0.
6 650.
210.6 .00174 .00213 330. 190000 405. 200. .0035 .00139 304.8 0.
143. 2587.8 25.8 100. 363.9 25.3 220000 0 0. 0. 0. 0.
```

```
3
7 800.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 36.6 100. 364.8 25.3 220000 0 0. 0. 0. 0.
7 850.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 36.6 100. 364.8 25.3 220000 0 0. 0. 0. 0.
7 650.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 36.6 100. 364.8 25.3 220000 0 0. 0. 0. 0.
```

```
9
8 1000.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.
8 1050.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.
8 1100.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.
8 1200.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.
8 1250.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.
8 1300.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.
8 1400.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.

8 1450.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.
8 1500.
210.6 .00174 .00208 330. 196880 410.2 200. .0035 .00139 304.8 0.
143. 2238.7 28.9 100. 364.8 25.3 220000 0 0. 0. 0. 0.
```

B.7 Printout of Input Data and Start of Output Printout

```
                BEHAVIORAL RESPONSE PREDICTION FOR STRUCTURAL
                  CONCRETE BEAM IN COMBINED MOMENT AND SHEAR
                LOADING USING COMPRESSION FIELD THEORY ANALYSIS


PREDICTIONS FOR BEAM CFT-T38          SOURCE:S SHITOTE UNIVERSITY OF NAIROBI(1983)

                    TABLE OF INPUT MATERIAL AND SECTION PROPERTIES
      BRS             BTS             BCS             ATS             ACS             AHS             SHS
 0.2000E 03      0.3040E 03      0.2550E 02      0.2239E 04      0.2106E 03      0.1430E 03      0.1000E 03

      YTS             YCS             YHS             PCS             YST             YSC             YSH
 0.4102E 03      0.3040E 03      0.3300E 03      0.2690E 02      0.2080E-02      0.1390E-02      0.1740E-02

                    CONCRETE STRAIN AT PEAK STRESS=0.3500E-02


                    MOMENT-SHEAR RATIO=1050.0

 TOP FACE STRAIN=0.00025

          PMOMENT         PCUR          MOMENT          CUR           SHEAR
       0.2468E 08     0.1205E-05      0.2529E 08     0.1304E-05     0.2409E 05

                ANGLES,SHEAR FLOWS,ESTR,TRST,DIAGST AT LEVELS SHOWN
                    1               2               3               4               5
                 26.57           32.60           36.45           39.21           41.31
                 87.09           89.00           90.92           92.84           94.75
            0.000E 00       0.564E-04       0.113E-03       0.169E-03       0.226E-03
            0.161E-03       0.210E-03       0.248E-03       0.279E-03       0.307E-03
            0.544E-04       0.497E-04       0.487E-04       0.496E-04       0.504E-04
     FCP    0.109E 01       0.980E 00       0.951E 00       0.946E 00       0.955E 00
     FCD    0.352E 02       0.348E 02       0.344E 02       0.341E 02       0.337E 02
COUNTERS          40              63              80              72              72               6
 ---------------------------------------------------------------------------------------------

 TOP FACE STRAIN=0.00050

          PMOMENT         PCUR          MOMENT          CUR           SHEAR
       0.4636E 08     0.2393E-05      0.4954E 08     0.2585E-05     0.4718E 05

                ANGLES,SHEAR FLOWS,ESTR,TRST,DIAGST AT LEVELS SHOWN
                    1               2               3               4               5
                 26.84           32.69           36.51           39.25           41.34
                171.31          174.96          178.62          182.27          185.93
            0.000E 00       0.111E-03       0.221E-03       0.332E-03       0.443E-03
            0.320E-03       0.414E-03       0.488E-03       0.549E-03       0.603E-03
            0.110E-03       0.102E-03       0.101E-03       0.103E-03       0.105E-03
     FCP    0.213E 01       0.192E 01       0.186E 01       0.186E 01       0.187E 01
     FCD    0.343E 02       0.336E 02       0.329E 02       0.323E 02       0.317E 02
COUNTERS          28              56              56              56              57               6
 ---------------------------------------------------------------------------------------------

 TOP FACE STRAIN=0.00075

          PMOMENT         PCUR          MOMENT          CUR           SHEAR
       0.7102E 08     0.3582E-05      0.7273E 08     0.3642E-05     0.6926E 05

                ANGLES,SHEAR FLOWS,ESTR,TRST,DIAGST AT LEVELS SHOWN
                    1               2               3               4               5
                 27.02           32.79           36.57           39.29           41.37
                252.60          257.82          263.04          268.26          273.48
            0.000E 00       0.163E-03       0.326E-03       0.489E-03       0.652E-03
            0.475E-03       0.612E-03       0.720E-03       0.809E-03       0.888E-03
            0.167E-03       0.156E-03       0.156E-03       0.160E-03       0.165E-03
     FCP    0.312E 01       0.283E 01       0.274E 01       0.273E 01       0.276E 01
     FCD    0.335E 02       0.325E 02       0.316E 02       0.307E 02       0.299E 02
COUNTERS          35              56              60              61              61               6
 ---------------------------------------------------------------------------------------------
```

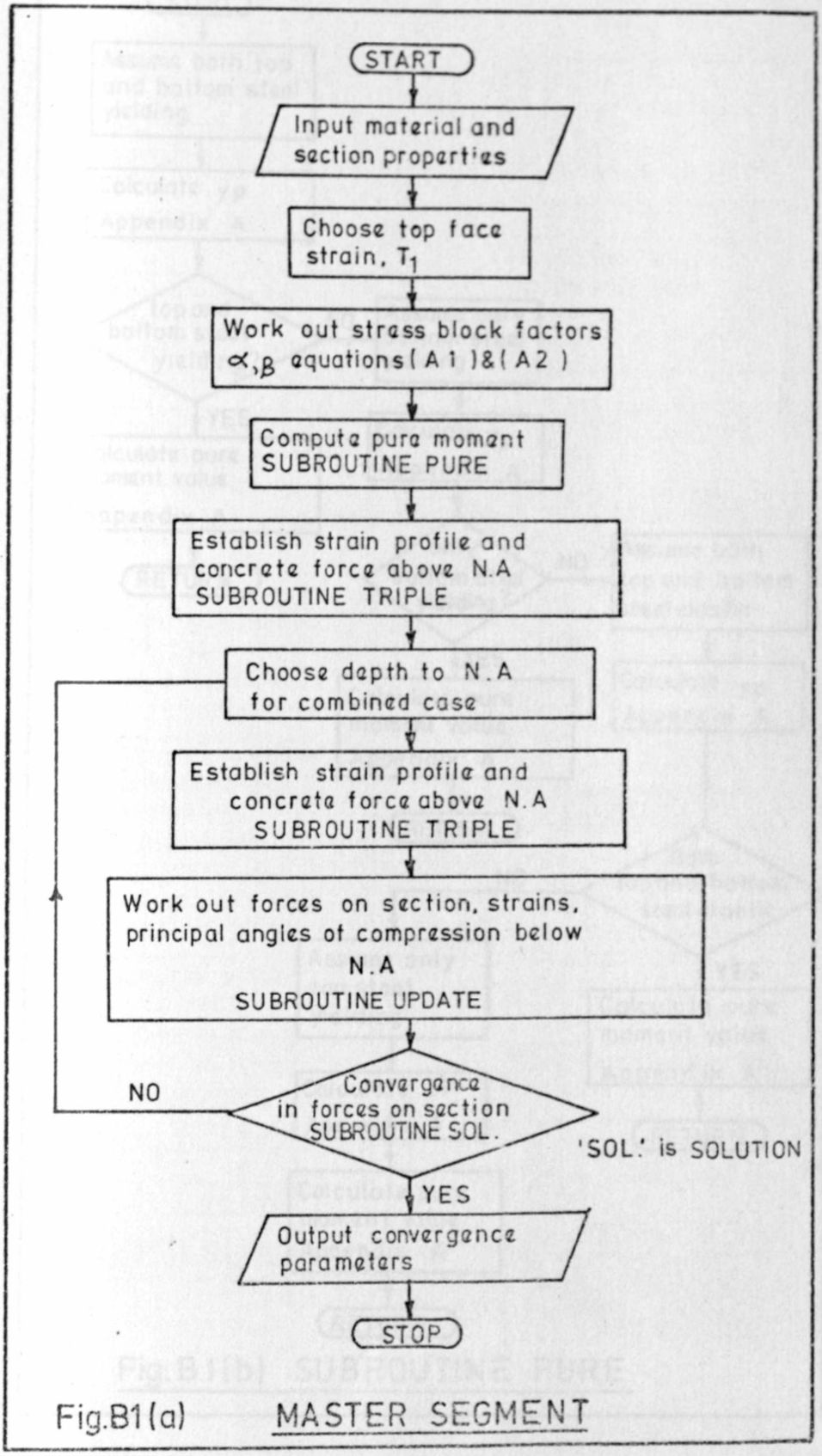


Fig.B1(a) MASTER SEGMENT

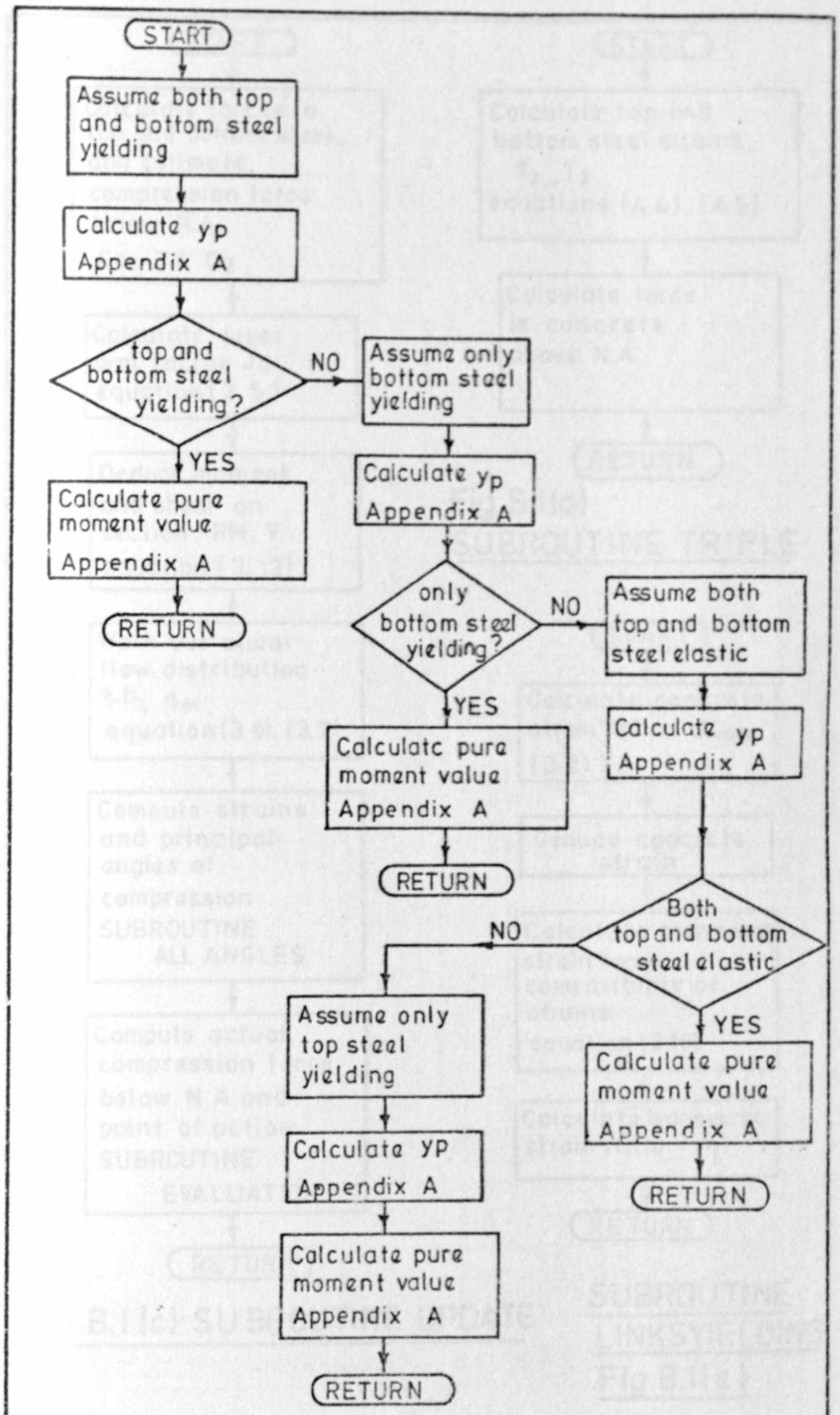


Fig. B.1(b) SUBROUTINE PURE

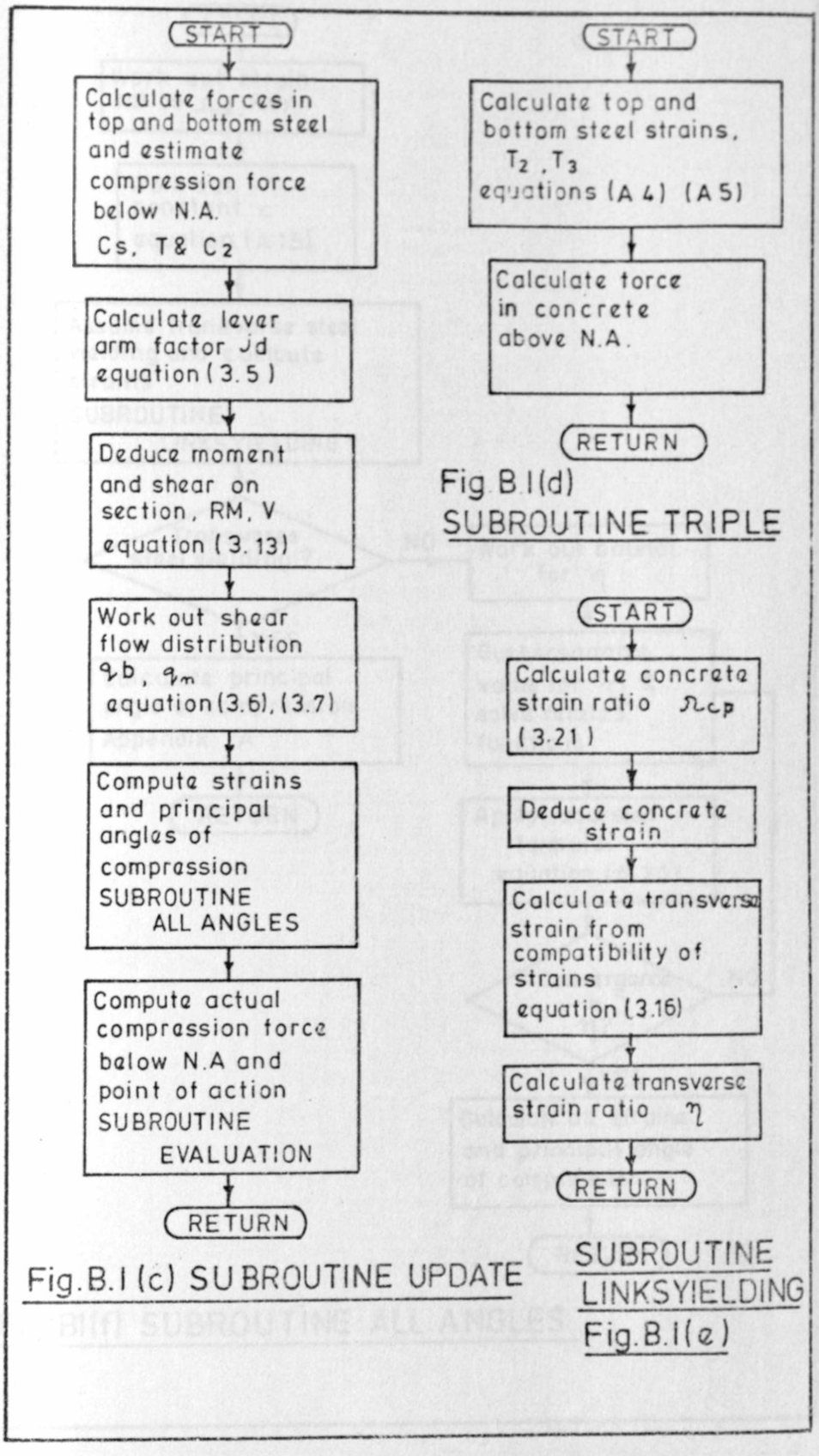


Fig.B.I(c) SUBROUTINE UPDATE

Fig.B.I(d) SUBROUTINE TRIPLE

SUBROUTINE LINKSYIELDING

Fig.B.I(e)

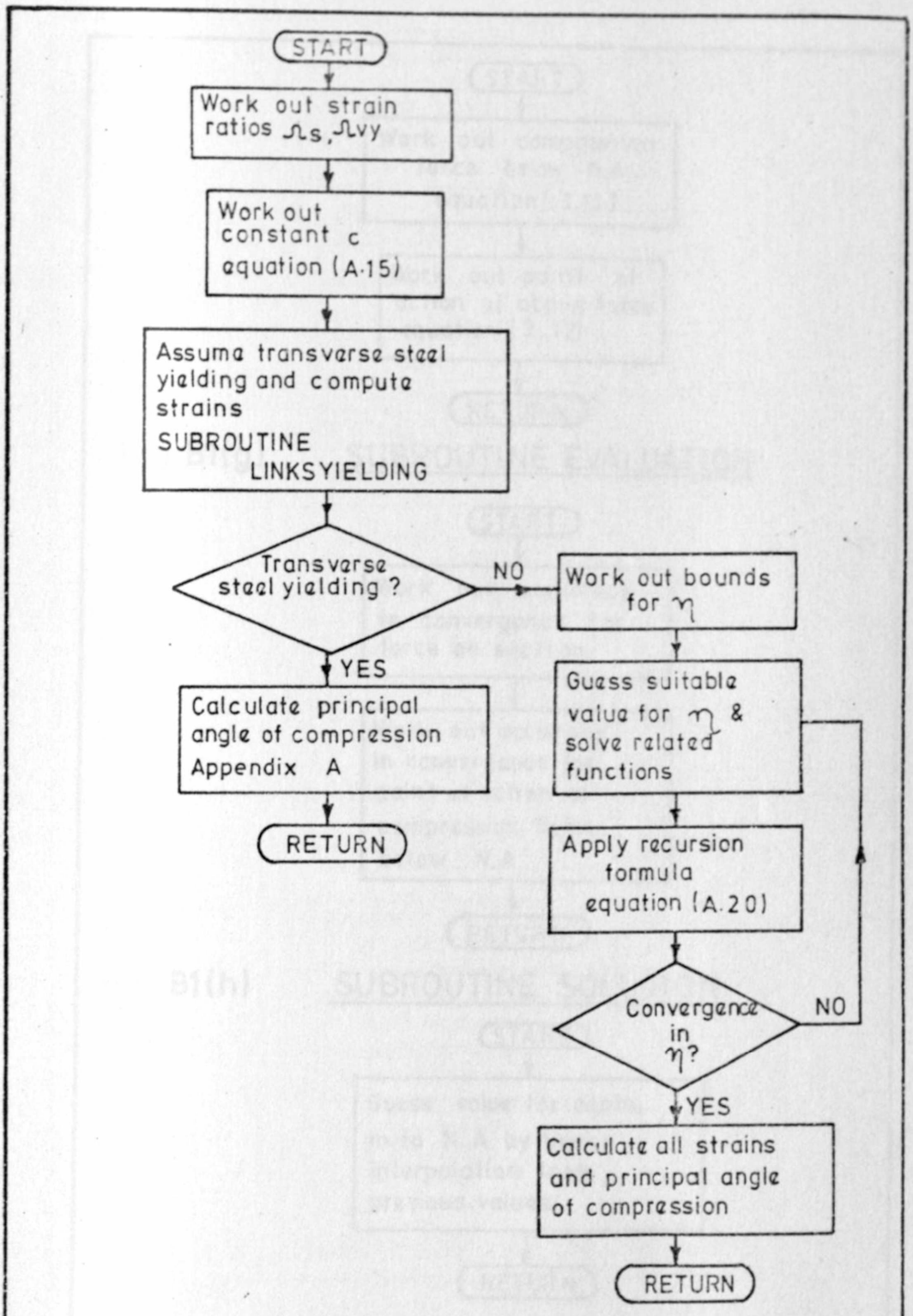


Fig. BI(f) SUBROUTINE ALL ANGLES

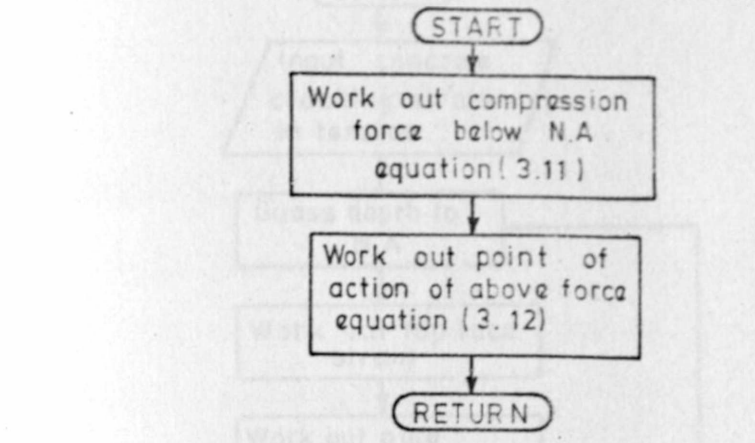


Fig. B1(g) SUBROUTINE EVALUATION

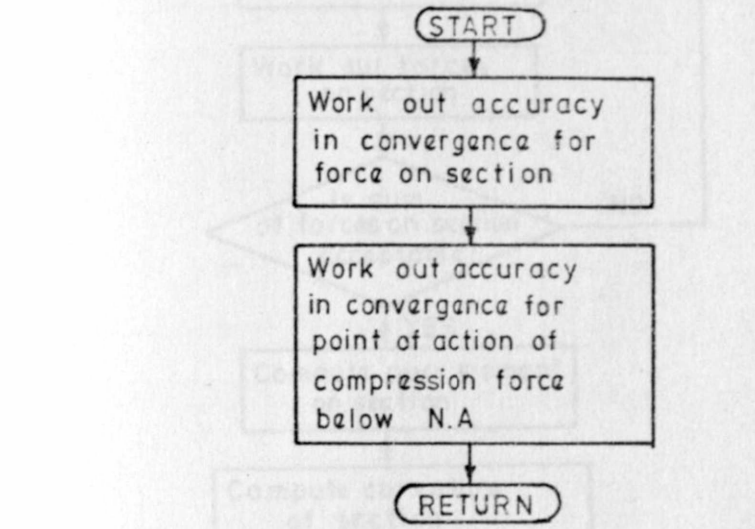


Fig. B1(h) SUBROUTINE SOLUTION

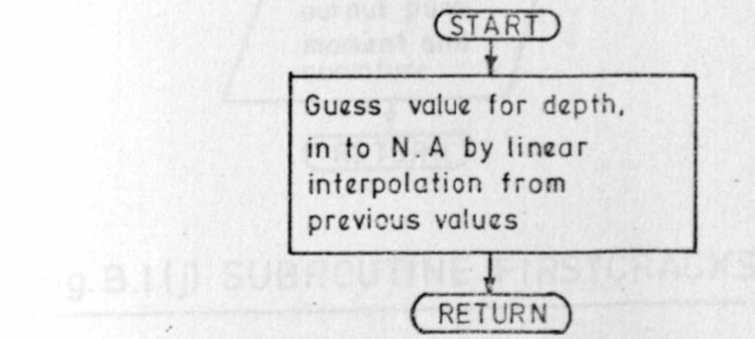


Fig. B1 (i) SUBROUTINE LINEARFIT

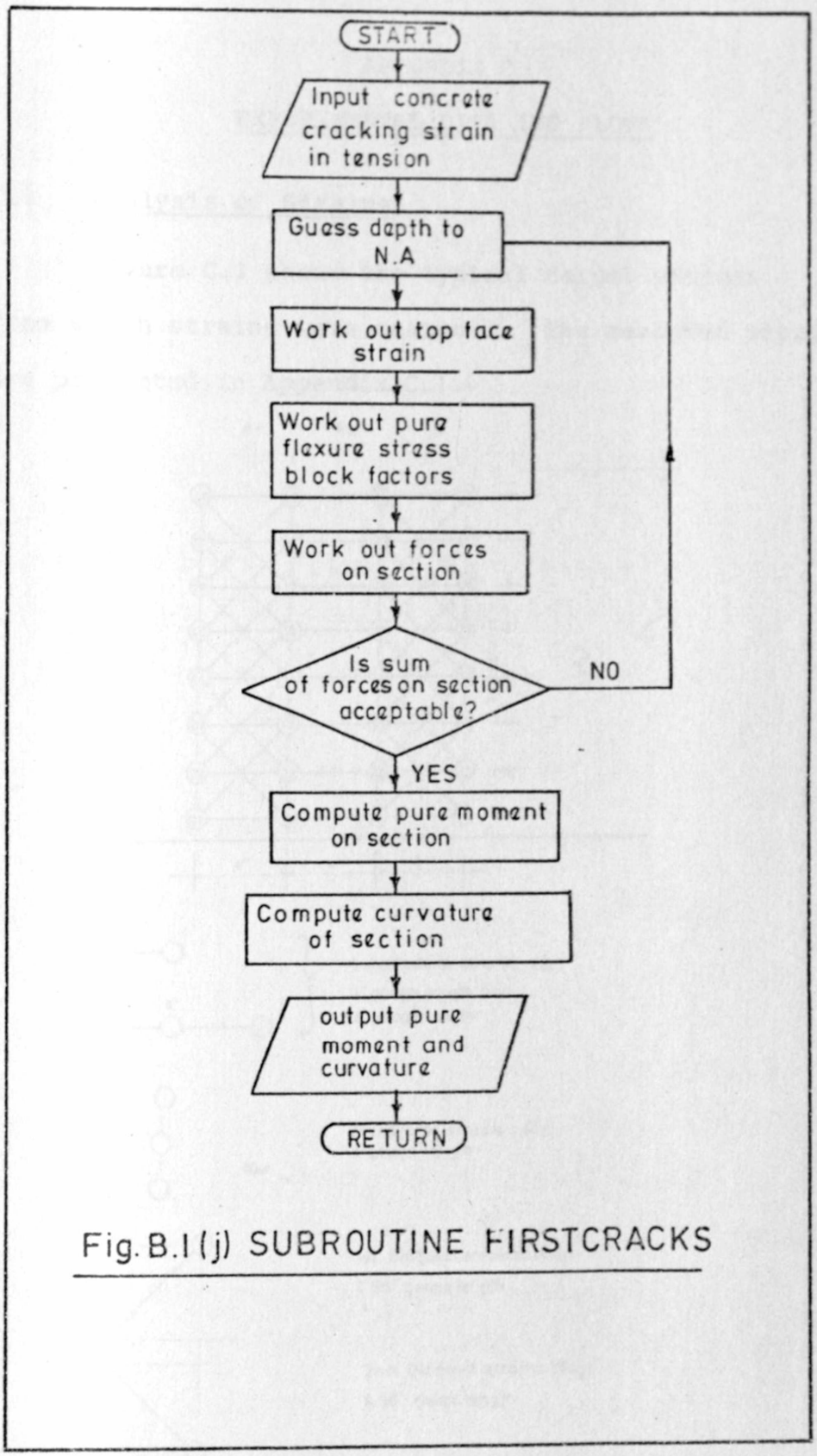


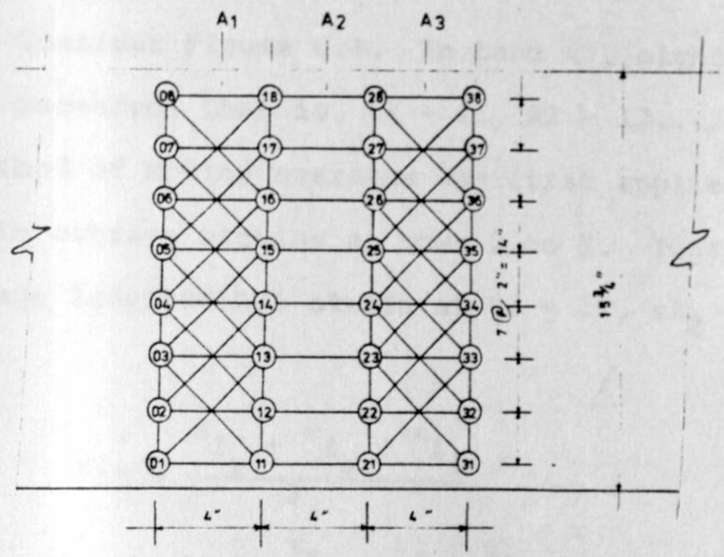
Fig. B.1 (j) SUBROUTINE FIRSTCRACKS

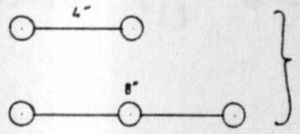
APPENDIX C

EXPERIMENTAL DATA AND PLOTS

C.1 Analysis of Strains

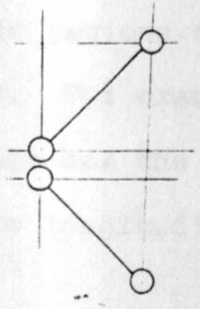
Figure C.1 shows the typical target pattern from which strains were measured. The measured strains are presented in Appendix C.1.4





Longitudinal strains (ε_l)
4" gauge length and
8" gauge length

Transverse strains (ε_v)
4" gauge length



1st. Diagonal strains (ε_{d_1})
4.56" gauge length

2nd. Diagonal strains (ε_{d_2})
4.56" gauge length

Figure C.1: Target Arrangement

Measurements for the various types of strains were taken over the gauge lengths indicated. For reasons already given in Chapter 5, average strains were considered in the analysis of the test specimens. The average strains were computed as outlined below:-

C.1.1 Longitudinal Strains

Consider Figure C.1. In band A1, eight strains were measured, that is, 01 - 11, 02 - 12.... 08 - 18. A method of moving averages was first applied to obtain average strains at rows 2 to 7. That is the average longitudinal strain at 02 - 12, $\varepsilon_{\ell 2}$

$$\varepsilon_{\ell 2} = \frac{\varepsilon_{\ell_1} + \varepsilon_{\ell_2} + \varepsilon_{\ell_3}}{3}$$

at 03-13. $\varepsilon_{\ell 3} = \frac{\varepsilon_{\ell_2} + \varepsilon_{\ell_3} + \varepsilon_{\ell_4}}{3}$ and so on.

This was then repeated for all regions with similar load conditions as band A1. Final averaging was then done for corresponding strains in such similar regions to give the average strains at rows 2 to 7. For example, if another band, say A6, on the beam has the same load condition as A1, then the average longitudinal strain at row 2 is given by:-

$$\varepsilon_{\ell_2} = \frac{\varepsilon_{\ell 2A1} + \varepsilon_{\ell 2A6}}{2}$$

C.1.2 Transverse Strains

Still considering band A1, averaging of transverse strains from adjacent columns was first done and assumed representing the strain at the middle of the band. That is measurement on 01-03 was averaged with that on 11-13, that on 02-04 with that on 12-14 and so on. The final average transverse strain was then obtained in the same way as for longitudinal strains by considering corresponding regions.

C.1.3 Diagonal Strains

For these, there was no averaging in the individual band. Averaging of corresponding diagonal strains was done directly to obtain two sets of diagonal strains; one set being predominantly commpressive (ε_{d1}) and the other predominantly tensile (ε_{d2}). ε_{d1} and ε_{d2} are chosen with respect to the load and care must be exercised to avoid obtaining wrong averages. Note that ε_{d1} and ε_{d2} are mutually perpendicular.

With the average longitudinal strains, average transverse strains and the average diagonal strains, it has been shown by Onsongo (1978) that the principal compression strains can be deduced using Mohr's circle of strains. Consider Figure C.2

From the circle, it can be seen that $\Delta A'A''B''$ is similar to $\Delta C''D''D'$ and $C''D''=A'A''=\gamma_{lt}$ If tension strains are taken to be positive then ε_{cp} will be negative; and assuming ε_{d1} is compressive deduce

$$\varepsilon_{d1} + \varepsilon_{d2} = \varepsilon_{\ell} + \varepsilon_{v} \quad \ldots\ldots\ldots\ldots\ldots\ldots (C.1)$$

and the shear strain $\gamma_{\ell t}$ is evaluated at

$$\gamma_{\ell t} = \varepsilon_{d2} - \varepsilon_{d1} \quad \ldots\ldots\ldots (C.2)$$

Using equations (3.9) and (3.10) and considering that ε_{cp} is negative, it follows that

$$\left(\frac{\gamma_{\ell t}}{2}\right)^2 = (\varepsilon_{\ell} - \varepsilon_{cp})\ (\varepsilon_{v} - \varepsilon_{cp})$$

$$\text{Hence } \varepsilon_{cp}^2 - (\varepsilon_{v} + \varepsilon_{\ell})\ \varepsilon_{dp} + \varepsilon_{v}\varepsilon_{\ell} - \left(\frac{\gamma_{\ell t}}{2}\right)^2 = 0$$

$$\varepsilon_{cp} = \tfrac{1}{2}(\varepsilon_{v} + \varepsilon_{\ell}) - \sqrt{(\varepsilon_{v} + \varepsilon_{\ell})^2 - 4\left(\varepsilon_{v}\varepsilon_{\ell} - \frac{\gamma_{\ell t}^2}{4}\right)}$$

$$= \tfrac{1}{2}\left((\varepsilon_{v} + \varepsilon_{\ell}) - \sqrt{(\varepsilon_{v} - \varepsilon_{\ell})^2 + \gamma_{\ell t}^2}\right) \quad \ldots\ldots\ldots (C.3)$$

Multiplying equations (3.14) and (3.5) leads to equation (3.16) from which the angle of principal compression is evaluated as

$$\tan^2\theta_p = \frac{\gamma_{\ell t}}{\varepsilon_{v} - \varepsilon_{\ell}} = \frac{\varepsilon_{d2} - \varepsilon_{d1}}{\varepsilon_{v} - \varepsilon_{\ell}} \quad \ldots\ldots\ldots\ldots (C.4)$$

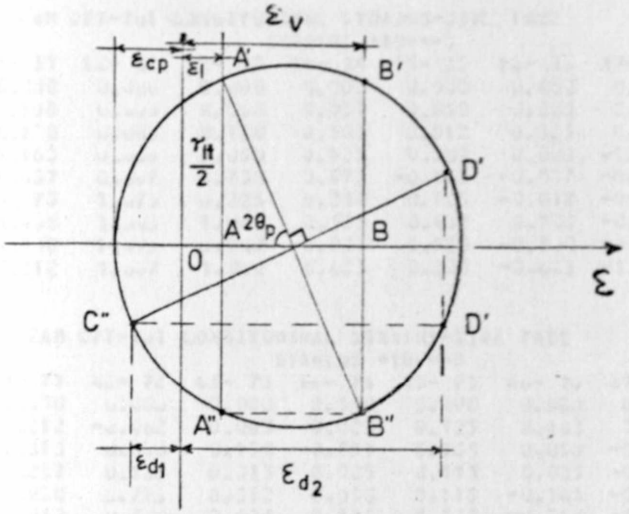


Fig. C.2 : Mohr's Circle For Measured Strains

C.1.4 Measured Strains

The demec readings taken during the experiment were used to compute strains. The computed strains are presented in this appendix consistent with the target patterns drawn in Figure 4.7. For each set of strains, the dynamic and static moments observed during the test have been recorded. In the rare cases that target points fell off during the test, demec readings were abandoned at those particular locations. Such locations are represented by blank spaces in the tables.

BEAM CFT-T01 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	11- 31	12- 32	13- 33	14- 34	15- 35	16- 36	17- 37	18- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.3	14.3	0.100	0.063	0.063	0.037	0.050	0.263	0.150	0.012
28.5	28.5	0.150	0.000	0.150	0.125	0.012	0.325	0.100	-0.100
39.2	39.2	0.163	0.088	0.050	0.125	0.000	0.000	-0.150	-0.462
71.3	71.3	0.637	0.387	0.738	0.475	-0.163	-0.087	-0.425	-0.912
89.2	89.2	1.275	1.075	0.325	0.287	0.125	-0.012	-0.512	-0.900
107.0	107.0	1.438	1.363	1.062	0.525	0.437	0.100	-0.662	-1.413
128.1	123.1	1.930	1.475	0.987	0.725	0.525	-0.200	-1.162	-2.175
144.3	142.7	2.212	1.887	1.062	0.625	0.325	-0.625	-1.737	-2.837

BEAM CFT-T01 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	41- 71	42- 72	43- 73	44- 74	45- 75	46- 76	47- 77	48- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.8	17.8	0.212	-0.062	0.063	-0.025	0.125	0.163	0.037	-0.062
35.7	35.7	0.313	0.050	0.150	-0.037	0.038	0.050	-0.100	-0.212
49.0	49.0	0.287	0.188	0.313	0.025	0.113	0.025	-0.150	-0.387
89.2	89.2	0.950	0.713	0.512	0.038	0.113	-0.163	-0.575	-0.938
111.5	111.5	1.012	0.700	0.638	0.188	0.125	-0.250	-0.800	-1.363
133.8	133.8	1.550	0.963	0.912	0.338	0.188	-0.375	-1.125	-1.950
156.8	156.8	1.463	1.062	0.862	0.138	-0.137	-0.675	-1.975	-3.137
180.6	178.4	1.612	1.062	0.775	0.000	-0.500	-1.525	-2.950	-4.575

BEAM CFT-T01 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	81-101	82-102	83-103	84-104	85-105	86-106	87-107	88-108
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.2	15.2	0.350	0.225	0.025	0.012	0.037	-0.037	-0.012	-1.337
30.3	30.3	0.425	0.287	0.063	0.037	0.000	-0.075	-0.100	-1.475
41.7	41.7	0.432	0.400	0.150	0.037	0.025	-0.037	-0.150	-1.587
75.8	75.8	0.963	0.825	0.427	-0.037	0.287	-0.287	-0.450	-2.000
94.8	94.8	1.387	1.162	0.775	-0.337	0.400	-0.212	-0.563	-2.163
113.7	113.7	1.950	1.587	0.900	-0.137	0.600	-0.163	-0.713	-2.412
130.8	130.8	2.487	1.900	0.125	-0.200	-0.050	-0.975	-1.925	-3.125
155.5	151.0	2.662	2.163	0.137	-0.287	-0.525	-1.712	-2.762	-4.000

BEAM CFT-TB2 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	11- 31	12- 32	13- 33	14- 34	15- 35	16- 36	17- 37	18- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.0	14.3	0.050	0.037	0.012	-0.037	-0.025	-0.087	-0.100	-0.112
29.3	28.5	0.212	0.100	0.037	-0.012	-0.062	-0.112	-0.200	-0.200
57.1	57.1	0.662	0.315	0.125	0.063	-0.150	-0.237	-0.438	-0.537
76.7	76.7	0.925	0.525	0.612	0.300	-0.050	-0.550	-0.637	-0.812
92.7	91.0	1.150	0.700	0.750	0.412	-0.025	-0.450	0.412	-1.025
107.4	106.7	1.550	0.967	0.937	0.500	0.012	-0.512	-1.012	-1.312
125.2	124.9	1.937	1.312	1.212	0.600	-0.062	-0.688	-1.325	-1.650
143.0	142.7	2.275	1.600	1.537	0.738	-0.125	-0.925	-1.662	-2.013
159.8	158.0	2.475	1.837	1.825	0.850	-0.175	-1.125	-1.950	-2.325
168.4	168.4	2.562	1.950	2.000	0.900	-0.262	-1.300	-2.250	-2.650
175.9	169.8	2.337	1.725	2.038	0.750	-0.637	-1.675	-2.650	-2.807
175.9	154.1	2.163	1.600	1.900	0.600	-0.713	-1.712	-2.650	-2.875
175.9	165.9	2.225	1.637	1.950	0.625	-0.762	-1.762	-2.737	-3.012
176.6	176.2	2.275	1.650	2.025	0.637	-0.787	-1.863	-2.900	-3.125

BEAM CFT-TB2 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	41- 71	42- 72	43- 73	44- 74	45- 75	46- 76	47- 77	48- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18.7	17.8	0.050	0.025	0.000	-0.037	-0.062	-0.100	-0.163	-0.175
36.6	35.7	0.212	0.113	0.063	-0.012	-0.112	-0.188	-0.262	-0.313
71.3	71.3	0.575	0.400	0.212	0.038	-0.125	-0.313	-0.550	-0.675
95.9	95.9	0.825	0.600	0.375	0.088	-0.225	-0.512	-0.887	-1.087
113.9	113.7	1.012	0.750	0.450	0.113	-0.275	-0.650	-1.137	-1.387
134.2	132.9	1.256	0.925	0.575	0.150	-0.325	-0.825	-1.437	-1.787
156.5	156.1	1.537	1.087	0.662	0.100	-0.475	-1.125	-1.925	-2.388
175.3	177.5	1.850	1.300	0.750	0.125	-0.612	-1.488	-2.575	-3.225
199.8	197.1	2.175	1.512	0.900	0.125	-0.750	-1.825	-3.187	-3.962
211.8	211.8	2.675	1.837	0.975	-0.150	-1.575	-3.475	-5.650	-7.000
219.8	192.8	2.712	1.712	0.725	-0.225	-1.637	-3.488	-5.812	-7.175
217.3	206.9	2.662	1.800	0.825	-0.250	-1.712	-3.637	-6.075	-7.512
220.7	219.8	3.025	2.100	0.975	-0.237	-1.875	-4.075	-6.787	-8.458

BEAM CFT-TB2 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	81-101	82-102	83-103	84-104	85-105	86-106	87-107	88-108
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.0	15.0	0.125	0.137	0.100	0.037	0.063	0.037	0.000	0.025
29.3	28.5	0.200	0.188	0.100	-0.025	0.000	-0.062	-0.112	-0.062
57.1	57.1	0.437	0.425	0.313	0.100	0.000	-0.150	-0.300	-0.400
76.7	76.3	0.713	0.612	0.462	0.188	0.225	0.012	-0.462	-0.638
92.7	92.7	0.900	0.775	0.575	0.188	0.287	-0.300	-0.588	-0.875
107.4	107.4	1.238	1.012	0.738	0.175	0.250	-0.438	-0.837	-1.162
125.2	124.5	1.512	1.200	0.850	0.175	0.225	-0.625	-1.075	-1.475
143.0	143.0	1.787	1.425	0.975	0.175	0.088	-0.875	-1.413	-1.837
159.8	156.9	2.038	1.675	1.062	0.175	-0.112	-1.125	-1.725	-2.238
168.4	147.0	2.038	1.550	0.812	-0.275	-0.963	-1.787	-2.238	-2.775
175.9	154.1	1.850	1.268	0.713	-0.300	-1.075	-1.900	-2.375	-2.950
175.9	165.2	1.912	1.312	0.725	-0.313	-1.137	-1.987	-2.487	-3.062
176.6	175.6	1.975	1.375	0.750	-0.325	-1.225	-2.100	-2.612	-3.237

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	11- 31	12- 32	13- 33	14- 34	15- 35	16- 36	17- 37	18- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.6	17.6	0.175	0.012	0.012	0.000	0.012	-0.037	-0.025	-0.037
30.0	30.0	0.175	0.012	-0.050	-0.075	-0.100	-0.150	-0.138	-0.200
47.7	47.4	0.537	0.000	-0.025	-0.012	-0.050	-0.137	-0.250	-0.313
108.1	107.7	1.137	0.025	-0.137	0.750	0.400	0.025	-0.350	-0.612
143.4	142.3	1.550	1.350	-0.262	0.862	0.512	-0.025	-0.550	-0.912
165.2	165.2	2.400	1.625	-0.275	0.875	0.550	-0.012	-0.637	-1.050
187.3	187.3	2.937	2.350	-0.275	0.938	0.537	-0.037	-0.700	-1.200
211.9	211.5	3.913	3.025	-0.325	1.000	0.688	-0.125	-0.912	-1.500
224.7	220.3	4.862	3.725	-0.337	0.837	0.563	-0.262	-1.025	-1.612
249.0	224.7	5.350	4.150	-0.438	0.775	0.425	-0.425	-1.125	-1.700
230.3	216.9	5.662	4.314	-0.450	0.713	0.337	-0.475	-1.137	-1.675
230.2	228.3	5.025	4.475	-0.475	0.637	0.275	-0.550	-1.200	-1.725

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	1- 11	2- 12	3- 13	4- 14	5- 15	6- 16	7- 17	8- 18
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.0	38.5	0.300	0.050	0.200	0.025	-0.050	-0.075	-0.175	-0.250
87.2	87.2	0.450	0.050	2.175	-0.125	-0.175	-0.225	-0.350	-0.425
104.3	103.2	0.325	0.175	2.500	0.000	-0.200	-0.225	-0.375	-0.475
119.6	115.6	0.275	0.175	2.550	0.175	-0.175	-0.225	-0.400	-0.550
134.2	133.9	0.275	0.275	2.550	0.575	-0.125	-0.325	-0.475	-0.625
152.2	150.7	0.250	0.275	2.625	0.875	-0.100	-0.350	-0.525	-0.725
172.2	170.4	0.150	0.325	2.800	1.075	-0.150	-0.400	-0.625	-0.825
182.6	177.7	-0.050	0.225	2.675	0.900	-0.325	-0.550	-0.800	-0.975
180.1	182.6	-0.075	0.150	2.500	0.900	-0.325	-0.550	-0.750	-0.950

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	21- 31	22- 32	23- 33	24- 34	25- 35	26- 36	27- 37	28- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.3	19.0	0.050	0.000	0.050	-0.025	-0.025	-0.100	-0.200	-0.125
32.0	31.0	0.725	0.125	0.075	0.000	0.000	-0.150	-0.375	-0.225
55.0	50.4	0.975	0.375	0.100	0.000	0.000	-0.175	-0.400	-0.325
114.3	114.1	2.425	1.550	-0.100	-0.225	-0.375	0.150	-0.600	-0.725
130.4	134.9	2.950	2.000	-0.125	-0.250	-0.400	0.225	-0.675	-0.850
152.4	151.2	3.675	2.975	-0.175	-0.275	-0.450	0.225	-0.700	-0.975
173.3	174.9	4.375	4.050	-0.175	-0.300	-0.500	0.250	-0.925	-1.200
199.0	196.7	6.050	5.275	-0.225	-0.350	-0.600	0.175	-1.025	-1.425
225.2	222.9	8.175	6.900	-0.375	-0.375	-0.600	0.175	-1.200	-1.725
233.3	230.0	10.225	8.350	-0.425	-0.525	-0.775	-0.100	-1.300	-1.950
243.4	236.8	11.350	9.100	-0.425	-0.575	-0.825	-0.250	-1.425	-2.025

BEAM CFT-TB3 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	1- 3	2- 4	3- 5	4- 6	5- 7	6- 8	11- 13	12- 14	13- 15	14- 16	15- 17	16- 18
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.6	38.5	0.225	-0.050	0.025	-0.025	-0.075	0.050	-0.050	0.075	0.050	0.000	-0.025	0.175
87.3	87.2	0.225	-0.050	-0.050	0.125	0.000	0.100	-0.975	2.075	2.150	-0.100	-0.150	0.050
104.3	102.6	0.900	0.525	0.475	0.025	0.075	0.150	-0.100	2.250	2.700	-0.150	-0.100	0.325
119.6	115.6	0.150	0.750	0.800	-0.075	-0.025	0.100	-0.150	3.150	3.150	-0.050	0.000	0.325
134.2	133.3	0.925	1.450	1.000	0.000	0.050	0.025	-0.250	3.625	3.750	0.075	0.225	0.100
152.2	151.0	4.125	2.100	2.375	-0.075	0.075	0.175	-0.250	4.375	4.425	0.025	0.325	0.200
172.2	170.4	5.175	2.750	2.975	0.050	0.050	0.325	-0.325	5.775	5.925	0.250	0.350	0.300
182.6	176.9	5.200	2.900	3.075	-0.075	-0.050	0.200	-0.450	6.450	6.525	0.225	0.300	0.100
180.1	182.6	6.050	2.925	3.250	-0.050	-0.025	0.250	-0.375	6.025	6.700	0.250	0.325	0.200

BEAM CFT-TB3 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	21- 23	22- 24	23- 25	24- 26	25- 27	26- 28	31- 33	32- 34	33- 35	34- 36	35- 37	36- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.6	18.2	0.025	0.000	-0.075	-0.075	-0.050	-0.125	-0.025	-0.100	-0.050	-0.100	-0.075	-0.100
32.0	31.0	-0.025	0.000	-0.125	-0.075	0.025	-0.100	-0.075	-0.050	-0.100	-0.050	-0.100	-0.075
55.0	50.4	0.000	0.050	-0.150	-0.175	-0.150	-0.150	-0.025	0.050	-0.125	-0.150	-0.050	-0.075
114.6	114.1	1.000	0.050	-0.325	0.900	1.500	-0.100	0.025	0.025	-0.125	-0.100	0.125	-0.475
133.4	134.2	-0.050	0.025	-0.425	1.175	1.550	-0.175	1.225	1.025	-0.050	-0.125	0.175	0.275
152.4	149.7	-0.325	-0.075	-0.600	1.500	1.825	-0.225	1.475	1.400	-0.200	-0.200	0.100	0.550
173.3	174.3	-0.275	0.050	-0.550	1.775	2.575	-0.025	2.275	2.175	-0.075	-0.175	0.175	0.475
199.0	196.2	-0.475	0.075	-0.625	1.500	2.825	-0.500	3.100	3.100	-0.300	-0.200	0.275	-1.925
225.2	222.9	-0.550	0.150	-0.725	2.500	3.625	0.175	4.650	4.475	-0.750	-0.325	0.250	0.825
233.3	235.7	-0.575	-0.075	-0.825	3.000	4.100	0.050	5.575	5.250	-0.425	-0.400	0.325	0.700
243.4	236.8	-0.450	0.025	-0.825	3.150	4.325	0.125	7.250	7.025	-0.100	-0.350	0.250	0.925

BEAM CFT-T03 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	1- 13	2- 14	3- 14	4- 15	5- 17	6- 18	11- 3	12- 4	13- 5	14- 6	15- 7	16- 8
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.6	38.5	-0.219	-0.164	-0.219	-0.219	-0.219	-0.329	0.285	0.197	0.197	0.066	0.022	-0.066
87.6	87.5	-0.614	-0.493	-0.351	-0.373	-0.439	-0.570	3.421	3.070	2.673	0.197	0.132	0.066
104.3	104.2	-0.614	-0.417	-0.373	-0.417	-0.526	-0.660	3.947	3.969	2.982	0.088	-0.265	0.154
110.5	110.9	-0.680	-0.417	-0.373	-0.482	-0.724	-0.724	4.145	4.759	4.252	0.329	0.241	0.197
134.2	134.2	-0.702	-0.417	-0.482	-0.543	-0.680	-0.811	4.385	5.570	5.044	0.724	0.482	0.219
152.2	152.0	-0.789	-0.461	-0.504	-0.653	-0.811	-0.877	4.759	6.711	6.031	1.053	0.592	0.307
172.2	170.4	-0.833	-0.504	-0.439	-0.746	-0.877	-0.967	5.570	8.140	7.259	1.272	0.724	0.329
182.8	176.7	-0.899	-0.526	-0.154	-0.702	-0.855	-0.855	5.945	8.728	7.588	1.272	0.636	0.285
188.1	182.3	-0.877	-0.504	-0.351	-0.739	-0.833	-0.855	6.021	8.772	7.719	1.294	0.702	0.417

BEAM CFT-T03 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	21- 33	22- 34	23- 35	24- 36	25- 37	26- 38	31- 23	32- 24	33- 25	34- 26	35- 27	36- 28
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.8	18.1	0.285	0.197	0.000	0.175	0.000	0.066	0.000	0.351	0.044	0.110	0.811	0.175
32.8	32.0	0.066	-0.066	-0.066	-0.066	-0.154	-0.154	0.154	0.022	0.022	-0.132	0.066	-0.219
53.0	50.4	-0.044	-0.175	-0.110	-0.066	-0.175	-0.219	0.504	0.461	-0.088	-0.351	-0.132	-0.439
114.3	114.3	-0.154	-0.197	-0.241	-0.526	-0.241	-0.592	1.669	1.601	-0.175	1.096	1.294	0.571
135.4	135.9	-0.307	-0.373	-0.482	-0.614	-0.373	-0.768	2.325	2.171	-0.241	1.382	1.601	0.659
152.4	151.4	-0.351	-0.351	-0.439	-0.702	-0.375	-0.855	3.044	3.004	-0.329	1.404	1.162	0.571
175.5	175.5	-0.482	-0.395	-0.504	-0.811	-0.482	-1.009	4.101	3.969	-0.329	1.645	1.316	0.747
193.0	197.0	-0.570	-0.526	-0.614	-0.987	-0.526	-1.228	5.417	5.529	-0.373	1.930	1.535	0.921
223.2	224.9	-0.570	-0.439	-0.680	-1.075	-0.461	-1.316	7.335	7.171	-0.395	2.456	1.776	1.184
230.8	232.0	-0.724	-0.548	-0.611	-1.140	-0.395	-1.360	9.649	8.991	-0.482	2.478	2.105	1.140
243.4	239.3	-0.680	-0.548	-0.658	-0.943	-0.241	-1.338	11.009	10.175	-0.439	2.522	1.754	1.140

BEAM CFT-T03 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-6							
D	S	41- 51	42- 52	43- 53	44- 54	45- 55	46- 56	47- 57	48- 58
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24.5	18.5	0.100	0.050	-0.012	-0.063	-0.112	-0.100	-0.125	
36.5	37.5	0.213	0.137	0.125	-0.012	-0.037	-0.212	-0.212	-0.275
62.4	59.3	0.450	0.287	0.338	0.063	-0.037	-0.275	-0.275	-0.450
133.1	134.7	1.388	0.950	1.225	0.287	0.812	-0.462	-0.850	-1.137
160.3	160.5	1.587	1.150	1.512	0.313	0.863	-0.550	-1.037	-1.387
177.3	176.4	1.725	1.287	1.725	0.375	0.925	-0.675	-1.250	-1.662
208.5	208.5	2.187	1.687	2.112	0.525	0.975	-0.775	-1.562	-2.062
234.1	234.1	2.700	2.013	2.537	0.675	0.725	-0.912	-1.912	-2.500
264.9	262.2	3.237	2.787	3.450	1.037	0.275	-1.262	-2.537	-3.350
268.9	279.1	4.350	4.462	4.500	2.112	0.862	-1.950	-4.012	-5.112
288.3	282.3	4.250	5.175	5.625	3.375	1.100	-2.300	-5.812	-11.600
291.5	271.1	11.350	6.300	7.187	5.025	1.700	-2.900	-6.250	-15.400
295.2	279.6	14.337	10.762	8.687	6.362	2.212	-3.900	-6.212	-15.987

BEAM CFT-T03 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	61- 81	62- 82	63- 83	64- 84	65- 85	66- 86	67- 87	68- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19.6	14.6	0.063	0.025	-0.012	0.037	-0.025	-0.075	-0.037	-0.025
38.6	30.3	0.137	0.050	0.050	0.050	-0.050	-0.150	-0.137	-0.100
49.7	47.4	0.250	0.212	0.100	0.037	-0.100	-0.225	-0.225	-0.287
108.1	107.7	1.275	0.975	0.775	0.425	0.063	-0.325	-0.537	-0.825
128.4	128.4	1.537	1.212	0.925	0.563	0.100	-0.350	-0.600	-0.963
143.4	142.7	1.937	1.437	1.062	0.650	0.125	-0.412	-0.713	-1.125
165.2	165.2	2.537	1.762	1.300	0.762	0.175	-0.462	-0.850	-1.300
187.3	186.6	3.350	2.300	1.488	0.925	0.137	-0.563	-1.012	-1.575
211.9	209.6	4.275	2.900	1.700	0.900	0.075	-0.650	-1.225	-1.912
244.7	220.1	5.350	3.762	1.762	0.937	-0.062	-0.825	-1.387	-2.062
229.0	225.3	1.787	2.850	1.612	0.862	-0.100	-0.862	-1.450	-2.138
233.3	210.9	5.975	3.900	1.750	0.737	-0.163	-0.900	-1.450	-2.150
238.2	243.7	6.250	3.950	1.725	0.775	-0.250	-0.963	-1.475	-2.200

BEAM CFT-T03 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	61- 71	62- 72	63- 73	64- 74	65- 75	66- 76	67- 77	68- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.8	15.5	0.150	0.075	0.075	0.000	-0.025	-0.050	-0.050	-0.050
32.8	31.8	0.150	0.100	0.125	0.025	-0.025	-0.125	-0.150	-0.575
53.0	50.4	0.250	0.150	0.350	0.100	-0.075	-0.175	-0.250	-0.750
114.3	114.3	0.950	0.675	0.500	0.475	0.225	-0.350	-0.675	-0.950
135.4	135.4	1.100	0.750	0.525	0.575	0.325	-0.350	-0.875	-1.525
152.4	149.7	1.175	0.850	0.675	0.650	0.375	-0.450	-0.850	-1.550
175.5	174.3	1.750	0.950	0.475	1.025	0.450	-0.500	-0.950	-1.725
193.0	196.0	2.250	0.950	0.175	1.000	0.500	-0.575	-1.075	-2.000
223.2	222.9	2.650	0.850	0.250	1.225	0.500	-0.725	-1.350	-2.325
230.8	232.7	3.075	-0.150	0.150	1.275	0.300	-0.850	-1.500	-2.325
243.4	239.2	3.250	0.150	0.075	1.225	0.175	-0.950	-1.575	-2.450

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
φ	S	81- 91	82- 92	83- 93	84- 94	85- 95	86- 96	87- 97	88- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.6	38.5	0.100	-0.100	0.375	0.000	-0.100	-0.100	-0.125	-0.250

BEAM CFT-TB3 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
φ	S	61- 63	62- 64	63- 65	64- 66	65- 67	66- 68	71- 73	72- 74	73- 75	74- 76	75- 77	76- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.3	15.8	0.025	0.050	-0.175	0.025	0.000	-0.025	0.025	0.400	-0.025	0.075	-0.150	0.050
32.3	31.6	0.050	0.000	0.100	0.000	-0.025	-0.025	0.025	0.375	-0.025	0.000	0.075	0.125
52.0	50.4	-0.025	0.025	0.075	-0.050	-0.175	-0.025	0.000	0.450	-0.050	-0.025	0.050	-0.050
114.3	114.3	-0.025	-0.075	0.050	-0.025	-0.125	0.050	0.000	0.150	0.175	0.275	-0.025	0.325
130.4	136.1	0.050	-0.025	0.100	0.125	0.075	0.125	0.000	0.525	0.750	0.550	0.050	0.050
152.4	149.3	0.100	-0.100	-0.025	0.150	0.075	0.150	0.000	0.650	0.950	0.675	0.000	0.000
175.3	172.6	0.225	-0.250	-0.075	0.500	0.425	0.350	0.000	0.925	1.475	0.800	0.025	0.125
197.0	198.6	-0.725	1.150	-0.700	1.500	-0.325	0.675	-1.350	1.000	2.225	-0.450	0.000	0.175
220.2	197.1	-0.075	1.050	-0.725	1.725	-0.525	0.000	-1.500	1.050	2.200	-0.450	0.000	0.125
238.8	222.9	1.525	-0.425	-0.125	0.175	0.175	0.400	-0.175	1.550	2.275	0.925	-0.050	0.150
246.4	232.3	2.525	-0.550	-0.350	0.050	0.175	0.375	-0.275	1.950	2.625	0.750	-0.175	0.275
247.9	239.2	3.050	-0.275	-0.400	0.000	0.150	0.250	-0.375	2.175	2.875	0.750	-0.200	0.175

BEAM CFT-TB3 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
φ	S	81- 83	82- 84	83- 85	84- 86	85- 87	86- 88	91- 93	92- 94	93- 95	94- 96	95- 97	96- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.6	38.5	-0.025	-0.100	-0.100	-0.075	0.000	0.100	0.000	0.000	-0.175	-0.025	-0.050	-0.025

BEAM CFT-TB3 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
φ	S	61- 73	62- 74	63- 75	64- 76	65- 77	66- 78	71- 83	72- 84	73- 85	74- 86	75- 87	76- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.3	16.0	0.175	0.000	0.022	0.044	0.044	-0.175	0.088	0.132	0.110	0.110	0.044	0.132
32.3	31.6	0.221	0.110	0.044	0.022	0.066	-0.197	0.132	0.088	0.044	-0.066	-0.044	-0.066
53.0	50.4	0.175	0.177	0.014	0.022	0.084	-0.022	0.241	0.154	0.022	-0.132	-0.110	-0.307
114.3	114.1	0.036	0.036	0.455	0.451	0.154	-0.219	0.373	0.044	-0.175	-0.110	-0.351	-0.307
130.4	134.9	0.058	0.058	1.053	0.543	0.066	-0.614	0.307	0.154	-0.022	-0.088	-0.329	-0.351
152.4	150.6	0.093	0.033	1.404	0.943	0.265	-0.432	0.307	0.000	-0.263	-0.154	-0.504	-0.546
175.3	175.3	1.272	1.140	1.711	1.113	0.373	-0.439	0.219	-0.066	-0.307	-0.241	-0.636	-0.614
197.0	199.0	2.061	1.250	1.908	1.184	0.461	-0.526	0.132	-0.175	-0.351	-0.263	-0.724	-0.724
222.2	222.9	3.553	1.861	2.303	1.425	0.461	-0.439	-0.110	-0.329	-0.482	-0.351	-0.987	-1.031
238.8	234.0	5.044	1.850	3.350	1.404	0.461	-0.700	-0.197	-0.461	-0.614	-0.351	-1.031	-0.942
243.4	239.0	6.228	2.032	2.632	1.601	0.482	-0.504	-0.285	-0.526	-0.614	-0.636	-1.140	-1.053

BEAM CFT-TB3 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
φ	S	81- 93	82- 94	83- 95	84- 96	85- 97	86- 98	91- 83	92- 84	93- 85	94- 86	95- 87	96- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.6	38.5	0.044	0.000	0.022	0.044	-0.066	-0.088	0.022	-0.044	0.000	-0.022	-0.066	0.000
67.8	67.1	0.044	0.044	0.066	0.132	-0.132	-0.219	-0.154	-0.110	-0.197	-0.175	-0.044	-0.110

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
φ	S	111-131	112-132	113-133	114-134	115-135	116-136	117-137	118-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30.3	30.0	0.063	0.075	0.012	-0.075	-0.125	-0.201	-0.201	-0.250
49.9	47.4	0.287	0.200	0.113	-0.025	-0.125	-0.200	-0.250	-0.225
108.1	107.7	0.950	1.225	0.925	0.550	0.150	-0.200	-0.450	-0.725
129.4	126.1	1.075	1.512	1.125	0.700	0.200	-0.212	-0.512	-0.875
143.4	142.7	1.162	1.787	1.337	0.825	0.237	-0.275	-0.537	-1.000
165.2	165.2	1.312	2.187	1.637	0.975	0.300	-0.287	-0.725	-1.225
187.3	187.3	1.362	2.350	1.863	1.087	0.287	-0.313	-0.825	-1.413
211.9	209.0	1.475	2.900	2.038	1.112	0.175	-0.512	-1.087	-1.787
224.7	218.3	1.525	3.050	2.125	1.075	0.050	-0.600	-1.225	-1.912
229.0	225.4	1.575	3.187	2.175	1.075	0.000	-0.650	-1.250	-1.987
233.3	216.9	1.537	3.150	2.163	1.025	-0.025	-0.700	-1.250	-1.987
236.2	223.7	1.537	3.187	2.100	0.987	-0.075	-0.700	-1.312	-2.013

BEAM CFT-T32 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	101-111	102-112	103-113	104-114	105-115	106-116	107-117	108-118
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
43.6	38.5	-0.075	-0.050	0.050	0.000	-0.050	-0.100	-0.150	-0.250

BEAM CFT-T33 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	121-131	122-132	123-133	124-134	125-135	126-136	127-137	128-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55.0	50.4	0.125	0.050	0.075	0.000	-0.050	-0.075	-0.275	-0.425
152.4	149.0	-0.250	1.350	0.825	1.775	0.825	-0.275	-0.675	-1.225
225.2	222.9	-0.050	1.450	0.775	2.525	0.875	-0.600	-1.225	-2.325

BEAM CFT-T03 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	101-103	102-104	103-105	104-106	105-107	106-108	111-113	112-114	113-115	114-116	115-117	116-118
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

BEAM CFT-T03 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	121-123	122-124	123-125	124-126	125-127	126-128	131-133	132-134	133-135	134-136	135-137	136-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55.0	50.4	0.075	0.050	-0.050	-0.075	0.000	0.025	0.150	-0.125	0.050	-0.050	-0.025	0.000
152.4	149.0	0.975	1.450	1.375	-0.225	0.050	0.150	0.000	-0.025	0.025	0.775	0.900	0.175
225.2	222.9	1.350	2.725	2.700	-0.325	-0.025	0.450	0.550	-0.150	-0.075	1.100	1.125	0.325

BEAM CFT-T33 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	101-113	102-114	103-115	104-116	105-117	106-118	111-103	112-104	113-105	114-106	115-107	116-108
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
43.6	38.5	-0.022	-0.044	-0.022	-0.066	-0.110	-0.022	-0.022	0.022	-0.066	0.044	-0.022	0.000

BEAM CFT-T03 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	121-133	122-134	123-135	124-136	125-137	126-138	131-123	132-124	133-125	134-126	135-127	136-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55.0	50.4	0.022	0.044	-0.022	-0.022	-0.154	-0.110	0.241	0.110	0.066	0.066	0.000	0.022
152.4	149.1	-0.285	-0.000	-0.373	-0.373	-0.570	-0.636	1.272	2.829	2.368	-0.461	1.294	-0.044
225.2	224.4	-0.307	-0.110	-0.763	-0.525	-0.965	-0.811	2.053	4.364	3.909	2.500	1.535	-0.219

BEAM CFT-T03 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	141-151	142-152	143-153	144-154	145-155	146-156	147-157	148-158
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30.5	30.0	0.250	0.150	0.100	-0.025	-0.100	-0.175	-0.225	-0.300
62.4	59.3	0.550	0.287	0.212	0.075	-0.100	-0.200	-0.300	-0.450
135.1	134.7	1.125	0.663	0.462	0.475	0.012	-0.387	-0.736	-1.137
160.5	160.1	1.486	0.787	0.537	0.575	0.037	-0.475	-0.935	-1.400
179.5	179.4	1.437	0.875	0.538	0.650	0.037	-0.512	-1.087	-1.687
208.5	208.5	1.887	1.062	0.688	0.893	0.037	-0.653	-1.337	-2.125
234.1	234.1	2.038	1.200	0.812	0.950	0.037	-0.859	-1.750	-2.662
264.7	262.2	2.612	1.687	1.150	1.325	0.050	-1.262	-2.662	-4.125
280.7	272.9	3.138	2.025	2.238	2.353	0.150	-2.264	-4.912	-8.525
286.5	281.0	7.012	5.925	3.675	3.362	0.350	-3.025	-5.137	-12.775
291.0	271.0	11.375	8.050	6.312	5.112	0.938	-3.750	-6.325	-15.775
295.2	280.5	14.275	11.437	9.275	6.987	1.262	-4.625	-7.400	

BEAM CFT-T33 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	161-131	162-132	163-133	164-134	165-135	166-136	167-137	168-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30.5	30.0	0.125	0.100	-0.012	-0.050	-0.125	-0.175	-0.188	-0.225
49.7	47.4	0.275	0.225	0.088	0.000	-0.100	-0.225	-0.362	-0.325
105.1	107.7	0.975	0.775	0.487	0.438	-0.025	-0.325	-0.675	-0.900
128.4	128.1	1.275	1.012	0.637	0.512	0.037	-0.362	-0.738	-1.037
143.4	142.7	1.350	1.050	0.787	0.588	0.038	-0.412	-0.862	-1.238
165.2	165.2	2.075	1.637	1.050	0.775	0.063	-0.462	-1.000	-1.450
187.3	186.9	2.700	2.162	1.537	0.637	0.037	-0.550	-1.187	-1.712
211.7	209.6	3.650	2.850	1.850	1.087	-0.062	-0.775	-1.525	-2.100
244.7	237.6	4.362	3.387	2.163	1.150	-0.250	-0.963	-1.687	-2.250
269.0	225.4	4.800	3.675	2.363	1.187	-0.313	-1.037	-1.762	-2.325
288.5	237.6	4.950	3.787	2.413	1.175	-0.375	-1.075	-1.737	-2.250
296.2	224.4	5.100	3.900	2.437	1.137	-0.425	-1.112	-1.837	-2.263

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	161-171	162-172	163-173	164-174	165-175	166-176	167-177	168-178
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
53.0	50.4	0.575	0.400	0.250	0.075	-0.075	-0.125	-0.275	-0.325
152.4	149.1	3.350	2.350	1.750	1.300	-0.075	-0.250	-0.350	-1.250
225.2	224.4	6.075	6.200	4.075	2.525	-0.275	-0.650	-1.625	-2.225

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	181-191	182-192	183-193	184-194	185-195	186-196	187-197	188-198
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.6	38.5	0.250	0.225	0.150	-0.050	-0.100	-0.125	-0.175	-0.225
119.3	113.9	0.800	2.225	1.650	1.075	-0.100	-0.325	-0.500	-0.650
172.2	171.6	0.350	2.575	1.625	1.950	-0.175	-0.575	-0.800	-1.000

BEAM CFT-TB3 TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	161-163	162-164	163-165	164-166	165-167	166-168	171-173	172-174	173-175	174-176	175-177	176-178
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
53.0	50.4	-0.025	-0.125	0.025	0.000	0.050	-0.025	-0.025	-0.150	-0.100	-0.025	-0.025	0.125
152.4	149.0	-0.075	-0.075	0.350	0.700	-0.175	-0.025	-0.025	-0.050	0.050	0.100	0.100	0.350
225.2	224.4	-0.100	0.075	2.800	2.400	-0.350	0.250	1.125	-0.275	-0.175	0.475	0.250	0.650

BEAM CFT-TB3 TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	181-183	182-184	183-185	184-186	185-187	186-188	191-193	192-194	193-195	194-196	195-197	196-198
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.6	38.5	-0.050	-0.025	0.000	0.025	0.050	0.000	-0.075	0.025	-0.025	0.175	0.000	0.325
119.3	113.9	0.025	0.400	1.250	1.225	0.050	0.275	1.850	0.200	0.125	0.150	0.100	0.050
172.2	171.6	-0.225	0.400	2.575	2.400	-0.100	0.400	4.025	1.375	1.125	-0.100	-0.025	0.025

BEAM CFT-TB3 DIAGONAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	161-173	162-174	163-175	164-176	165-177	166-178	171-163	172-164	173-165	174-166	175-167	176-168
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
53.0	50.4	0.395	0.263	0.110	-0.022	-0.083	-0.154	0.197	0.066	0.022	0.044	-0.088	-0.175
152.4	149.3	2.675	2.259	1.798	1.316	-0.307	-0.439	0.417	0.022	-0.241	-0.285	-0.461	-0.429
225.2	222.9	6.535	5.036	4.539	3.443	-0.329	-0.329	0.110	-0.548	-0.526	-0.636	-0.811	-0.577

BEAM CFT-TB3 DIAGONAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	181-193	182-194	183-195	184-196	185-197	186-198	191-183	192-184	193-185	194-186	195-187	196-188
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.6	38.5	0.154	0.066	-0.044	-0.110	-0.066	-0.154	0.132	-0.066	-0.022	0.066	-0.044	0.000
119.3	114.0	2.763	2.459	2.127	1.360	-0.038	-0.307	-0.175	-0.461	-0.197	0.000	-0.241	-0.197
172.2	170.4	3.794	3.473	3.860	2.917	-0.110	-0.417	-0.395	-1.294	-0.592	-0.461	-0.504	-0.548

BEAM CFT-TB3 LONGITUDINAL STRAINS-TOP FACE

STRAINS *10**-3

MOMENT D	MOMENT S	ECT1	ECT2	ECT3	ECT4	ECT5	ECT6
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000
19.6	17.8	-0.087	-0.100	-0.087	-0.112	-0.075	-0.062
30.6	30.0	-0.250	-0.237	-0.250	-0.262	-0.237	-0.237
49.9	47.4	-0.287	-0.313	-0.325	-0.337	-0.325	-0.313
108.1	107.7	-0.575	-0.612	-0.700	-0.809	-0.663	-0.650
143.4	142.3	-0.862	-0.900	-1.000	-0.975	-0.850	-0.787
165.2	165.2	-0.963	-1.037	-1.162	-1.087	-0.933	-0.925
187.3	187.3	-1.037	-1.175	-1.350	-1.275	-1.100	-1.050
211.9	211.3	-1.200	-1.375	-1.562	-1.475	-1.262	-1.225
224.7	220.3	-1.300	-1.413	-1.637	-1.737	-1.537	-1.525
229.0	224.7	-1.363	-1.475	-1.650	-1.812	-1.600	-1.525
233.3	230.9	-1.300	-1.400	-1.525	-1.812	-1.562	-1.512
236.2	226.3	-1.337	-1.437	-1.650	-1.863	-1.650	-1.512

BEAM CFT-T04 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT P	MOMENT S	11- 31	12- 32	13- 33	14- 34	15- 35	16- 36	17- 37	18- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.3	14.0	0.075	0.075	0.037	0.012	-0.050	-0.062	-0.100	-0.125
30.3	30.0	0.337	0.475	0.325	0.000	-0.062	-0.137	-0.175	-0.237
39.2	39.2	0.936	0.775	0.137	0.075	-0.050	-0.188	-0.275	-0.412
56.3	56.3	1.687	1.463	0.550	0.313	0.037	-0.225	-0.412	-0.750
71.3	71.3	2.400	1.850	0.825	0.537	0.175	-0.200	-0.500	-0.925
85.3	85.3	2.862	2.100	0.950	0.637	0.212	-0.188	-0.650	-1.250
100.6	100.6	3.450	2.650	1.037	0.675	0.188	-0.150	-0.812	-1.625
114.2	113.4	5.350	4.450	0.987	0.675	0.175	-0.163	-0.963	-2.000
117.8	116.8	6.050	5.062	0.937	0.662	0.150	-0.200	-1.037	-2.138
118.8	115.9	6.912	5.862	0.963	0.650	0.150	-0.200	-1.075	-2.212
119.5	116.3	7.412	6.263	0.950	0.637	0.125	-0.225	-1.125	-2.275
120.3	117.4	7.862	6.650	0.912	0.625	0.137	-0.225	-1.112	-2.275
120.2	116.1	9.087	7.825	0.875	0.650	0.113	-0.237	-1.112	-2.300
121.5	116.1	10.400	7.850	0.825	0.825	0.100	-0.275	-1.162	-2.312

BEAM CFT-T04 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT P	MOMENT S	21- 31	22- 32	23- 33	24- 34	25- 35	26- 36	27- 37	28- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.3	16.3	0.075	0.000	-0.025	-0.025	-0.025	-0.075	-0.100	-0.150
31.3	31.1	0.700	0.525	-0.150	-0.075	-0.075	-0.200	-0.275	-0.375
41.7	41.7	1.075	0.850	-0.175	-0.075	-0.075	-0.225	-0.275	-0.500
62.2	62.2	1.925	1.650	-0.250	-0.150	-0.100	-0.275	-0.600	-0.375
75.3	75.0	1.725	1.125	-0.275	-0.200	-0.200	-0.250	-0.700	-1.150
90.3	89.6	2.100	1.400	-0.275	-0.175	-0.225	-0.250	-0.850	-1.475
106.9	106.3	2.950	2.050	-0.400	-0.175	-0.225	-0.325	-1.125	-2.025
121.3	120.3	7.175	5.775	-0.350	-0.175	-0.325	-0.375	-1.275	-2.600
124.3	123.2	8.475	7.100	-0.350	-0.175	-0.350	-0.350	-1.300	-2.300
124.3	122.4	10.125	8.650	-0.350	-0.200	-0.350	-0.425	-1.375	-2.925

BEAM CFT-T04 TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT P	MOMENT S	21- 23	22- 24	23- 25	24- 26	25- 27	26- 28	31- 33	32- 34	33- 35	34- 36	35- 37	36- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.3	15.9	0.025	-0.025	-0.025	-0.025	0.100	0.000	-0.025	0.025	0.025	-0.075	0.000	0.000
31.3	31.1	-0.050	-0.050	0.025	-0.075	-0.100	-0.100	-0.275	-0.025	-0.175	-0.225	-0.050	-0.075
41.7	41.7	0.000	-0.025	0.000	-0.050	-0.025	-0.050	-0.050	0.175	-0.600	-0.100	-0.075	-0.100
62.2	62.2	-0.025	-0.150	0.025	0.125	0.125	-0.125	0.175	0.175	-0.150	-0.150	-0.200	-0.175
75.3	75.0	-0.025	-0.100	-0.125	0.475	0.025	-0.225	0.150	0.275	-0.125	-0.250	-0.100	-0.200
90.3	89.7	-0.050	-0.050	0.025	0.300	0.075	-0.325	0.275	0.425	-0.150	-0.250	-0.175	0.000
106.9	106.3	-0.075	-0.050	0.125	.200	0.000	-0.250	0.675	0.375	-0.250	-0.375	-0.525	-0.050
121.3	120.3	-0.125	-0.150	0.200	1.375	1.200	0.000	2.750	2.800	-0.400	-0.425	-1.125	-0.150
124.3	123.2	-0.150	-0.075	0.200	1.375	1.075	0.000	3.125	3.250	-0.475	-0.525	-0.700	-0.575
124.3	122.4	-0.350	-0.100	0.350	1.500	1.075	-0.300	4.125	4.125	-0.450	-0.575	-0.725	-0.225

BEAM CFT-T04 DIAGONAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT P	MOMENT S	21- 33	22- 34	23- 35	24- 36	25- 37	26- 38	31- 23	32- 24	33- 25	34- 26	35- 27	36- 28
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.3	16.3	-0.018	0.018	0.035	0.018	-0.071	-0.035	-0.053	0.053	-0.018	-0.018	-0.018	-0.035
31.3	31.1	-0.071	0.124	0.053	-0.053	-0.159	-0.159	0.247	0.300	-0.124	-0.106	-0.088	-0.141
41.7	41.7	-0.141	-0.124	-0.035	-0.141	-0.212	-0.247	0.459	0.477	-0.194	-0.141	-0.177	-0.194
62.2	62.2	-0.106	-0.124	-0.053	-0.177	-0.247	-0.336	0.707	0.636	-0.159	-0.053	-0.159	-0.300
75.3	75.0	-0.124	-0.124	-0.106	-0.230	-0.265	-0.442	0.831	0.742	-0.141	0.212	-0.053	-0.318
90.3	90.2	-0.124	-0.141	-0.106	-0.247	-0.336	-0.565	1.060	0.936	-0.159	0.406	0.000	-0.406
106.9	106.3	-0.194	-0.177	-0.141	-0.318	-0.442	-0.742	1.731	1.537	-0.247	0.583	0.053	-0.477
121.3	121.3	-0.194	-0.159	-0.141	-0.353	-0.583	-1.007	4.364	4.152	-0.300	0.089	0.106	-0.495
124.3	123.2	-0.300	-0.194	-0.176	-0.424	-0.689	-1.148	5.263	4.965	-0.318	0.707	0.106	-0.495
124.3	122.4	-0.530	-0.194	-1.961	-0.406	-0.707	-1.201	6.519	7.015	-0.265	0.742	0.141	-0.495

BEAM CFT-TB4 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	41- 71	42- 72	43- 73	44- 74	45- 75	46- 76	47- 77	48- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19.2	19.2	0.150	0.150	0.038	0.025	-0.012	-0.100	-0.100	-0.125
37.3	37.3	0.550	0.462	0.325	0.175	0.000	-0.150	-0.262	-0.350
49.0	49.0	0.738	0.600	0.400	0.225	0.075	-0.175	-0.362	-0.487
73.1	73.1	1.100	0.837	0.583	0.262	0.012	-0.300	-0.612	-0.812
89.2	89.2	1.387	1.075	0.725	0.362	0.037	-0.338	-0.725	-1.012
106.6	106.1	1.762	1.375	0.900	0.475	0.050	-0.475	-1.050	-1.375
125.7	125.3	2.537	2.000	1.363	0.738	0.137	-0.588	-1.387	-1.863
142.7	141.8	5.325	4.388	3.163	1.950	1.050	-0.575	-0.938	-1.300
146.3	145.8	6.925	5.487	3.987	2.525	1.488	-0.575	-2.550	-3.875
146.3	144.9	10.650	8.437	6.200	4.112	2.875	-0.450	-3.587	-4.662
149.4	145.4	14.012	11.037	8.175	5.412	4.037	-0.487	-4.787	-4.650
149.8	146.3	16.713	13.575	10.137	6.850	5.400	-0.350	-5.362	-4.412
150.3	147.6		16.987	11.787	8.062	6.850	-0.137	-6.712	-4.150
151.0	147.1		17.038	14.737	9.925	8.850	0.250	-7.962	-3.700

BEAM CFT-TB4 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	51- 61	52- 62	53- 63	54- 64	55- 65	56- 66	57- 67	58- 68
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19.2	18.7	0.225	0.125	0.075	0.025	0.025	-0.075	-0.050	-0.100
37.4	37.1	0.425	0.200	0.175	0.150	0.125	-0.075	-0.175	-0.250
49.1	49.1	0.325	0.100	0.000	0.025	0.000	-0.125	-0.250	-0.425
73.2	73.2	0.725	0.375	0.125	0.025	-0.025	-0.225	-0.475	-0.675
89.2	89.2	1.100	0.650	0.325	0.125	-0.075	-0.325	-0.625	-0.875
106.6	106.6	1.725	1.100	0.675	0.350	-0.025	-0.325	-0.800	-1.075
125.8	125.6	2.675	1.675	1.400	0.775	0.075	-0.300	-1.050	-1.500
142.7	141.8	6.825	5.200	6.075	2.300	0.750	-0.400	-1.300	-2.600
146.2	145.6	8.550	6.850	4.725	2.900	1.225	-0.425	-2.100	-3.000
146.2	144.9	12.875	7.750	7.750	5.025	2.350	-0.275	-3.000	-3.575

BEAM CFT-TB4 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	81-101	82-102	83-103	84-104	85-105	86-106	87-107	88-108
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.3	15.3	0.088	0.050	0.063	-0.012	-0.037	-0.050	-0.112	-0.062
30.0	29.6	0.538	0.325	0.362	0.063	-0.050	-0.100	-0.163	-0.250
39.2	39.2	0.975	0.650	0.637	0.125	-0.025	-0.112	-0.250	-0.325
58.5	58.5	1.600	-0.200	1.012	0.012	-0.087	-0.150	-0.350	-0.563
71.3	71.3	2.175	1.512	1.450	0.225	0.025	-0.163	-0.433	-0.713
85.5	84.2	2.987	2.112	1.962	0.362	0.125	-0.200	-0.563	-0.975
100.6	100.2	4.013	2.962	2.637	0.487	0.188	-0.225	-0.688	-1.288
114.2	114.2	6.267	4.675	4.062	0.637	0.262	-0.262	-0.775	-1.587
117.0	116.3	6.862	5.363	4.425	0.637	0.262	-0.237	-0.837	-1.625
117.0	115.2	8.200	6.362	5.225	0.762	0.350	-0.275	-0.837	-1.700
119.5	115.9	8.750	6.837	5.437	0.750	0.313	-0.300	-0.938	-1.762
120.0	117.0	9.350	7.237	5.800	0.738	0.313	-0.313	-0.975	-1.737
120.0	118.1	9.637	7.462	5.925	0.750	0.313	-0.325	-0.987	-1.800
121.3	117.7	10.113	7.850	6.175	0.750	0.300	-0.325	-0.987	-1.812

BEAM CFT-TB4 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	81- 91	82- 92	83- 93	84- 94	85- 95	86- 96	87- 97	88- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.3	15.9	0.075	0.050	-0.025	0.000	-0.025	-0.050	-0.150	-0.100
31.8	31.8	0.750	0.500	0.600	0.200	-0.050	-0.025	-0.200	-0.300
41.7	41.7	1.150	0.925	0.850	0.125	-0.100	-0.150	-0.350	-0.500
62.2	62.2	2.275	2.000	1.725	-0.100	-0.150	-0.200	-0.475	-0.825
75.8	75.8	2.850	2.525	2.200	0.000	-0.150	-0.100	-0.600	-1.050
90.6	90.2	3.850	3.025	2.675	-0.250	-0.300	-0.150	-0.800	-1.425
106.9	106.5	4.850	3.900	3.250	-0.300	-0.425	-0.075	-0.875	-1.725
121.3	120.5	5.900	4.800	5.675	-0.350	-0.425	-0.175	-1.175	-2.225
124.3	123.9	9.350	7.775	6.275	-0.400	-0.400	-0.150	-1.250	-2.300
124.3	123.2	11.225	9.350	7.475	-0.425	-0.450	-0.150	-1.300	-2.450

BEAM CFT-TD4 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3										
D	S	81- 83	82- 84	83- 85	84- 86	85- 87	86- 88	91- 93	92- 94	93- 95	94- 96	95- 97	96- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.3	15.9	-0.025	-0.025	0.075	0.100	0.125	0.025	0.000	-0.025	2.475	0.100	0.100	0.000
31.4	31.4	0.050	-0.050	0.125	0.050	0.325	0.025	0.075	0.100	2.525	0.075	0.175	0.025
41.7	41.7	-0.025	0.075	0.325	0.000	0.100	0.025	0.000	0.025	2.525	0.100	0.100	0.050
62.2	62.2	-0.125	0.650	0.675	-0.225	0.025	0.025	0.075	0.100	2.700	0.200	0.300	0.100
75.8	75.8	0.050	1.250	0.975	-0.175	0.025	0.100	0.150	0.100	2.575	0.400	0.425	0.050
90.8	90.2	-0.100	1.550	1.425	-0.475	0.150	0.275	0.150	0.175	2.475	0.850	0.775	-0.050
106.9	106.5	-0.075	2.150	1.800	-0.525	0.025	0.400	-0.100	0.050	2.500	1.325	1.275	-0.100
121.3	121.3	0.000	3.900	3.475	-0.750	-0.175	0.950	-0.075	0.100	2.675	1.925	1.775	0.075
124.3	123.6	0.175	4.450	3.950	-0.775	-0.225	1.000	-0.050	0.125	2.700	2.150	1.900	-0.075
124.3	122.8	0.000	5.000	5.175	-0.800	-0.250	1.150	-0.100	0.225	2.775	2.375	2.150	-0.050

BEAM CFT-TD4 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3										
D	S	81- 93	82- 94	83- 95	84- 96	85- 97	86- 98	91- 83	92- 84	93- 85	94- 86	95- 87	96- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.3	16.3	0.053	0.035	0.000	-0.035	0.035	0.053	0.000	0.018	-0.071	-0.124	-0.124	-0.053
31.8	31.5	0.424	0.336	0.265	0.053	-0.018	-0.088	0.124	-0.053	-0.106	-0.124	-0.212	-0.230
41.7	41.7	0.760	0.707	0.583	-0.053	-0.035	-0.035	0.265	0.018	-0.124	-0.177	-0.265	-0.265
62.2	62.2	1.519	1.360	1.307	-0.124	-0.918	-0.071	0.406	0.124	-0.194	-0.212	-0.317	-0.406
75.8	75.8	1.764	1.714	1.572	-0.053	-0.035	-0.035	0.459	0.000	-0.194	-0.247	-0.336	-0.495
90.8	89.8	2.367	2.120	1.890	0.159	0.159	-0.035	0.495	0.918	-0.247	-0.318	-0.459	-0.654
106.9	106.1	3.216	2.643	2.509	0.318	0.318	-0.013	0.530	0.071	-0.247	-0.406	-0.406	-0.513
121.3	120.9	5.565	4.905	4.399	0.548	0.583	0.124	0.742	-0.071	-0.300	-0.442	-0.583	-0.330
124.3	123.6	6.290	5.650	4.982	0.654	0.636	0.141	0.830	-0.035	-0.283	-0.442	-0.636	-0.830
124.3	122.0	7.820	7.120	6.290	0.760	0.742	0.177	0.848	-0.141	-0.300	-0.459	-0.671	-0.866

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
Φ	S	11- 31	12- 32	13- 33	14- 34	15- 35	16- 36	17- 37	18- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.4	16.1	0.025	0.050	0.000	0.000	-0.012	-0.062	-0.050	-0.075
31.4	26.7	0.163	0.000	0.038	0.063	0.000	-0.062	-0.075	-0.125
55.3	54.9	0.400	0.050	0.175	0.085	0.037	-0.075	-0.150	-0.225
75.1	72.9	0.700	0.012	0.462	0.250	0.150	-0.062	-0.262	-0.412
89.5	89.5	0.875	0.012	1.030	0.612	0.362	-0.012	-0.237	-0.500
108.1	106.1	1.075	0.063	0.912	0.750	0.500	0.037	-0.387	-0.650
128.4	128.4	1.325	-0.025	0.975	0.787	0.688	0.050	-0.525	-0.787
143.0	143.0	1.487	-0.063	1.012	0.800	0.800	0.063	-0.588	-0.938
162.3	162.1	1.738	0.050	1.025	0.738	0.600	-0.012	-0.700	-1.012
177.3	177.3	2.025	0.037	0.967	0.675	0.837	-0.087	-0.950	-1.250
193.0	192.5	2.250	1.012	1.025	0.675	0.925	-0.175	-0.963	-1.425
202.3	201.2	2.450	1.413	0.967	0.550	0.837	-0.262	-1.050	-1.562
213.0	209.8	2.967	1.000	1.000	-0.725	0.825	-0.313	-1.162	-1.750
220.5	218.0	4.550	1.000	0.959	0.462	0.812	-0.375	-1.250	-1.800
224.4	222.6	4.950	2.050	0.925	0.400	0.713	-0.450	-1.262	-1.837
229.4	227.2	5.300	2.250	0.862	0.362	0.637	-0.550	-1.325	-1.887

BEAM CFT-TB3 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
Φ	S	21- 31	22- 32	23- 33	24- 34	25- 35	26- 36	27- 37	28- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.5	16.2	0.100	0.100	0.000	0.025	-0.025	-0.050	0.050	-0.100
32.3	32.3	0.250	0.025	0.075	0.050	-0.025	-0.075	-0.100	-0.175
62.2	62.2	0.625	-0.050	0.000	-0.050	-0.050	-0.125	-0.150	-0.350
82.3	82.3	1.325	-0.075	-0.100	-0.175	0.100	-0.150	-0.400	-0.550
100.7	100.3	1.825	-0.075	-0.125	-0.175	0.575	0.050	-0.325	-0.675
121.0	120.5	2.075	-0.075	-0.125	-0.175	0.950	0.200	-0.400	-0.850
144.5	143.9	2.675	-0.025	-0.100	-0.250	1.225	0.225	-0.450	-1.025
160.9	159.5	3.350	-0.075	-0.150	-0.250	1.400	0.275	-0.600	-1.250
182.0	181.0	4.550	0.750	-0.125	-0.300	1.575	0.225	-0.850	-1.275
199.5	198.0	5.900	1.575	-0.125	-0.275	1.575	0.175	-0.925	-1.525
217.1	217.1	6.875	2.000	-0.125	-0.250	1.775	0.100	-1.000	-1.750
227.0	225.5	7.075	2.625	-0.275	-0.375	1.900	0.050	-1.375	-1.950
239.0	236.0	6.500	3.150	-0.325	-0.425	1.950	0.000	-1.425	-2.100

BEAM CFT-TB3 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Φ	S	21- 23	22- 24	23- 25	24- 26	25- 27	26- 28	31- 33	32- 34	33- 35	34- 36	35- 37	36- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.5	16.2	0.000	0.000	-0.025	0.075	0.025	0.050	-0.025	-0.100	-0.050	0.000	0.000	0.025
32.3	32.3	0.050	0.075	0.050	0.050	0.050	0.075	0.025	-0.025	0.025	0.050	0.025	-0.025
62.2	62.2	0.100	0.100	0.100	0.075	-0.050	0.075	0.025	-0.100	-0.175	0.000	0.025	-0.075
82.3	82.3	0.050	0.050	0.425	0.350	-0.275	0.025	0.225	-0.325	-0.125	-0.075	-0.025	0.000
100.7	100.3	0.075	0.050	1.275	1.025	-0.475	-0.375	0.225	-0.100	0.000	-0.025	-0.100	-0.400
121.0	120.5	0.025	0.025	2.025	1.675	-0.325	0.000	0.400	-0.150	0.025	-0.050	0.350	0.350
144.5	144.5	-0.075	-0.050	2.650	2.250	-0.225	-0.075	0.600	-0.200	-0.100	-0.100	0.500	0.650
160.9	160.3	-0.175	-0.200	3.475	3.375	-0.525	-0.125	0.900	-0.400	0.000	-0.050	0.750	0.775
182.0	181.0	-0.225	-0.050	3.900	3.275	-0.750	-0.125	1.950	0.475	-0.175	-0.150	0.775	0.825
199.5	198.0	-0.150	0.000	4.750	3.825	-0.500	0.100	2.550	1.025	-0.075	-0.100	0.925	1.025
217.1	217.1	-0.325	-0.350	5.425	4.225	-0.550	-0.075	3.125	1.575	-0.175	-0.125	0.975	1.175
227.0	227.0	-0.425	-0.150	6.000	5.625	-0.700	-0.050	4.375	2.650	-0.175	-0.225	1.300	1.450
239.0	236.4	-0.475	-0.225	7.050	5.950	-1.050	-1.325	4.900	2.625	-0.375	-0.350	1.250	1.500

BEAM CFT-TB3 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Φ	S	21- 33	22- 34	23- 35	24- 36	25- 37	26- 38	31- 33	32- 34	33- 35	34- 36	35- 37	36- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.5	16.2	0.044	-0.022	-0.022	-0.022	-0.022	-0.022	0.088	0.044	0.066	0.022	0.329	-0.044
32.3	32.3	0.110	0.044	0.000	-0.022	-0.044	-0.044	0.175	0.022	0.089	0.088	0.329	0.000
62.2	62.2	0.110	0.000	-0.044	-0.088	-0.154	-0.176	0.574	-0.066	0.022	0.022	0.285	-0.022
82.3	82.3	0.110	-0.044	-0.088	-0.154	-0.219	-0.285	0.397	-0.066	0.395	0.197	0.439	-0.044
100.7	100.3	0.197	0.022	-0.110	-0.175	-0.307	-0.395	1.113	-0.088	1.250	0.789	0.767	0.219
121.0	121.0	0.175	-0.022	-0.154	-0.241	-0.482	-0.526	1.491	-0.154	2.018	1.338	1.223	0.504
144.5	144.5	0.132	-0.022	-0.175	-0.285	-0.658	-0.702	2.013	-0.154	2.587	1.864	1.754	0.154
160.9	160.7	0.066	-0.088	-0.219	-0.285	-0.811	-0.811	2.675	-0.154	3.445	2.215	2.018	0.965
182.0	181.0	-0.044	-0.154	-0.263	-0.351	-0.679	-0.699	4.013	0.877	3.772	2.500	2.171	1.689
199.5	199.5	-0.197	-0.241	-0.307	-0.373	-1.140	-1.096	4.398	1.601	4.013	2.675	2.281	1.896
217.1	216.5	-0.219	-0.263	-0.373	-0.417	-1.272	-1.184	6.162	2.478	4.893	3.026	2.585	1.206
227.0	227.1	-0.614	-0.636	-0.658	-0.680	-1.992	-1.904	7.237	3.377	5.351	3.487	3.092	1.316
239.0	236.4	-0.789	-0.658	-0.746	-0.658	-2.171	-2.061	8.092	3.982	5.570	3.684	3.248	1.338

BEAM CFT-T05 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 11- 12	12- 14	13- 16	17- 14				
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
164.5	162.9	2.575	1.500	3.125	1.150	-0.275	-0.450	-0.300	-0.650
173.0	170.1	2.700	1.575	3.125	1.800	-0.425	-0.550	-0.750	-0.975

BEAM CFT-T05 TRANSVERSE STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 11- 13	12- 14	13- 15	14- 16	15- 17	16- 18						
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
164.5	164.0	4.775	4.025	-0.100	-0.075	0.025	0.050	1.050	2.050	2.575	2.950	-0.075	0.025
173.0	170.7	5.075	4.925	-0.150	-0.275	0.000	0.950	3.875	3.375	2.725	3.250	-0.075	0.025

BEAM CFT-T05 DIAGONAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 13- 14	15- 16	17- 13	11- 12	13- 14	15- 16						
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
164.5	163.8	1.634	1.650	1.513	1.333	1.220	1.382	10.855	9.759	5.355	5.322	2.659	-0.417
173.0	170.4	-0.417	-0.965	-0.702	-0.877	-0.987	-0.658	9.035	7.961	3.750	2.961	0.395	-0.263

BEAM CFT-T05 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 41- 51	42- 52	43- 53	44- 54	45- 55	46- 56	47- 57	48- 58
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.5	20.5	0.075	0.025	-0.012	-0.037	-0.037	-0.050	-0.100	-0.137
37.2	36.1	0.237	0.150	0.100	0.012	-1.712	-0.087	-0.125	-0.175
69.1	68.9	0.525	0.000	0.462	0.225	0.025	-0.037	-0.250	-0.400
91.4	91.4	0.738	0.900	0.688	0.350	0.037	-0.175	-0.400	-0.625
111.9	111.9	0.938	1.162	0.925	0.475	0.100	-0.200	-0.512	-0.800
133.1	134.9	1.112	1.463	1.150	0.612	0.113	-0.262	-0.650	-0.987
160.5	160.5	1.300	1.800	1.413	0.757	0.137	-0.313	-0.825	-1.262
178.8	178.8	1.436	2.050	1.612	0.925	0.188	-0.375	-1.000	-1.525
202.9	202.2	1.687	2.400	1.875	1.037	0.225	-0.450	-1.238	-1.837
221.6	221.6	1.900	2.737	2.112	1.262	0.250	-0.588	-1.500	-2.286
241.2	240.6	2.375	3.375	2.750	1.675	0.433	-0.683	-1.900	-2.950
252.8	251.5	2.838	4.175	3.175	2.100	0.662	-0.675	-2.200	-3.475
266.2	262.2	3.062	5.025	3.875	2.625	0.938	-0.700	-2.600	-4.150
275.6	272.2	5.575	8.015	6.537	4.512	1.950	-0.775	-3.937	-7.350
280.5	278.0	7.450	11.737	9.037	6.200	2.937	-0.683	-4.888	-10.300
286.7	284.5	11.212	16.238	13.562	9.400	5.025	-0.250	-6.187	-14.213

BEAM CFT-T05 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 61- 81	62- 82	63- 83	64- 84	65- 85	66- 86	67- 87	68- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.4	16.4	0.075	-0.075	0.012	-0.037	0.088	-0.025	-0.100	-0.100
31.4	28.9	0.188	0.075	0.113	0.012	0.037	-0.037	-0.112	-0.150
56.5	55.3	0.412	0.225	0.200	-1.137	0.088	-0.075	-0.212	-0.250
73.1	73.1	0.525	0.362	0.250	-1.200	0.313	-0.062	-0.338	-0.450
89.5	89.2	0.612	0.438	0.262	-1.162	0.462	-0.050	-0.325	-0.550
108.1	107.6	0.837	0.650	0.225	-1.325	0.500	-0.037	-0.400	-0.662
126.4	126.2	1.262	0.975	0.150	-0.125	0.563	-0.050	-0.575	-0.837
143.0	142.5	1.600	1.275	0.150	-0.137	0.787	0.050	-0.588	-0.987
162.3	161.8	2.062	1.650	0.212	-0.175	0.850	0.025	-0.725	-1.125
177.3	176.8	2.650	2.050	0.500	-0.150	0.900	0.050	-0.787	-1.325
193.0	192.6	3.338	2.787	1.000	-0.125	0.975	0.037	-0.900	-1.450
202.3	201.5	3.650	3.125	1.375	-0.100	0.925	-1.325	-1.150	-1.662
213.0	209.8	4.225	3.413	1.562	-0.075	0.925	-0.087	-1.225	-1.775
220.5	218.0	4.737	3.800	1.825	-0.012	0.912	-0.150	-1.300	-1.850
224.4	222.2	5.038	3.937	1.912	-0.012	0.887	-0.175	-1.350	-1.887
229.4	227.9	5.325	4.150	2.038	-0.025	0.837	-0.250	-1.363	-1.950

BEAM CFT-T05 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 71- 71	72- 72	73- 73	74- 74	75- 75	76- 76	77- 77	78- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.4	17.2	0.100	0.100	0.025	0.050	0.000	-0.050	-0.025	0.025
35.4	30.7	0.075	0.000	0.125	0.050	0.050	0.000	-0.075	-0.075
58.8	58.7	0.075	0.475	0.350	0.175	0.025	-0.075	-0.225	-0.275
77.7	77.7	0.175	0.625	0.525	0.350	0.100	-0.075	-0.250	-0.400
95.1	94.8	0.150	0.825	0.550	0.275	0.075	-0.025	-0.375	-0.600
114.3	114.0	0.050	0.975	0.525	0.175	0.000	0.075	-0.475	-0.650
136.5	136.4	1.525	4.250	0.400	0.150	-0.050	0.150	-0.500	-0.875
152.0	151.6	2.100	4.775	0.450	0.075	-0.125	0.350	-0.650	-1.050
172.2	171.9	3.000	5.562	0.575	0.050	-0.175	0.350	-0.750	-1.250
186.4	186.0	3.725	6.575	1.200	0.100	-0.150	0.450	-0.700	-1.325
205.1	204.5	4.650	7.750	2.325	0.050	-0.175	0.400	-1.000	-1.550
214.9	213.0	5.525	8.462	3.225	-0.125	-0.250	0.400	-1.150	-1.775
220.5	222.9	6.075	8.950	3.625	-0.225	-0.350	0.350	-1.275	-1.950

BEAM CFT-T33 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Ø	S	61- 63	62- 64	63- 65	64- 66	65- 67	66- 68	71- 73	72- 74	73- 75	74- 76	75- 77	76- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.4	16.9	0.125	0.100	0.075	0.175	0.275	0.125	0.200	-0.025	0.025	0.050	0.025	0.150
35.4	30.7	0.100	0.025	-0.250	0.150	0.250	0.100	0.225	0.000	0.025	0.075	0.025	0.200
53.3	58.0	0.100	0.050	-0.025	0.175	0.300	0.150	0.250	0.150	0.025	0.100	0.075	0.200
77.7	77.7	0.200	0.175	0.100	0.175	0.400	0.250	0.425	15.275	-0.575	0.225	0.150	0.275
95.1	95.1	0.100	0.075	0.100	0.275	0.475	0.200	0.425	15.250	0.025	0.575	0.525	0.175
114.8	114.7	0.325	0.350	0.050	0.250	0.400	0.250	0.450	15.300	0.075	1.050	0.925	0.275
136.3	136.4	0.800	0.625	0.100	0.200	0.450	0.325	0.350	15.275	0.025	1.400	1.400	0.200
152.0	152.0	1.000	1.125	0.025	0.125	0.000	0.475	0.450	15.275	-0.050	1.925	-0.600	0.100
172.5	172.5	1.475	1.575	0.175	0.125	0.300	0.575	0.275	15.250	-0.050	2.300	2.300	0.150
188.4	188.2	1.575	2.050	0.400	0.050	0.775	0.625	0.575	15.200	-0.100	2.650	2.675	0.125
205.1	204.5	1.800	3.025	1.300	0.000	0.925	0.700	1.100	15.275	-0.050	3.075	3.050	0.175
214.9	213.8	1.275	3.350	2.050	-0.300	0.675	0.750	1.275	15.200	-0.250	3.700	3.725	-0.100
226.3	222.9	1.225	3.800	2.275	-1.025	0.850	0.750	1.425	15.200	-0.275	3.875	3.900	-0.075

BEAM CFT-T33 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Ø	S	61- 73	62- 74	63- 75	64- 76	65- 77	66- 78	71- 63	72- 64	73- 65	74- 66	75- 67	76- 68
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.4	17.4	0.088	0.066	0.088	0.066	0.066	0.066	0.088	0.044	0.088	0.088	-0.044	0.088
35.4	30.7	0.066	0.066	0.044	0.022	0.044	-0.044	0.066	0.066	0.066	0.154	-0.088	0.044
53.3	58.7	0.373	0.197	0.110	0.022	0.000	-0.285	0.066	10.811	0.132	0.000	-0.175	-0.175
77.7	77.5	0.592	0.417	0.307	0.197	0.066	-0.132	-0.022	11.031	0.132	0.022	-0.197	-0.175
95.1	94.6	0.658	0.373	0.263	0.548	0.307	-0.110	-0.088	10.965	0.088	-0.066	-0.197	-0.263
114.3	114.1	1.184	0.877	0.285	0.833	0.504	0.000	-0.154	10.787	0.000	-0.110	-0.241	-0.373
136.3	135.9	1.930	1.579	0.219	1.184	0.746	0.044	-0.263	11.053	-0.044	-0.241	-0.263	-0.526
152.0	150.7	2.500	2.149	0.219	1.711	1.075	0.307	-0.329	10.965	-0.110	-0.329	-0.241	-0.614
172.5	171.5	3.399	2.765	0.417	2.039	1.228	0.417	-0.461	10.897	-0.329	-0.351	-0.285	-0.680
188.4	186.4	4.220	3.618	0.833	2.851	1.360	0.461	-0.543	10.877	-0.197	-0.548	-0.263	-0.766
205.1	205.0	5.038	5.082	1.930	2.654	1.667	0.571	-0.548	10.811	-0.241	-0.636	-0.307	-0.965
214.9	214.9	6.711	5.659	2.917	2.675	1.798	0.439	-0.702	10.439	-0.543	-0.877	-0.526	-1.404
226.3	223.2	7.412	6.535	3.333	2.807	1.842	0.461	-0.702	10.461	-0.570	-0.943	-0.504	-1.535

BEAM CFT-T33 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
Ø	S	81- 82	83- 84	85- 86	87- 88				
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
164.3	163.2	1.800	1.075	0.450	1.500	-0.200	-0.400	-2.900	-0.850
173.0	170.4	1.900	1.200	0.525	1.475	-0.275	-0.425	-3.225	-0.900

BEAM CFT-T33 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Ø	S	81- 83	82- 84	83- 85	84- 86	85- 87	86- 88						
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
164.3	163.3	0.000	0.000	4.275	5.625	0.200	-0.025	0.075	3.350	4.375	1.050	1.025	0.150
173.0	170.4	-0.050	1.050	4.725	3.500	0.100	-0.075	0.225	4.150	4.250	1.100	1.150	0.075

BEAM CFT-T33 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Ø	S	81- 82	83- 84	85- 86	83- 84	85- 86	87- 88						
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
164.3	164.3	1.996	3.110	4.649	3.925	0.351	-0.154	-0.548	-0.284	0.439	-0.592	-0.175	-0.956
173.0	171.3	2.237	3.326	5.083	4.123	0.417	-0.197	-0.504	-0.636	0.482	-0.614	-0.219	-0.967

BEAM CFT-T33 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
Ø	S	101-121	102-122	103-123	104-124	105-125	106-126	107-127	108-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55.3	55.3	0.418	0.429	0.412	0.033	0.812	0.025	-0.163	-0.250
103.1	107.0	0.936	0.802	-0.125	0.575	0.338	-0.087	-0.437	-0.762
177.3	176.4	2.256	1.971	0.313	0.500	0.563	-0.138	-1.275	-1.900
202.3	200.5	3.338	1.450	1.612	0.113	0.512	-0.375	-1.325	-1.863
213.0	209.6	3.750	2.937	-1.050	0.353	0.436	-0.338	-1.425	-2.075
220.3	217.6	4.537	3.300	1.537	0.100	0.538	-0.437	-2.112	-2.175
224.4	222.2	4.775	3.413	1.413	0.343	0.300	-0.525	-1.550	-2.238
229.4	226.3	5.075	3.637	1.500	0.075	0.262	-0.588	-1.612	-2.300

BEAM CFT-T05 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
Ø	S	111-121	112-122	113-123	114-124	115-125	116-126	117-127	118-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.3	58.7	0.325	0.375	-0.050	-0.025	-0.050	-0.175	-0.300	-0.350
114.3	113.3	0.950	1.300	-0.125	-0.100	0.900	0.075	-0.475	-0.875
186.4	185.9	1.525	3.700	1.050	-0.250	0.925	0.125	-1.225	-1.825

BEAM CFT-T05 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Ø	S	111-113	112-114	113-115	114-116	115-117	116-118	121-123	122-124	123-125	124-126	125-127	126-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.3	58.7	0.125	-0.075	-0.150	-0.375	0.025	0.050	0.000	-0.350	-0.050	0.025	0.200	0.050
114.3	113.3	0.000	-0.025	1.300	1.225	-0.175	0.025	0.675	0.075	-0.050	-0.200	0.225	0.150
186.4	186.3	2.300	-0.175	2.625	3.725	0.925	0.025	1.625	1.675	0.575	-0.325	0.825	0.950

BEAM CFT-T05 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Ø	S	111-123	112-124	113-125	114-126	115-127	116-128	127-113	122-114	123-115	124-116	125-117	126-118
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.3	58.7	0.000	0.000	0.373	0.197	0.000	0.044	0.000	-0.937	-0.219	0.022	0.287	-0.086
114.3	113.9	0.000	2.147	0.307	-0.022	0.000	-0.261	0.724	-0.789	-0.175	0.066	0.307	-0.066
186.4	186.9	0.000	1.974	-0.110	-0.235	0.000	-0.614	1.667	0.154	1.352	1.206	3.136	0.241

BEAM CFT-T05 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
Ø	S	131-141	132-142	133-143	134-144	135-145	136-146	137-147	138-148
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
69.1	69.1	0.450	0.500	0.237	0.050	-0.012	-0.163	-0.362	-0.412
139.1	138.8	1.325	0.775	0.412	0.125	-1.238	-0.438	-0.762	-1.150
241.6	218.3	1.675	1.387	0.925	0.525	-0.287	-1.162	-2.175	-2.962
252.3	250.6	2.000	2.100	1.525	0.787	-0.212	-1.525	-3.175	-4.687
260.2	262.2	3.375	2.475	2.100	1.112	-0.137	-1.712	-3.612	-5.700
275.2	271.8	6.162	5.187	4.150	2.363	0.362	-2.337	-5.475	-9.737
280.5	277.5	8.225	7.525	5.600	3.013	0.575	-3.137	-6.662	-13.462
280.7	285.8	12.362	11.288	8.713	4.575	0.787	-4.787	-6.812	-21.938

BEAM CFT-T05 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
Ø	S	151-171	152-172	153-173	154-174	155-175	156-176	157-177	158-178
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.3	58.3	0.000	0.113	0.038	0.000	-0.062	-0.188	-0.300	-0.375
103.1	106.7	0.662	0.587	0.312	0.511	0.325	-0.275	-0.537	-0.937
177.3	175.0	1.962	1.337	0.925	0.512	0.525	-0.550	-0.975	-1.475
200.3	200.8	2.037	0.962	0.963	0.537	0.462	-0.812	-1.275	-1.875
215.3	209.8	2.050	-0.737	0.933	0.350	0.375	-0.887	-1.325	-2.050
223.3	217.2	2.312	2.812	0.550	0.237	0.275	-0.925	-1.425	-2.125
224.4	222.1	3.587	2.987	0.350	0.200	0.225	-0.975	-1.450	-2.163
227.4	226.7	3.962	3.275	0.812	0.175	0.163	-1.012	-1.475	-2.200

BEAM CFT-T05 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
Ø	S	151-161	152-162	153-163	154-164	155-165	156-166	157-167	158-168
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.3	58.7	0.275	-0.075	0.275	0.100	-0.050	-0.125	-0.175	-0.100
114.3	113.7	1.000	0.450	0.125	-0.050	0.750	-0.200	-0.475	-0.550
186.4	186.3	2.800	2.900	0.075	-0.050	1.275	-0.400	-0.900	-1.150

BEAM CFT-T05 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
Ø	S	151-153	152-154	153-155	154-156	155-157	156-158	161-163	162-164	163-165	164-166	165-167	166-168
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.3	58.7	0.075	0.075	0.100	-0.350	0.000	0.050	0.050	-0.075	0.050	0.100	-0.050	0.225
114.3	113.9	0.275	0.275	-0.025	0.125	0.100	0.025	0.000	0.425	1.250	1.175	-0.150	0.050
186.4	186.9	2.025	1.950	-0.100	0.550	0.550	0.150	0.475	0.400	3.200	3.100	-0.250	-0.025

BEAM CFT-TU5 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
U	S	151-163	152-164	153-165	154-166	155-167	156-168	161-173	162-174	163-175	164-176	165-177	166-178
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.3	58.7	0.263	0.197	0.132	0.071	0.044	0.000	0.154	-0.175	0.000	-0.241	-0.175	-0.241
114.3	113.5	0.899	0.724	1.360	0.943	0.526	-0.132	0.175	-0.285	-0.088	-0.285	-0.439	-0.592
186.4	186.3	3.640	3.648	3.004	2.193	1.404	-0.044	-0.329	-0.461	-0.395	-0.395	-1.162	-1.206

BEAM CFT-TU5 LONGITUDINAL STRAINS-TOP FACE

MOMENT		STRAINS *10**-3					
U	S	LCT1	LCT2	LCT3	LCT4	LCT5	LCT6
0.0	0.0	0.000		0.000	0.000		0.000
10.4	10.1	-0.075		-0.100	0.012		-0.087
31.4	28.7	-0.163		-0.137	0.000		-0.150
55.5	54.9	-0.325		-0.338	-0.325		-0.325
7[illegible].1	7[illegible].7	-0.500		-0.525	-0.537		-0.537
89.5	89.5	-0.637		-0.675	-0.650		-0.700
103.1	100.1	-0.787		-0.875	-0.837		-0.712
1[illegible].4	12[illegible].4	-0.975		-1.062	-1.037		-1.125
143.0	14[illegible].0	-1.087		-1.212	-1.225		-1.325
162.3	16[illegible].1	-1.250		-1.350	-1.425		-1.600
177.3	177.3	-1.425		-1.537	-1.625		-1.[illegible]
193.0	19[illegible].3	-1.612		-1.737	-1.812		-2.150
202.3	201.2	-1.750		-1.937	-2.100		-2.512
213.0	209.8	-1.837		-2.175	-2.275		-2.725
220.5	216.0	-2.000		-2.212	-2.337		-2.812
224.4	222.8	-2.013		-2.250	-2.393		-2.887
229.4	227.2	-2.062		-2.275	-2.437		-2.937

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	11- 31	12- 32	13- 33	14- 34	15- 35	16- 36	17- 37	18- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21.0	19.1	0.100	0.113	0.063	0.050	-0.050	-0.050	-0.075	-0.050
35.0	34.6	0.188	0.150	0.113	0.063	-0.062	-0.100	-0.163	-0.212
52.3	47.4	0.262	0.225	0.325	0.037	-0.062	-0.137	-0.237	-0.338
113.1	110.9	1.350	1.087	0.800	0.537	0.125	-0.300	-0.612	-0.987
144.8	144.3	2.350	1.900	1.350	0.862	0.163	-0.450	0.338	-1.337
166.8	166.2	3.337	2.650	1.825	1.037	0.150	-0.662	-1.312	-1.975
186.0	177.3	4.138	3.288	2.288	1.312	0.212	-0.775	-1.562	-2.312
192.6	184.4	4.537	3.600	2.437	1.312	0.163	-0.963	-1.775	-2.537
199.4	188.9	4.712	3.700	2.425	1.250	0.012	-1.050	-1.850	-2.575
200.8	182.3	4.812	3.762	2.400	1.250	-0.037	-1.112	-1.875	-2.625
200.8	172.7	4.725	3.687	2.350	1.200	-0.012	-1.087	-1.837	-2.562

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	1- 11	2- 12	3- 13	4- 14	5- 15	6- 16	7- 17	8- 18
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.9	90.1	0.300	0.075	-0.050	1.300	-0.175	-0.200	-0.500	-0.525
152.8	143.3	0.350	-0.225	-0.350	2.525	-2.975	-0.500	-0.975	-1.100

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	21- 31	22- 32	23- 33	24- 34	25- 35	26- 36	27- 37	28- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22.4	19.7	0.150	0.100	0.050	0.025	0.000	-0.050	-0.025	-0.125
37.1	36.6	0.275	0.175	0.125	0.050	-0.025	-0.100	-0.175	-0.250
56.1	51.7	0.450	0.325	0.175	0.100	-0.025	-0.175	-0.250	-0.350
120.2	117.9	1.575	1.025	1.750	1.250	-0.200	-0.300	-0.775	-1.100
153.9	153.5	2.000	1.600	2.175	2.125	-0.325	-0.500	-1.125	-1.575
177.0	177.0	2.225	1.925	4.425	2.825	-0.375	-0.700	-1.550	-2.100
199.8	188.4	2.350	1.450	3.450	3.425	-0.450	-0.875	-1.875	-2.600
204.7	196.3	2.200	1.325	0.050	3.475	-0.500	-1.050	-2.175	-2.925
211.9	197.8	1.900	1.125	5.225	3.450	-0.600	-1.200	-2.275	-2.975

BEAM CFT-T06 TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	1- 3	2- 4	3- 5	4- 6	5- 7	6- 8	11- 13	12- 14	13- 15	14- 16	15- 17	16- 18
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.9	90.1	0.000	2.075	2.350	0.000	0.000	0.025	0.050	0.300	1.575	1.400	-0.025	0.075

BEAM CFT-T06 TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	21- 23	22- 24	23- 25	24- 26	25- 27	26- 28	31- 33	32- 34	33- 35	34- 36	35- 37	36- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22.4	20.1	0.050	0.075	0.050	-0.050	0.000	0.175	0.150	0.075	0.025	0.050	0.100	0.125
37.1	36.6	0.050	0.050	0.025	0.000	0.075	0.200	0.100	0.050	-0.025	0.050	0.100	0.125
56.1	51.5	-0.025	-0.025	-0.025	-0.025	-0.025	0.125	0.125	0.050	-0.025	0.025	0.100	0.125
120.2	117.9	1.575	0.700	-0.025	-0.075	0.150	0.475	0.100	0.025	1.000	0.825	-0.325	-0.325
153.9	153.5	3.050	2.000	-0.150	-0.175	0.375	0.925	-0.025	0.000	1.925	1.650	-0.250	0.350
177.0	177.0	5.500	4.425	-0.200	-0.475	0.650	1.725	0.000	-0.025	2.675	2.275	-0.425	0.150
199.8	188.4	7.225	6.150	-0.200	-0.475	0.825	2.450	0.025	0.000	3.325	2.800	-0.425	0.725
204.7	196.3	8.550	7.200	-0.250	-0.575	0.900	2.925	-0.050	0.000	3.875	3.300	-0.575	1.300
211.9	197.5	9.600	8.450	-0.225	-0.600	1.025	3.375	-0.125	-0.075	4.575	3.925	-0.575	1.575

BEAM CFT-T06 DIAGONAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	1- 13	2- 14	3- 14	4- 16	5- 17	6- 18	11- 3	12- 4	13- 5	14- 6	15- 7	16- 8
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.9	90.1	-0.152	-0.329	0.038	-0.329	-0.570	-0.461	0.038	2.329	2.325	1.579	-0.219	-0.124

BEAM CFT-T06 DIAGONAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	21- 33	22- 34	23- 35	24- 36	25- 37	26- 38	31- 23	32- 24	33- 25	34- 26	35- 27	36- 28
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22.4	22.4	0.000	0.000	-0.066	-0.044	-0.088	-0.132	0.022	0.000	-0.044	-0.088	-0.132	-0.176
37.1	36.4	0.044	0.000	-0.088	-0.088	-0.176	-0.132	0.044	0.022	-0.044	-0.066	-0.132	-0.176
56.1	50.6	0.044	-0.022	-0.088	-0.088	-0.176	-0.265	0.176	0.132	0.000	-0.088	-0.132	-0.197
120.2	117.9	0.462	-0.197	-0.373	-0.461	-0.614	-0.526	2.500	2.127	1.952	1.360	-0.417	-0.373
153.9	153.5	0.611	-0.175	-0.395	-0.548	-0.768	-0.570	4.496	3.853	3.487	2.566	-0.132	-0.175
177.0	176.1	0.768	-0.461	-0.614	-0.855	-1.053	-0.856	6.867	5.914	4.860	3.509	-0.088	0.000
199.8	187.8	0.768	-0.636	-0.724	-0.987	-1.404	-0.988	8.155	6.982	5.811	4.145	-0.022	0.307
204.7	196.1	0.702	-0.789	-0.768	-1.754	-1.425	-0.504	9.254	7.873	6.469	4.539	-0.022	0.442
211.9	197.5	0.548	-0.921	-0.768	-1.184	-1.491	-0.251	10.065	8.575	7.018	4.863	-0.044	0.417

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 41- 51	42- 52	43- 53	44- 54	45- 55	46- 56	47- 57	48- 58
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26.3	24.3	0.237	0.163	0.050	-0.025	-0.112	-0.137	-0.137	-0.175
43.7	43.3	0.337	0.287	0.163	0.012	-0.087	-0.188	-0.300	-0.275
66.0	59.5	0.487	0.362	0.225	0.075	-0.075	-0.300	-0.425	-0.400
141.4	138.7	1.150	0.687	0.512	0.237	-0.150	-0.688	-1.037	-1.275
181.0	180.6	1.650	1.162	0.700	0.362	-0.225	-1.000	-1.650	-2.000
208.2	207.3	2.013	1.563	0.837	0.300	-0.450	-1.625	-2.288	-2.950
235.0	221.2	2.537	1.863	1.037	0.362	-0.512	-2.038	-3.288	-3.625
240.8	230.5	3.062	2.087	1.137	0.313	-0.625	-2.962	-3.562	-4.013
249.3	232.3	3.712	2.462	1.375	0.412	-0.938	-3.762	-6.162	
251.0	227.9	3.962	2.662	1.463	0.438	-0.975	-4.075	-6.725	

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 61- 81	62- 82	63- 83	64- 84	65- 85	66- 86	67- 87	68- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21.0	19.6	0.475	0.375	0.150	0.150	-0.150	-0.150	0.100	-0.150
35.0	34.2	0.800	0.600	0.325	0.100	-0.150	-0.150	0.025	-0.325
52.8	47.8	1.125	0.800	0.475	0.375	-0.075	-0.250	-0.350	-0.475
113.1	110.9	2.050	1.150	0.350	0.325	1.650	0.375	-0.300	-1.725
114.8	143.9	3.725	2.425	1.175	1.300	1.900	-0.050	-1.675	-2.825
166.0	165.9	5.850	4.075	2.350	3.150	2.075	-0.500	-2.200	-4.450
188.0	176.6	7.300	5.375	3.350		2.175	-0.625	-3.300	-5.825
192.6	184.8	9.300	6.225	4.250		2.100	-0.975	-3.850	-6.800
199.4	185.9	10.975	7.000			3.075	-0.750	-5.350	
200.8	182.3	14.225	9.050			5.325	0.450	-7.550	
200.8	172.7	15.900	10.375			6.800	3.475	-9.425	

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 71- 71	72- 72	73- 73	74- 74	75- 75	76- 76	77- 77	78- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22.4	21.6	0.350	0.275	0.150	0.050	-0.050	-0.025	0.025	-0.100
37.1	36.4	0.600	0.475	0.325	0.100	-0.075	-0.050	-0.050	-0.175
56.1	50.4	0.825	0.575	0.500	0.175	-0.025	-0.075	-0.100	-0.300
120.2	117.9	1.275	0.850	0.500	0.025	-0.800	0.650	-0.475	-1.050
153.7	153.5	2.050	0.725	1.775	0.950	-1.100	0.575	-0.825	-1.650
177.0	175.9	3.475	2.450	3.500	1.675	-1.325	0.150	-1.650	-2.750
199.6	187.6	4.975	4.150	4.300	2.375	-1.375	-0.100	-2.150	-3.675
204.7	196.0	5.300	5.400	5.750	2.725	-1.375	-0.425	-2.650	-4.475
211.9	197.5	4.000	7.100	6.975	3.300	-1.225	-0.550	-3.450	

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 81- 91	82- 92	83- 93	84- 94	85- 95	86- 96	87- 97	88- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.9	90.1	0.300	0.000	3.525	3.275	-0.125	-0.325	-0.350	-0.475
117.7	117.4	0.275	9.000	7.525	4.675	-0.200	-0.425	-0.425	-0.600
135.3	134.8	0.225	11.900	8.650	4.800	0.350	-0.525	-0.725	-0.875
152.8	143.5	0.200	13.000	9.800		0.775	-0.675	-0.750	-1.050
156.5	149.8	0.200	16.375	10.700		1.225	-0.825	-1.000	-1.125
162.0	151.0	0.500	22.525	32.175		1.850	-0.950	-1.075	-1.175

BEAM CFT-T36 TRANSVERSE STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 61- 63	62- 64	63- 65	64- 66	65- 67	66- 68	71- 73	72- 74	73- 75	74- 76	75- 77	76- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22.4	22.4	0.000	0.075	0.050	0.125	0.350	0.150	0.100	0.075	0.225	0.125	0.075	0.225
37.1	36.4	0.000	0.050	0.150	0.150	0.400	0.100	0.075	0.050	0.275	0.125	0.000	0.175
56.1	50.4	-0.150	-0.050	0.150	0.250	0.500	0.150	-0.075	0.075	0.250	0.150	0.075	0.200
120.2	117.7	0.050	0.050	0.150	0.500	1.975	1.775	0.200	0.250	0.000	4.875	4.600	0.150
153.7	153.5	0.000	-0.100	1.750	2.475	2.325	2.575	1.500	1.675	0.000	6.525	6.550	0.425
177.0	175.9	-0.100	-0.050	3.575	4.150	2.025	4.225	3.450	1.900	0.175	8.275	8.150	0.475
199.6	187.6	0.025	-0.050	4.350	5.275	1.750	4.475	5.500	1.850	0.600	9.525	9.025	1.300
204.7	196.0	0.075	-0.025	6.275	6.575	1.600	4.975	7.625	1.900	1.000	12.975	9.575	2.225
211.9	197.1	0.250	-0.450	7.800	8.050	1.325		10.700	2.050	1.675	11.825	10.050	6.200

BEAM CFT-T36 TRANSVERSE STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 81- 83	82- 84	83- 85	84- 86	85- 87	86- 88	91- 93	92- 94	93- 95	94- 96	95- 97	96- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.9	90.1	-0.050	0.000	6.225	7.400	-0.100	0.050	8.500	-0.075	-0.075	0.000	0.000	0.025
117.7	117.1	-0.125	0.275	9.775	10.425	0.025	0.150	13.050	-0.200	0.025	0.075	-0.050	0.075
135.3	128.5	-0.125	0.350	13.875		0.525	0.175	14.600	-0.225	2.325	2.325	-0.150	0.125
152.8	143.5	-0.200	.	16.525		0.925	0.250	20.350	-0.400	3.900	3.700	-0.350	0.050
156.5	149.6	-0.125		16.575		2.075	0.275	24.051	-0.650	5.475	5.475	-0.275	0.075
162.0	150.4			39.350		5.200	1.075	31.900	-0.425	7.600	7.300	-0.225	0.050

BEAM CFT-T06 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	61- 73	62- 74	63- 75	64- 76	65- 77	66- 78	71- 63	72- 64	73- 65	74- 66	75- 67	76- 68
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22.4	20.1	0.110	0.132	0.088	0.022	0.000	-0.022	-0.044	-0.219	-0.197	-0.154	-0.088	-0.066
37.1	36.4	0.439	0.417	0.285	0.110	0.022	-0.044	-0.132	-0.351	-0.219	-0.197	-0.197	-0.197
56.1	51.2	0.746	0.658	0.570	0.307	0.110	-0.022	-0.132	-0.197	-0.329	-0.263	-0.307	-0.461
120.2	117.9	1.447	1.031	0.329	4.101	2.632	1.776	-0.154	-0.417	-0.592	-0.526	0.241	-0.833
153.9	153.1	3.947	3.229	2.237	7.215	3.355	2.346	-0.526	-1.360	-0.855	-0.702	0.373	-1.116
177.0	177.0	6.535	5.504	4.364	9.825	3.706	2.456	-0.373	-2.105	-1.075	-0.877	0.219	-0.877
199.0	188.4	10.789	7.346	6.113	11.667	4.057	2.675	-0.154	-2.500	-1.272	-1.031	0.066	-1.338
199.8	196.3	10.614	11.228	7.917	12.961	3.832	2.697	-0.083	-3.136	-1.425	-1.118	0.000	-1.140
204.7	197.8	15.504	13.399	10.132	14.890	4.035	3.684	-0.132	-4.057	-1.557	-1.228	-0.263	

BEAM CFT-T06 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	81- 93	82- 94	83- 95	84- 96	85- 97	86- 98	91- 83	92- 84	93- 85	94- 86	95- 87	96- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.7	90.1	6.379	8.136	7.325	6.134	0.044	0.000	-0.570	-2.525	-0.417	-0.307	-0.175	-0.504
117.7	117.4	13.130	12.061	10.377	3.947	0.088	0.022	-0.877	-3.860	-0.614	-0.417	-0.263	-0.636
135.5	135.1	16.513	15.219	16.009	13.180	0.680	0.154	-1.162	-5.263	-0.724	-0.175	-0.417	-0.833
152.3	143.9	21.645	17.962	19.946	.	1.342	0.241	-1.294		-0.768	0.088	-0.504	-0.743
156.5	150.1	22.544	22.785	23.246		2.346	0.395	-1.382		-0.899	0.373	-0.570	-0.787
162.0	151.1	28.377	28.838	30.307		3.509	0.175			-0.877	0.636	-0.658	-0.768

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	111-131	112-132	113-133	114-134	115-135	116-136	117-137	118-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21.0	19.4	-1.050	0.000	-0.100	0.012	-0.050	0.000	-0.100	-0.087
35.0	34.8	0.525	0.250	-0.100	0.037	0.000	-0.050	-0.112	-0.175
52.5	48.7	0.675	0.375	-0.075	0.050	-0.037	-0.037	-0.163	-0.250
113.1	110.9	1.075	0.775	-0.200	1.312	0.425	-0.212	-0.662	-0.963
144.5	144.5	1.950	1.466	0.225	1.537	0.612	-0.338	-0.887	-1.375
160.6	160.6	3.012	2.562	1.175	2.413	0.975	-0.350	-1.275	-2.087
183.0	177.3	3.500	3.425	1.737	2.637	1.112	-0.525	-1.725	-2.425
192.5	184.8	3.475	3.887	2.087	2.900	0.925	-0.750	-2.263	-2.675
199.4	186.2	3.375	4.000	2.425	3.350	1.337	-0.750	-2.950	-2.950
200.4	182.5	3.500	5.062	2.925	6.000	2.238	-0.525	-4.762	-4.062
200.4	172.7	5.587	6.075	3.050	7.800	2.950	0.787	-6.150	-4.600

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	101-111	102-112	103-113	104-114	105-115	106-116	107-117	108-118
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.7	90.1	1.750	0.000	5.675	-0.450	-0.250	-0.275	-0.375	-0.450
117.7	117.1	1.750	0.050	5.775	-0.550	-0.325	-0.400	-0.525	-0.600
135.5	135.4	2.475	0.125	7.675	-0.750	0.000	-0.425	-0.650	-0.875
152.3	144.0	3.600	0.075	9.250	-0.850	0.500	-0.475	-0.700	-0.925
156.5	150.1	5.150	-0.050	10.650	-1.225	1.025	-0.575	-0.750	-1.000
162.0	151.0	7.775	0.000	12.300	-1.100	1.900	-0.650	-0.825	-1.000

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	121-131	122-132	123-133	124-134	125-135	126-136	127-137	128-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.2	117.9	1.225	1.000	-0.050	-0.150	-0.250	-0.125	-0.875	-1.250
153.9	153.1	1.500	3.000	0.875	-0.300	-0.350	-0.325	-1.350	-1.925
177.0	176.8	1.750	4.975	2.675	-0.375	-0.375	-0.275	-1.825	-2.675
199.8	188.4	1.775	6.525	3.500	-0.425	-0.400	-0.450	-2.425	-2.875
204.7	196.3	1.650	6.275	4.600	-0.500	-0.500	-0.800	-3.125	-2.875
211.9	197.8	1.525	6.975	5.775	-0.625	-0.575	-0.875	-4.025	-2.450

BEAM CFT-T06 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	101-103	102-104	103-105	104-106	105-107	106-108	111-113	112-114	113-115	114-116	115-117	116-118
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.7	90.1	5.375	5.400	-0.075	0.000	-0.025	0.000	0.050	4.975	5.050	-0.400	0.025	0.125
135.5	135.3	14.400	13.700	1.550	1.000	-0.125	-0.075	0.525	12.350	11.950	-0.425	0.125	0.075
152.8	143.9	18.150	16.925	3.450	3.725	-0.050	-0.025	2.225	14.350	14.550	0.275	1.075	0.175
156.5	149.6	21.775	20.450	5.375	5.050	-0.175	-0.050	5.025	16.375	16.400	1.675	2.075	0.250
162.0	150.4	29.175	27.000	7.550	7.975	-0.175	-0.050	8.500	19.850	20.125	2.825	3.675	0.750

BEAM CFT-T06 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	121-125	122-126	123-127	124-128	125-129	126-130	131-135	132-136	133-137	134-138	135-139	136-140
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.2	117.9	0.350	-0.075	-0.275	2.475	2.700	0.825	0.450	0.300	-0.200	-0.125	0.175	0.700
199.8	187.6	6.200	0.075	-0.350	7.375	7.875	0.375	1.350	5.050	3.300	-0.225	0.825	5.350
[illegible]	195.6	8.450	0.750	-0.300	8.250	8.725	0.925	1.425	6.675	4.700	-0.475	-0.150	6.750
211.9	196.7	11.250	1.400	-0.425	9.575	9.300	2.550	1.500	7.950	5.975	-0.675	-0.450	8.550

BEAM CFT-T06 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	101-115	102-116	103-117	104-118	105-119	106-120	111-125	112-126	113-127	114-128	115-129	116-130
0.0	0.0	0.000	[illegible]	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.9	90.1	-0.219	[illegible]	-0.285	-0.285	-0.219	-0.551	0.564	5.673	5.197	-0.576	-0.110	-0.197
139.3	134.9	-0.307	2.900	[illegible]	-0.044	-0.548	-0.548	15.899	15.070	15.531	0.373	0.329	1.206
152.8	143.2	-0.285	3.407	-0.688	[illegible]	-0.636	-0.636	20.592	15.526	17.370	1.279	1.706	-0.110
156.5	148.5	-0.285	3.816	-0.811	[illegible]	-0.630	-0.614		20.833	21.162	2.273	2.301	-0.068
162.0	150.9	0.154	5.044	-0.877	0.921	-0.855	-0.351		30.867	21.711	-1.908	3.726	-0.000

BEAM CFT-T06 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	121-135	122-136	123-137	124-138	125-139	126-140	131-123	132-124	133-125	134-126	135-127	136-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.2	117.9	-0.263	-0.150	-0.225	-0.375	0.150	-0.614	1.382	1.118	-0.375	1.447	0.853	0.022
199.8	187.2	-0.595	-1.250	-0.[illegible]	-0.724	0.614	0.899	5.299	7.619	4.649	4.101	2.127	0.241
204.7	195.6	-0.482	-1.069	-0.76[illegible]	-0.759	0.724	1.903	10.395	9.518	6.096	4.366	1.906	0.154
211.9	197.1	-0.504	-1.974	-0.945	-0.74[illegible]	0.768	3.969	13.158	11.667	7.785	5.132	2.105	0.526

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	141-151	142-152	143-153	144-154	145-155	146-156	147-157	148-158
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.3	23.[illegible]	0.237	0.175	0.125	0.063	-0.050	-0.100	-0.137	-0.150
43.7	43.0	0.[illegible]7	0.300	0.150	0.100	-0.025	-0.112	-0.163	-0.212
68.0	60.6	0.[illegible]	[illegible]	0.212	-0.433	-0.100	-0.212	-0.313	-0.375
141.4	138.7	1.112	0.[illegible]	0.400	0.387	-0.237	-0.650	-1.025	-1.250
181.0	180.6	1.612	0.[illegible]	[illegible]	0.500	-0.325	-1.062	-1.700	-2.112
203.2	208.2	1.937	1.[illegible]	-0.650	-[illegible]	-0.612	-1.600	-2.612	-3.163
235.0	221.6	2.300	1.037	0.775	0.662	-[illegible]	-2.037	-3.425	-4.112
240.[illegible]	229.2	2.812	1.9[illegible]	0.938	0.713	-0.975	-2.875	-4.812	-6.337
[illegible]	232.8	3.325	2.187	1.000	0.662	-1.300	-[illegible]	-6.537	-9.525
251.[illegible]	237.9	3.562	2.325	0.937	0.538	-1.488	-4.487	-7.575	-11.325
251.0	239.8	3.500	2.225	0.975	0.600	-1.488	-4.512	-7.612	-11.450

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	161-181	162-182	163-183	164-184	165-185	166-186	167-187	168-188
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21.0	19.4	0.175	-0.050	[illegible]	-1.200	0.125	0.050	-0.050	0.150
35.0	34.9	0.350	-0.037	0.13[illegible]	[illegible]	0.125	0.012	-0.075	0.088
52.3	47.8	0.475	-0.462	0.250	0.[illegible]	0.063	-0.025	-0.175	-0.062
113.1	110.9	1.500	0.[illegible]	0.887	-0.025	-0.150	-0.125	-0.537	-0.700
144.3	144.5	2.368	1.050	1.400	-0.050	-0.21[illegible]	-0.250	-0.887	-1.137
160.8	160.4	3.288	1.775	1.863	-0.125	-0.525	-0.525	-1.413	-1.812
180.0	177.5	4.163	2.475	2.350	-0.100	-0.513	-0.[illegible]	-1.700	-2.138
192.[illegible]	184.8	4.462	2.762	2.487	-0.125	-0.575	-0.85[illegible]	-1.962	-2.325
197.4	185.9	4.612	1.[illegible]12	2.475	-0.225	-0.[illegible]50	-1.050	-2.150	-2.412
200.8	182.1	4.700	2.[illegible]62	2.475	-0.262	-0.[illegible]25	-1.112	-2.225	-2.487

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	161-171	162-172	163-173	164-174	165-175	166-176	167-177	168-178
0.0	0.0	0.[illegible]	[illegible]	0.000	0.000	0.000	0.000	0.000	0.000
120.2	117.5	1.[illegible]0	2.650	2.025	0.025	-0.250	-0.250	-0.650	-1.025
153.9	155.1	1.125	4.550	3.125	-0.050	-0.375	-0.400	-1.125	-1.600

BEAM CFT-T06 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-							
D	S	181-191	182-192	183-193	184-194	185-195	186-196	187-197	188-198
0.0	0.0	0.000	0.000	0.000	[illegible].000	0.000	0.000	0.000	0.000
91.9	90.1	0.050	-0.575	-0.[illegible]	1.400	0.625	-0.425	-0.525	-0.925

BEAM CFT-T36 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3										
D	S	161-1[illegible]	162-164	163-165	164-166	165-167	166-168	171-173	172-174	173-175	174-176	175-177	176-178
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.2	117.9	-0.100	1.400	1.475	0.100	0.000	0.275	2.225	-0.300	0.050	0.175	0.525	0.675

BEAM CFT-T36 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	181-183	182-184	183-185	184-186	185-187	186-188	191-193	192-194	193-195	194-196	195-197	196-198
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.9	90.1	-0.200	-0.675	0.025	1.975	2.375	-0.025	-0.150	4.250	4.450	-0.125	-0.200	0.025

BEAM CFT-T36 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	161-173	162-174	163-175	164-165	165-177	166-178	171-163	172-164	173-165	174-166	175-167	176-168
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
120.2	117.9	3.158	2.500	2.259	0.110	0.235	0.022	0.241	-0.439	-0.417	-0.526	-0.658	-0.504

BEAM CFT-T36 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	181-193	182-194	183-195	184-196	185-197	186-198	191-183	192-184	193-185	194-186	195-187	196-188
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
91.9	90.1	-0.132	2.741	2.939	4.342	1.491	-0.263	-0.395	-0.546	-0.658	1.711	-0.570	-0.921

BEAM CFT-T36 LONGITUDINAL STRAINS-TOP FACE

MOMENT		STRAINS *10**-3						
D	S	ECT1	ECT2	ECT3	ECT4	ECT5	ECT6
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000
21.0	19.1				-0.037	-0.062	-0.012
55.0	54.0				-0.100	-0.163	-0.087
92.[illegible]	47.4				-0.138	-0.113	-0.175
113.1	110.7	0.462	-0.725	-0.738	-0.550	-0.525	-0.537
144.[illegible]	144.[illegible]	0.125	-0.950	-1.112	-0.837	-0.900	-0.800
160.[illegible]	160.[illegible]	-0.275	-1.363	-1.662	-1.238	-1.225	-1.300
183.0	177.[illegible]	-0.462	-1.525	-1.750	-1.550	-1.437	-1.463
192.[illegible]	184.4	-0.685	-1.725	-1.962	-1.737	-1.625	-1.562
199.4	193.9	-0.837	-1.737	-1.737	-1.837	-1.737	-1.737
200.8	182.3	-0.837	-1.775	-2.025	-1.700	-1.475	-1.600
200.[illegible]	176.7	-0.583	-1.675	-1.950	-1.437	-1.312	-1.637

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	11- 31	12- 32	13- 33	14- 34	15- 35	16- 36	17- 37	18- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19.0	18.9	0.150	0.137	0.100	0.037	0.050	-0.012	-0.037	-0.037
38.7	38.5	0.225	0.175	0.050	-0.025	-0.050	-0.175	-0.212	-0.237
60.5	60.3	0.375	0.287	0.225	0.037	-0.112	-0.262	-0.400	-0.487
109.2	109.2	0.925	0.750	0.700	0.412	0.063	-0.387	-0.775	-1.037
144.3	144.1	1.463	1.175	0.950	0.601	0.037	-0.587	-1.112	-1.537
176.9	176.6	2.250	1.833	1.162	0.637	-0.137	-0.900	-1.625	-2.175
201.7	197.6	3.025	2.387	1.413	0.525	-0.525	-1.200	-2.112	
215.1	208.2	3.212	2.475	1.425	0.637	-0.500	-1.463	-2.400	
222.5	208.2	3.450	2.425	1.500	0.737	-0.650	-1.650	-2.625	
222.5	194.9	5.296	3.925	1.587	0.737	-0.862	-1.812	-2.700	
222.6	196.4	3.050	2.125	1.212	0.550	-1.000	-1.687	-2.700	

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	1- 11	2- 12	3- 13	4- 14	5- 15	6- 16	7- 17	8- 18
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88.7	88.7	0.875	0.575	1.375	0.800	-0.200	-0.225	-0.475	-0.650
147.9	143.5	0.000	0.000	2.075	0.925	-0.600	-0.550	-0.850	-1.100
164.1	160.9	0.550	-0.150	2.425	0.875	-0.750	-0.650	-1.000	-1.250
174.3	166.7	0.450	-0.275	2.375	0.700	-0.825	-0.750	-1.100	-1.425
180.3	166.9	0.350	-0.400	2.150	0.400	-0.875	-0.775	-1.125	-1.400
180.3	159.1	0.275	-0.575	1.725	0.025	-0.875	-0.825	-1.175	-1.350

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	21- 31	22- 32	23- 33	24- 34	25- 35	26- 36	27- 37	28- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.6	20.6	0.125	0.200	0.075	0.025	0.025	-0.025	-0.100	-0.100
41.3	39.8	0.225	0.200	0.050	0.025	-0.025	-0.100	-0.175	-0.200
64.1	64.1	0.450	0.300	0.200	0.050	-0.050	-0.225	-0.375	-0.375
115.9	115.9	1.050	1.075	1.250	0.875	-0.200	-0.225	-0.750	-0.925
153.9	153.9	1.800	2.050	1.950	1.400	-0.325	-0.250	-1.125	-1.525
192.2	189.1	1.450	3.075	2.575	1.675	-0.450	-0.600	-1.800	-2.325
214.5	210.4	1.025	4.550	3.150	1.975	-0.775	-1.025	-2.550	
223.0	219.4	1.350	4.975	3.350	2.050	-0.575	-1.225	-2.925	
223.0	219.1	1.250	5.400	3.475	2.175	-0.650	-1.350	-3.200	
230.3	207.3	1.050	5.125	3.250	1.925	-0.675	-1.775	-3.300	

BEAM CFT-TU7 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	1- 3	2- 4	3- 5	4- 6	5- 7	6- 8	11- 13	12- 14	13- 15	14- 16	15- 17	16- 18
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88.7	88.7	2.650	2.750	-0.175	0.050	0.400	0.425	0.550	0.550	1.475	1.400	0.125	0.175
164.1	159.7	10.050	10.250	-0.175	1.725	3.050	1.525	0.675	0.475	7.725	7.475	-0.075	0.475

BEAM CFT-TU7 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	21- 23	22- 24	23- 25	24- 26	25- 27	26- 28	31- 33	32- 34	33- 35	34- 36	35- 37	36- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.6	20.6	0.175	0.150	0.000	-0.200	0.025	-0.175	-0.075	0.200	0.175	0.150	0.050	-0.050
41.3	40.2	0.150	-0.050	0.025	-0.200	0.050	0.250	0.050	0.175	0.375	0.250	0.050	0.375
64.1	64.1	0.250	0.150	0.100	0.150	-0.025	0.200	0.150	0.250	0.025	0.225	-0.025	0.125
115.9	115.9	0.900	0.050	0.050	0.600	0.350	0.300	0.150	0.075	0.875	1.050	-0.150	0.175
153.9	153.9	1.050	-0.150	-0.025	1.775	1.075	0.275	-0.200	-0.025	1.575	1.375	-0.225	0.375
192.2	189.1	3.225	0.050	0.050	2.725	2.750	0.325	-0.025	-0.050	2.525	2.625	-0.225	0.150
214.5	208.8	4.350	0.025	-0.025	3.450	3.550	0.525	-0.075	0.100	3.125	3.450	-0.300	-0.350
223.0	219.4	6.200	0.000	0.050	3.975	4.050	0.625	0.075	-0.125	3.675	4.025	-0.325	
230.3	219.1	7.500	-0.025	0.000	4.450	4.450	0.650	-0.175	-0.350	4.500	4.875	-0.375	

BEAM CFT-TU7 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	1- 13	2- 14	3- 14	4- 16	5- 17	6- 18	11- 3	12- 4	13- 5	14- 6	15- 7	16- 8
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88.7	88.7	-0.439	-0.838	-0.855	-0.614	-0.636	-0.439	3.043	2.763	1.491	1.228	-0.482	-0.570
164.1	159.8	-0.789	-1.088	-1.338	-0.599	-0.614	-0.395	8.882	7.961	0.272	0.404	0.375	-0.263

BEAM CFT-TU7 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	21- 33	22- 34	23- 35	24- 36	25- 37	26- 38	31- 23	32- 24	33- 25	34- 26	35- 27	36- 28
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.8	20.5	-0.119	-0.275	-0.235	-0.375	-0.351	-0.197	-0.112	-0.175	-0.197	-0.263	-0.235	-0.107
41.5	41.3	-0.263	-0.417	-0.329	-0.439	-0.351	-0.439	-0.022	-0.066	-0.066	-0.154	-0.219	-0.154
64.1	64.1	-0.197	-0.395	-0.395	-0.548	-0.526	-0.570	0.044	0.044	-0.022	0.020	-0.175	-0.307
110.4	116.2	-0.351	-0.570	-0.570	-0.702	-0.570	-0.746	1.711	1.491	1.162	1.272	-0.197	-0.461
153.9	152.2	-0.526	-0.833	-0.702	-0.899	-0.658	-1.184	3.004	2.476	1.930	2.329	0.066	-0.482
192.2	188.0	-0.680	-1.404	-0.855	-1.031	-0.658	-2.061	4.803	3.602	2.917	4.079	0.241	-0.570
214.5	208.6	-0.724	-1.796	-0.899	-1.075	-0.417	37.083	6.601	4.734	3.904	5.439	0.307	-0.570
228.3	219.1	-0.811	-2.195	-1.096	-1.250	-0.630	37.083	7.061	5.461	4.798	5.658	0.219	-0.655
236.3	219.1	-0.768	-2.719	-1.184	-1.316	-0.570	37.083	7.851	6.206	4.761	6.228	0.154	-0.377

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	41- 51	42- 52	43- 53	44- 54	45- 55	46- 56	47- 57	48- 58
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24.5	25.6	0.138	0.125	0.113	0.050	0.037	-0.012	-0.075	-0.050
48.6	48.6	0.237	0.175	0.125	0.012	-0.100	-0.112	-0.262	-0.325
73.4	75.4	0.525	0.300	0.200	0.050	-0.150	-0.300	-0.512	-0.575
136.4	136.4	1.057	0.662	0.425	0.113	-0.212	-0.575	-1.037	-1.262
181.0	180.1	1.488	1.012	0.575	0.163	-0.275	-0.875	-1.525	-2.000
220.1	221.2	2.125	1.437	0.887	0.262	-0.375	-1.288	-2.337	-3.075
252.4	247.0	3.175	2.350	1.463	0.537	-0.425	-1.525	-3.200	-4.437
268.7	257.7	5.212	3.800	2.475	1.162	-0.362	-1.425	-5.525	-7.575
278.2	257.7	9.537	7.138	4.838	2.737	-0.125	-4.225	-8.925	-14.037
278.2	243.5	14.375	11.325	7.275	4.025	-1.562	-8.050	-13.325	

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	61- 81	62- 82	63- 83	64- 84	65- 85	66- 86	67- 87	68- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19.6	18.9	0.137	0.163	0.113	0.050	0.025	0.025	-0.012	-0.075
38.9	38.9	0.262	0.175	0.037	0.025	-0.050	-0.100	-0.175	-0.138
60.3	60.3	0.637	0.438	0.250	0.113	0.037	-0.163	-0.212	-0.387
109.2	109.2	1.375	1.050	0.912	0.537	0.100	-0.350	-0.675	-0.875
144.3	144.1	2.038	1.587	1.275	0.750	0.088	-0.525	-0.912	-1.325
180.9	176.9	2.975	2.287	1.675	0.912	0.025	-0.738	-1.200	-1.650
201.7	197.3	3.725	2.437	2.125	1.125	-0.050	-0.875	-1.525	-2.238
215.1	206.5	4.300	2.812	2.263	1.150	-0.100	-0.963	-1.600	-2.588
222.6	205.3	4.650	2.125	2.100	1.050	-0.262	-1.037	-1.675	-2.575
222.6	195.1	4.700	1.562	2.025	0.562	-0.375	-1.050	-1.700	-2.312
222.6	196.6	3.350	1.787	1.937	0.762	-0.450	-1.087	-1.587	-2.175

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	61- 71	62- 72	63- 73	64- 74	65- 75	66- 76	67- 77	68- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.8	20.5	0.250	0.175	0.200	0.100	0.075	0.050	-0.050	-0.050
41.5	41.3	0.325	0.225	0.125	0.075	-0.025	-0.075	-0.200	-0.175
64.1	64.1	0.525	0.300	0.100	0.050	0.050	-0.075	-0.275	-0.350
110.3	115.9	1.000	0.400	0.100	-0.075	0.500	-0.250	-0.700	-0.925
153.9	153.5	1.400	0.525	0.125	-0.075	0.775	-0.350	-0.925	-1.350
192.2	187.4	1.950	0.525	-0.025	-0.175	0.725	-0.600	-1.350	-2.000
214.5	208.6	2.675	0.125	-0.100	-0.225	0.675	-0.850	-1.725	-2.475
228.3	218.9	3.900	0.100	-0.150	-0.250	0.575	-0.925	-1.800	-2.600
236.3	219.1	4.825	0.050	-0.150	-0.500	0.400	-1.075	-1.850	-2.625
236.3	207.3	5.250	0.000	1.100	-0.400	0.125	-1.075	-1.850	-2.525

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	81- 91	82- 92	83- 93	84- 94	85- 95	86- 96	87- 97	88- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83.7	88.7	-0.075	-0.063	-0.100	-0.200	-0.175	-0.125	-0.375	-0.500
147.0	143.3	1.950	0.475	-0.175	-0.350	-0.425	-0.075	-0.575	-0.925
164.1	159.7	3.250	1.050	-0.225	-0.450	-0.500	-0.025	-0.700	-1.125
174.3	166.7	3.800	2.450	-0.225	-0.450	-0.525	-0.100	-0.725	-1.175
180.8	150.0	4.125	2.825	-0.175	-0.425	-0.500	-0.125	-0.675	-1.000

BEAM CFT-T07 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	61- 63	62- 64	63- 65	64- 66	65- 67	66- 68	71- 73	72- 74	73- 75	74- 76	75- 77	76- 78
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.3	20.1	0.125	0.075	0.275	0.250	0.175	0.050	0.125	0.175	0.075	0.175	0.200	0.100
41.3	41.3	0.225	0.050	0.300	0.225	-0.025	0.025	0.050	0.125	-0.025	0.000	0.075	0.050
64.1	64.1	0.025	0.050	0.300	0.050	0.175	0.025	0.025	0.100	0.000	0.025	0.175	0.075
115.9	116.4	0.225	-0.050	0.075	0.125	0.150	-0.150	-0.050	-0.075	1.200	1.350	0.000	0.000
153.9	153.1	0.300	-0.050	0.000	0.425	0.500	0.100	0.050	-0.025	2.475	2.500	0.050	0.050
192.2	187.6	1.175	-0.250	0.025	0.450	0.575	0.150	-0.075	0.025	3.650	3.725	-0.100	0.175
214.5	209.6	2.200	-0.375	-0.025	0.775	0.700	0.200	-0.100	0.050	4.725	4.750	-0.025	0.125
228.6	219.1	3.125	-0.375	0.100	0.750	0.375	0.150	-0.250	0.000	5.300	5.300	-0.125	0.125
236.5	219.1	4.450	-0.450	0.100	1.650	1.025	0.225	-0.150	-0.025	5.850	6.000	-0.050	0.150

BEAM CFT-T07 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	81- 83	82- 84	83- 85	84- 86	85- 87	86- 88	91- 93	92- 94	93- 95	94- 96	95- 97	96- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
87.7	87.0	0.000	-0.075	-0.450	0.075	-0.325	0.100	-0.175	0.100	-0.050	-0.125	0.150	-0.025
164.1	160.3	6.975	0.025	0.075	0.100	0.525	0.725	-0.325	0.075	0.000	2.125	2.500	0.325

BEAM CFT-T07 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	61- 73	62- 74	63- 75	64- 76	65- 77	66- 78	71- 63	72- 64	73- 65	74- 66	75- 67	76- 68
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.6	20.5	0.038	0.000	-0.110	-0.038	-0.022	0.066	-0.069	0.000	-0.132	-0.066	-0.044	0.110
41.3	40.8	0.000	-0.197	-0.307	-0.329	-0.219	-0.132	-0.197	-0.154	-0.329	-0.548	-0.373	-0.219
64.1	64.1	0.044	-0.241	-0.241	-0.307	-0.263	-0.285	-0.110	-0.197	-0.329	-0.395	-0.395	-0.351
115.9	116.0	0.307	-0.197	0.987	0.636	0.263	-0.504	0.001	-0.175	-0.417	-0.395	-0.659	-0.960
153.9	153.7	0.592	-0.154	1.930	1.360	0.653	-0.373	-0.132	-0.307	-0.548	-0.373	-1.098	-1.452
192.2	188.4	1.469	-0.263	2.566	1.732	0.702	-0.504	-0.263	-0.482	-0.636	-0.285	-1.406	-1.447
214.5	210.4	2.219	-0.197	3.353	2.281	0.811	-0.439	-0.482	-0.614	-0.768	-0.197	-1.711	-1.732
228.6	219.3	3.291	-0.263	3.634	2.434	0.877	-0.592	-0.526	-0.746	-0.833	-0.088	-1.842	-1.886
236.5	219.1	5.439	-0.329	3.382	2.522	0.833	-0.636	11.992	-0.811	-0.833	0.066	-1.908	-1.908

BEAM CFT-T07 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
P	S	81- 93	82- 94	83- 95	84- 96	85- 97	86- 98	91- 83	92- 84	93- 85	94- 86	95- 87	96- 88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
87.7	87.7	0.307	-0.197	-0.175	-0.066	-0.197	-0.307	-0.351	-0.351	-0.351	-0.395	-0.307	-0.329
164.1	160.7	6.447	1.447	1.974	1.426	0.833	0.263	-0.724	-0.636	-0.811	-0.769	-0.154	-0.702

BEAM CFT-T07 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	111-131	112-132	113-133	114-134	115-135	116-136	117-137	118-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19.0	19.5	0.100	0.012	0.050	0.075	0.038	0.012	-0.025	-1.338
38.7	37.6	0.137	0.037	0.025	-0.037	-0.012	-0.125	-0.212	-1.463
63.3	60.3	0.275	0.013	0.188	0.063	0.025	-0.150	-0.375	-1.650
109.1	109.1	1.762	1.425	1.112	0.675	0.325	-0.287	-0.537	-2.075
144.3	144.8	2.550	2.000	1.612	1.037	0.462	-0.425	-0.750	-2.500
181.7	176.0	3.675	2.837	2.175	1.187	0.375	-0.650	-1.062	-3.034
201.7	196.0	5.675	2.987	2.625	1.363	0.400	-0.753	-1.312	-3.525
219.1	208.3	4.812	1.787	2.712	1.213	0.175	-0.875	-1.463	-3.762
222.6	208.2	5.175	1.950	2.725	1.212	0.025	-0.938	-1.537	-3.787
222.6	195.3	5.263	1.875	2.475	0.937	-0.175	-1.025	-1.600	-3.750

BEAM CFT-T07 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
P	S	101-111	102-112	103-113	104-114	105-115	106-116	107-117	108-118
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
87.0	85.9	0.200	-0.100	-0.125	0.025	-0.175	-0.075	-0.325	-0.500
117.7	117.1	1.200	0.475	-0.100	0.100	-0.325	0.150	-0.400	-0.650
147.0	143.8	2.750	1.950	-0.200	-0.350	-0.350	0.300	-0.575	-0.825
164.1	160.3	4.025	3.300	-0.200	-0.250	-0.425	0.275	-0.675	-0.975
174.0	167.5	4.525	3.025	-0.225	-0.350	-0.425	0.250	-0.675	-1.050
180.3	158.4	4.450	3.600	-0.250	-0.500	-0.475	0.100	-0.725	-1.025

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	121-131	122-132	123-133	124-134	125-135	126-136	127-137	128-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41.3	41.3	0.250	0.250	0.175	0.150	0.000	-0.075	-0.17	-0.250
64.1	64.1	0.400	0.325	0.250	0.250	0.075	-0.100	-0.225	-0.425
110.4	110.9	0.775	0.550	0.450	0.400	0.925	-0.275	-0.550	-1.025
192.2	188.0	1.025	1.000	0.825	0.675	1.575	-0.475	-1.125	-2.250
214.3	209.0	0.175	0.725	0.275	0.325	1.325	-0.600	-1.550	-2.900
220.3	217.9	4.075	0.675	0.175	0.150	1.175	-0.750	-1.650	-3.150
230.3	207.3	0.750	0.725	0.150	0.075	0.700	-0.900	-1.500	-3.125

BEAM CFT-TU7 TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	101-103	102-104	103-105	104-106	105-107	106-108	111-113	112-114	113-115	114-116	115-117	116-118
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
89.3	86.9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
117.7	117.1	-0.175	-0.075	-0.125	1.225	1.275	0.025	3.600	-0.100	-0.025	-0.200	-0.025	0.075
147.0	144.8	-0.125	0.025	0.050	2.275	2.300	0.000	4.975	1.025	-0.075	-0.050	0.250	0.525
164.1	160.8	-0.200	0.000	-0.050	2.050	2.350	0.150	6.650	2.900	0.000	0.000	0.000	0.000
174.3	167.8	-0.150	0.075	0.100	3.325	3.225	0.075	7.925	3.775	-0.100	-0.025	0.600	1.025

BEAM CFT-TU7 TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	121-123	122-124	123-125	124-126	125-127	126-128	131-133	132-134	133-135	134-136	135-137	136-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110.3	115.9	0.075	0.050	1.775	1.450	-0.125	0.000	0.000	-0.050	-0.475	0.225	0.250	-0.025
214.3	210.0	0.275	0.400	3.325	3.225	-0.100	0.375	1.825	0.125	0.150	1.250	1.125	1.325

BEAM CFT-TU7 DIAGONAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	101-113	102-114	103-115	104-116	105-117	106-118	111-103	112-104	113-105	114-106	115-107	116-108
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
89.7	88.7	-0.351	-0.327	-0.351	-0.375	-0.329	-0.351	0.759	-0.273	-2.246	-0.644	-0.219	-0.241
117.7	117.1	-0.395	-0.482	-0.548	-0.543	-0.329	-0.614	0.434	-0.110	-2.412	0.680	0.395	-0.175
147.0	143.9	-0.395	-0.417	-0.636	-0.614	-0.219	-0.702	4.215	2.018	-2.368	1.645	1.031	0.570
164.1	159.8	-0.526	-0.460	-0.504	-0.570	0.132	-0.833	6.641	3.947	-2.346	1.908	1.250	0.766
174.3	168.9	-0.570	-0.461	-0.548	-0.653	0.197	-0.855	7.391	4.515	-2.434	1.930	1.338	0.811

BEAM CFT-TU7 DIAGONAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	121-133	122-134	123-135	124-136	125-137	126-138	131-123	132-124	133-125	134-126	135-127	136-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110.0	115.9	0.175	-0.150	-0.329	-0.241	-0.860	-0.611	0.081	0.906	1.579	0.927	-0.329	-0.154
214.3	208.3	1.087	-0.014	-0.570	0.417	-1.754	-1.447	3.114	0.859	4.934	3.048	1.162	-0.000

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	141-151	142-152	143-153	144-154	145-155	146-156	147-157	148-158
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24.3	24.1	0.275	0.150	0.050	0.125	-0.025	0.050	-0.125	-0.150
43.0	47.3	0.512	0.250	0.100	0.163	-0.062	-0.075	-0.237	-0.300
75.4	75.4	0.925	0.500	0.325	0.225	-0.012	-0.125	-0.275	-0.512
134.4	130.4	1.050	1.037	0.750	0.462	0.000	-0.000	-0.775	-1.187
181.0	181.0	1.675	1.425	0.975	0.625	0.050	-0.462	-1.137	-1.737
220.1	224.9	2.762	2.025	1.350	0.500	-0.012	-0.750	-1.625	-2.725
252.4	247.5	3.537	3.012	2.112	1.537	0.188	-0.975	-2.650	-3.850
266.7	258.2	4.300	4.050	3.362	2.325	0.000	-1.250	-4.101	-4.475
270.2	257.7	14.462	5.550	5.437	3.312	2.013	-1.737	-5.437	-7.550
278.2	243.9	10.000	14.300	10.200	10.062	4.267	-2.212	-7.762	

BEAM CFT-TU7 LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	101-131	102-132	103-133	104-134	105-135	106-136	107-137	108-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.6	19.3	0.212	0.287	0.175	0.113	0.075	0.000	0.012	0.000
36.9	37.6	0.438	0.313	0.200	0.050	-0.025	-0.087	-0.163	-0.150
60.3	60.3	0.737	0.475	0.287	0.075	0.038	-0.137	-0.212	-0.313
109.1	109.1	1.062	1.050	0.800	0.313	0.425	-0.025	-0.787	-0.862
144.3	144.3	2.275	1.512	1.287	0.850	0.537	-0.112	-0.850	-1.062
168.9	173.0	3.062	2.100	1.525	0.850	0.638	-0.163	-0.812	-1.263
201.9	196.0	3.937	2.675	2.050	0.850	0.838	-0.275	-1.075	-1.712
212.1	206.2	4.400	3.000	2.338	0.812	0.775	-0.350	-1.212	-1.875
262.0	260.2	4.825	3.350	2.675	0.812	0.725	-0.367	-1.262	-1.950
222.0	195.1	4.075	3.300	2.388	-0.075	0.525	-0.275	-1.101	-1.787

BEAM CFT-TB7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 161-171	162-172	163-173	164-174	165-175	166-176	167-177	168-178
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41.5	40.7	0.575	0.450	0.350	0.250	0.000	-0.050	-0.175	-0.100
64.1	64.1	0.875	0.725	0.575	0.350	0.025	-0.100	-0.225	-0.275
116.0	115.9	2.500	2.025	1.600	0.825	-0.125	0.150	-0.425	-0.650
192.2	188.0	5.025	4.575	3.425	0.625	-0.225	0.475	-0.950	-1.325
214.5	208.6	7.750	6.025	4.425	0.550	-0.225	0.400	-1.375	-1.750
226.6	217.9	8.000	6.750	4.900	0.525	-0.300	0.350	-1.575	-1.925
230.5	207.3	9.400	7.550	5.275	0.350	-0.450	0.025	-1.675	-1.850

BEAM CFT-TB7 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 181-191	182-192	183-193	184-194	185-195	186-196	187-197	188-198
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88.7	88.7	-0.125	2.025	2.225	1.675	-0.075	-0.050	-0.075	-0.475
117.7	116.9	-0.250	2.500	2.975	2.125	-0.375	-0.175	-0.300	-0.675
164.1	159.7	-0.175	2.675	3.700	2.650	-0.525	-0.225	-0.400	-0.825
174.8	166.7	-0.250	2.650	4.325	2.900	-0.675	-0.250	-0.575	-1.000
180.8	168.2	-0.250	2.150	4.550	3.050	-0.700	-0.300	-0.500	-1.000

BEAM CFT-TB7 TRANSVERSE STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 161-163	162-164	163-165	164-166	165-167	166-168	171-173	172-174	173-175	174-176	175-177	176-178
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
116.0	115.9	0.000	-0.175	0.850	1.025	0.000	0.150	0.000	0.150	0.200	0.825	0.925	0.250
214.5	208.6	0.000	2.075	3.575	0.675	0.375	2.225	-0.250	-0.125	0.075	5.100	5.125	0.575

BEAM CFT-TB7 TRANSVERSE STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 181-183	182-184	183-185	184-186	185-187	186-188	191-193	192-194	193-195	194-196	195-197	196-198
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88.7	88.7	0.025	0.150	2.475	2.450	0.000	-0.050	2.950	0.500	-0.100	-0.150	0.325	0.025
117.7	116.9	0.000	-0.050	5.100	5.050	-0.125	-0.125	5.800	3.350	-0.125	-0.225	1.250	3.675
147.0	143.5	-0.100	0.125	8.025	7.775	-0.050	0.175	9.375	6.425	0.000	-0.325	2.675	2.400
164.1	159.7	-0.125	0.200	10.325	10.375	0.075	0.000	12.675	9.425	0.000	-0.075	3.100	2.250
174.8	167.2	-0.050	0.075	11.575	11.525	0.150	0.025	14.425	10.650	-0.125	0.025	3.375	3.150

BEAM CFT-TB7 DIAGONAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 161-173	162-174	163-175	164-166	165-177	166-178	171-163	172-164	173-165	174-166	175-167	176-168
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
116.0	115.9	2.039	1.842	1.801	1.864	0.263	0.022	0.110	-0.768	-0.504	-0.680	-0.702	-0.335
214.5	209.8	6.264	6.360	5.154	4.781	2.083	1.535	-0.175	-1.184	-0.789	-0.877	-0.375	-1.069

BEAM CFT-TB7 DIAGONAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 181-193	182-194	183-195	184-196	185-197	186-198	191-183	192-184	193-185	194-186	195-187	196-188
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
88.7	89.0	3.136	1.089	2.917	4.737	-0.044	-0.066	-0.373	-1.009	-0.702	-0.877	-0.680	-0.634
117.7	117.1	5.417	5.197	4.731	4.211	0.285	0.044	-0.439	-1.272	-0.768	-0.877	-0.592	-0.285
147.0	143.5	8.180	7.675	7.478	6.332	0.769	0.526	-0.548	-1.513	-0.987	-0.833	-0.746	0.066
164.1	160.1	10.614	10.219	9.518	8.130	1.053	0.592	-0.636	-1.952	-1.250	-1.031	-0.526	0.068
174.8	167.4	11.842	11.404	10.504	9.167	1.162	0.614	-0.653	-2.061	-1.360	-1.272	-0.482	0.263

BEAM CFT-TB7 LONGITUDINAL STRAINS-TOP FACE

MOMENT D	MOMENT S	STRAINS *10**-3 ECT1	ECT2	ECT3	ECT4	ECT5	ECT6
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000
19.6	18.9	-0.037	-0.062	0.000	-0.075	0.100	-0.025
38.9	38.3	-0.225	-0.250	-0.163	-0.250	-0.112	-0.175
60.3	58.3	-0.450	-0.432	-0.387	-0.412	-0.300	-0.375
109.2	109.2	-0.963	-0.875	-0.775	-0.775	-0.625	-0.713
144.8	144.1	-1.337	-1.225	-1.100	-1.150	-0.950	-1.100
166.9	170.8	-1.687	-1.550	-1.400	-1.463	-1.250	-1.400
201.9	197.8	-2.000	-1.700	-1.625	-1.750	-1.537	-1.712
213.1	208.2	-2.100	-1.937	-1.750	-1.812	-1.550	-1.737
222.8	208.2	-2.137	-1.950	-1.737	-1.825	-1.512	-1.725
222.8	194.9	-2.100	-1.812	-1.625	-1.687	-1.525	-1.700

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 1- 21	2- 22	3- 23	4- 24	5- 25	6- 26	7- 27	8- 28
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.5	14.5	0.163	-0.012	0.100	0.050	-0.025	-0.075	0.012	-0.012
40.4	43.5	0.338	0.100	0.100	0.025	-0.062	-0.150	-0.163	-0.200
77.3	75.8	0.612	0.325	0.200	0.125	-0.075	-0.262	-0.412	-0.525
115.6	112.8	1.350	0.450	0.183	0.038	-0.025	-0.350	-0.600	-0.963
141.9	130.6	1.437	0.738	0.063	-0.037	0.025	-0.462	-0.787	-1.062
160.1	151.7	1.837	0.950	0.063	-0.037	0.037	-0.338	-0.925	-1.262
168.1	150.3	1.712	0.675	0.000	-0.112	-0.037	-0.612	-0.950	-1.312
170.4	153.6	1.637	0.675	-0.025	-0.125	-0.100	-0.637	-0.975	-1.400

BEAM CFT-T35 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 21- 41	22- 42	23- 43	24- 44	25- 45	26- 46	27- 47	28- 48
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.3	17.3	0.125	0.150	0.037	0.063	-0.025	0.037	-0.037	-0.150
55.2	51.3	0.438	0.300	0.163	0.088	-0.050	-0.137	-0.200	-0.438
92.0	90.3	0.750	0.713	0.425	0.225	-0.075	-0.237	-0.425	-0.825
137.7	134.3	1.337	0.938	0.738	0.375	-0.150	-0.425	-0.775	-1.262
168.9	155.5	2.200	1.400	0.800	0.350	-0.212	-0.563	-1.000	-1.625
190.6	180.6	2.975	1.867	0.900	0.362	-0.300	-0.688	-1.250	-2.025
200.1	178.9	3.200	2.056	0.762	0.225	-0.400	-0.812	-1.300	-2.112
202.9	182.8	3.237	2.075	0.700	0.183	-0.450	-0.850	-1.337	-2.138

BEAM CFT-T34 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 41- 61	42- 62	43- 63	44- 64	45- 65	46- 66	47- 67	48- 68
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.0	20.0	0.433	0.250	0.375	0.150	-0.050	-0.100	-0.225	-0.250
64.0	59.5	0.950	0.563	0.725	0.300	-0.137	-0.287	-0.550	-0.700
106.7	104.7	1.337	1.250	1.125	0.500	-0.125	-0.525	-1.037	-1.375
159.7	155.2	1.562	1.350	1.762	0.837	-0.037	-0.713	-1.463	-1.912
195.9	180.4	1.837	1.525	2.225	1.025	-0.125	-1.012	-1.962	-2.400
221.1	209.5	2.562	1.150	1.912	0.750	-0.375	-1.238	-2.112	-1.263
232.1	207.5	2.175	1.012	1.325	0.612	-1.737	-1.325	-2.283	-2.612
235.5	212.1	3.775	0.963	1.725	0.537	-0.563	-1.337	-2.275	-2.612

BEAM CFT-T38 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 1- 11	2- 12	3- 13	4- 14	5- 15	6- 16	7- 17	8- 18
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13.8	13.4	0.025	0.025	0.025	0.050	0.025	0.050	0.000	0.000
44.1	41.0	-0.125	0.200	0.125	0.025	4.950	-0.100	-0.200	-0.250
75.6	72.2	-0.175	0.650	0.475	0.275	-0.050	-0.225	-0.325	-0.525
110.1	107.9	-0.175	0.725	0.500	0.300	0.000	-0.350	-0.525	-0.375
133.1	124.9	-0.125	0.600	0.325	0.225	0.200	-0.450	-0.625	-1.150
152.5	144.9	-0.025	0.500	0.275	0.150	0.375	-0.500	-0.775	-1.300
160.1	144.5	0.050	0.425	0.250	0.125	0.275	-0.575	-0.825	-1.325
162.5	146.3	0.050	0.525	0.150	0.050	0.125	-0.600	-0.850	-1.400

BEAM CFT-T37 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 31- 41	32- 42	33- 43	34- 44	35- 45	36- 46	37- 47	38- 48
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18.0	18.0	0.075	0.075	0.000	-0.050	-0.050	-0.050	-0.075	-0.200
57.4	53.9	0.200	0.200	0.100	0.025	-0.025	-0.175	-0.300	-0.475
94.3	93.9	1.500	0.450	0.275	0.150	-0.075	-0.250	-0.475	-0.750
143.2	139.1	2.675	0.350	0.200	0.125	-0.075	-0.450	-0.875	-1.275
175.0	161.7	4.200	1.000	0.075	0.050	-0.150	-0.650	-1.150	-1.625
198.2	185.5	5.775	2.025	0.025	0.050	-0.250	-0.850	-1.400	-2.025
208.1	186.1	6.275	3.075	-0.075	-0.100	-0.375	-0.950	-1.550	-2.150

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 51- 61	52- 62	53- 63	54- 64	55- 65	56- 66	57- 67	58- 68
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.7	20.1	0.125	0.025	0.050	0.050	0.025	-0.075	-0.075	-0.125
66.2	62.2	2.675	0.050	0.600	0.325	-0.050	-0.250	-0.375	-0.475
110.4	106.4	1.025	0.500	1.300	0.650	0.025	-0.350	-0.650	-0.875
165.2	161.9	1.200	0.000	1.375	0.950	0.075	-0.525	-1.200	-1.500
202.7	187.3	1.650	0.775	1.350	0.700	0.250	-0.800	-1.725	-2.125
223.7	217.4	2.375	1.000	2.000	0.550	0.225	-1.075	-2.275	-2.675
240.1	215.4	4.950	0.675	1.475	0.300	-0.175	-1.325	-2.550	-2.825
243.5	219.4	6.350	0.550	1.350	0.275	-0.225	-1.450	-2.675	-2.875
243.5	209.4	7.175	0.500	1.225	0.125	-0.425	-1.550	-2.775	-2.900

BEAM CFT-T03 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	31- 33	32- 34	33- 35	34- 36	35- 37	36- 38	41- 43	42- 44	43- 45	44- 46	45- 47	46- 48
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18.3	17.4	0.075	0.000	0.075	-0.075	0.150	0.025	-0.150	0.050	0.350	-0.025	-2.600	0.100
57.4	55.1	0.025	-0.100	0.025	0.025	0.150	0.075	-0.100	0.025	0.350	-0.050	-0.100	0.100
94.5	94.5	0.125	0.025	0.200	0.100	0.100	0.125	0.025	0.100	0.425	-0.025	-0.100	0.175

BEAM CFT-T03 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	51- 53	52- 54	53- 55	54- 56	55- 57	56- 58	61- 63	62- 64	63- 65	64- 66	65- 67	66- 68
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
66.2	63.5	0.075	0.025	-0.050	0.000	0.000	0.025	0.050	-0.150	0.050	-0.025	0.025	0.150
109.3	109.0	0.425	0.175	-0.025	0.050	0.000	0.125	0.050	-0.050	0.225	0.125	0.025	0.200
165.2	161.9	1.050	0.675	0.150	0.150	-0.075	0.300	0.200	-0.025	0.400	0.275	0.000	0.325
202.7	187.5	1.150	0.950	1.150	1.150	-0.125	0.550	0.150	0.025	0.525	0.500	0.250	0.600
223.7	217.4	1.300	0.950	1.875	1.850	-0.125	0.900	0.375	0.150	0.750	0.600	0.325	0.975
240.1	216.7	1.300	1.050	2.000	2.050	-0.125	1.050	2.925	0.050	0.650	0.475	0.250	1.175
243.3	219.4	1.400	1.100	2.075	2.075	-0.150	1.175	4.200	-0.075	0.575	0.475	0.325	1.275

BEAM CFT-T03 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	1- 13	2- 14	3- 15	4- 16	5- 17	6- 18	11- 3	12- 4	13- 5	14- 6	15- 7	16- 8
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110.1	107.0	-0.132	-0.154	-0.154	-0.154	-0.307	-0.461	0.833	0.658	1.009	0.461	-0.351	-0.329
135.1	124.4	-0.219	-0.329	-0.197	0.241	-0.548	-0.636	0.987	0.592	2.127	1.404	0.154	-0.219
152.5	144.5	-0.241	-0.395	-0.219	0.636	-0.636	-0.724	1.118	0.592	2.632	1.842	0.482	-0.241
160.1	143.1	-0.285	-0.504	-0.307	0.724	-0.702	-0.789	1.294	0.570	2.719	1.886	0.526	-0.307
162.3	146.3	-0.307	-0.526	-0.285	0.702	-0.680	-0.789	1.469	0.614	2.588	1.974	0.548	-0.351

BEAM CFT-T03 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	31- 43	32- 44	33- 45	34- 46	35- 47	36- 48	41- 33	42- 34	43- 35	44- 36	45- 37	46- 38
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18.3	17.4	0.066	0.132	0.132	0.132	0.175	0.063	0.088	0.044	0.022	0.088	0.132	0.000
57.4	53.3	0.088	0.110	0.022	0.000	-0.038	-0.066	0.482	0.154	0.044	0.132	0.110	-0.066
94.5	94.5	0.307	0.132	-0.066	-0.110	-0.219	-0.329	1.009	0.329	0.197	-0.110	-0.175	-0.351

BEAM CFT-T03 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	51- 63	52- 64	53- 65	54- 66	55- 67	56- 68	61- 53	62- 54	63- 55	64- 56	65- 57	66- 58
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
66.2	61.5	0.263	0.154	0.044	-0.044	-0.175	-0.219	0.724	-0.175	0.088	-0.110	-0.263	-0.197
110.4	109.0	0.285	0.307	0.088	-0.132	-0.329	-0.395	1.601	0.241	0.570	0.154	-0.263	-0.263
162.2	161.2	0.263	0.154	-0.154	-0.351	-0.614	-0.768	2.763	1.031	1.338	0.504	-0.175	-0.307
202.7	186.6	0.197	0.154	-0.307	-0.504	-0.943	-1.031	3.070	1.228	2.563	1.053	0.044	-0.219
224.7	214.7	0.088	0.000	-0.461	-0.570	-1.425	-1.184	3.750	1.491	3.070	1.425	0.000	-0.241
240.1	215.4	-0.219	-0.263	-0.636	-0.526	-1.601	-1.206	6.903	1.250	2.939	1.228	-0.088	-0.307
243.3	219.4	-0.197	-0.263	-0.746	-0.570	-1.711	-1.228	8.531	1.338	2.982	1.206	-0.132	-0.285

BEAM CFT-T08 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
		1- 3	2- 4	3- 5	4- 6	5- 7	6- 8	11- 13	12- 14	13- 15	14- 16	15- 17	16- 18
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13.8	13.8	0.000	-0.050	0.275	0.075	-0.025	0.025	0.050	0.250	0.025	0.100	0.275	0.350
110.1	106.4	0.300	-0.050	0.350	0.725	-0.125	0.150	0.251	0.350	0.525	0.525	0.225	0.425
138.1	124.9	0.875	-0.100	2.225	2.025	-0.125	0.075	0.350	0.225	0.850	1.200	0.700	0.450
152.5	144.2	0.950	0.175	3.225	3.075	-0.050	0.100	0.625	0.350	0.675	1.725	1.175	0.625
160.1	144.2	0.925	-0.100	3.500	3.275	-0.100	0.100	0.800	0.275	0.975	1.625	1.275	0.575
162.3	146.3	0.925	-0.150	3.500	3.225	-0.125	0.075	0.800	0.200	0.850	1.625	1.250	0.550

BEAM CFT-T08 TRANSVERSE STRAINS-SIDE FACE

LOAD		STRAINS *10**-3					
P	S	21- 23	22- 24	23- 25	24- 26	25- 27	26- 28
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000
175.4	164.1	3.625	1.975	-0.100	0.100	0.300	0.225
164.1	166.1	3.800	2.150	-0.100	0.075	0.250	0.250

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 71-81	72-82	73-83	74-84	75-85	76-86	77-87	78-88
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22.3	22.6	0.150	0.150	0.025	0.000	-0.025	-0.050	-0.100	-0.112
72.3	67.7	0.538	0.487	0.362	0.163	-0.075	-0.250	-0.412	-0.537
121.4	119.2	0.862	0.912	0.650	-0.900	-0.075	-0.450	-0.762	-1.112
181.7	176.6	0.938	1.286	0.775	0.375	-0.313	-0.900	-1.537	-2.125
229.9	205.3	1.087	1.662	1.000	0.462	-0.450	-1.350	-2.283	-3.137
251.3	238.4	1.500	2.475	1.837	0.775	-0.775	-2.250	-3.787	-5.150
264.1	236.2	3.112	5.350	4.512	1.725	-1.413	-5.133	-9.075	-10.062
267.3	240.6	4.937	8.412	6.625	2.375	-2.462	-8.000	-11.337	-15.412
267.3	230.3	6.975	10.575	8.700	3.038	-3.275	-10.362	-14.450	-20.150

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 91-111	92-112	93-113	94-114	95-115	96-116	97-117	98-118
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.0	20.0	0.063	0.113	0.025	0.012	-0.012	-0.037	-0.137	-0.100
64.0	59.5	0.425	0.287	0.175	0.175	0.012	-0.100	-0.412	-0.462
108.7	105.4	0.825	0.550	0.313	0.313	-0.112	-0.350	-0.688	-0.938
159.7	155.2	1.012	1.162	0.700	0.438	-0.188	-0.650	-1.187	-1.662
193.9	180.4	2.150	1.575	1.000	0.475	-0.275	-0.900	-1.700	-2.250
221.1	206.2	2.962	2.187	1.375	0.662	-0.325	-1.150	-2.200	-2.909
222.1	207.5	3.175	2.512	1.312	-0.725	-0.500	-1.337	-2.337	-3.075
236.3	212.1	3.237	2.525	1.350	0.462	-0.563	-1.413	-2.425	-3.112
235.3	202.4	3.137	2.325	1.288	0.400	-0.588	-1.450	-2.462	-3.087

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 111-131	112-132	113-133	114-134	115-135	116-136	117-137	118-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.3	17.3	0.000	-0.037	-0.212	-0.100	-0.075	-0.100	-0.137	-0.262
53.2	51.3	0.612	0.313	0.050	-0.062	-0.050	-0.188	-0.225	-0.462
92.0	90.9	1.112	0.650	1.650	-0.062	-0.188	-0.338	-0.525	-0.312
137.7	133.6	1.612	1.050	0.525	0.050	-0.188	-0.450	-0.775	-1.187
168.9	155.3	2.038	1.512	0.662	0.075	-0.262	-0.550	-0.950	-1.337
194.0	179.3	2.363	1.537	0.775	0.113	-0.137	-0.700	-1.087	-1.662
200.1	179.5	2.350	1.400	0.675	0.050	-0.425	-0.725	-1.175	-1.700
202.9	182.8	2.250	1.362	0.625	0.025	-0.425	-0.725	-1.150	-1.737

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 131-151	132-152	133-153	134-154	135-155	136-156	137-157	138-158
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.5	14.5	-0.037	-0.012	-0.075	-0.050	-0.062	0.012	-0.100	-0.138
43.4	43.1	0.125	0.050	-0.012	0.000	-0.137	-0.125	-0.275	-0.462
77.3	76.3	0.425	0.287	0.100	-0.025	-0.163	-0.262	-0.475	-0.700
115.6	112.4	0.725	0.550	0.300	0.150	-0.137	-0.400	-0.713	-0.987
141.7	130.6	0.837	0.462	0.200	0.063	-0.100	-0.412	-0.837	-1.137
160.1	150.6	0.837	0.438	0.225	0.100	-0.137	-0.500	-0.938	-1.350
168.1	150.6	0.500	0.362	0.175	0.000	-0.175	-0.550	-0.950	-1.235
173.4	153.6	0.438	0.412	0.150	-0.037	-0.163	-0.537	-0.900	-1.162

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 91-101	92-102	93-103	94-104	95-105	96-106	97-107	98-108
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.7	20.1	0.025	0.000	0.000	0.000	0.000	-0.050	-0.150	-0.175
66.2	61.5	0.350	0.350	0.350	0.150	2.450	-0.225	-0.400	-0.525
110.4	109.7	1.775	1.175	0.750	0.275	2.400	-0.425	-0.725	-1.025
165.2	161.2	2.775	2.300	1.575	0.725	-0.150	-0.700	-1.275	-1.875
202.7	186.6	3.550	3.325	2.050	0.900	-0.250	-1.000	-1.925	-2.625
226.7	216.7	4.350	4.375	2.825	1.200	-0.425	-1.400	-2.625	-3.400
240.1	215.4	4.025	4.600	2.925	1.075	-0.550	-1.575	-2.925	-3.600
245.3	219.4	3.925	4.850	2.925	1.025	-0.675	-1.750	-3.050	-3.725
245.3	209.4	3.725	4.775	2.850	0.975	-0.725	-1.825	-3.125	-3.750

BEAM CFT-T36 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 111-121	112-122	113-123	114-124	115-125	116-126	117-127	118-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
57.4	53.3	0.625	0.525	0.275	-0.025	-0.250	-0.275	-0.525	-0.525
95.8	95.1	1.700	1.250	0.725	-0.075	-0.125	-0.400	-0.550	-0.625
175.6	161.7	1.950	2.050	1.725	0.475	-0.300	-0.675	-1.000	-1.200
198.2	185.5	1.925	2.675	2.025	0.550	-0.575	-0.825	-1.175	-1.375
208.1	186.1	1.875	3.125	1.800	0.425	-0.450	-0.850	-1.275	-1.450

BEAM CFT-T3S LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	121-131	122-132	123-133	124-134	125-135	126-136	127-137	128-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.6	16.6	0.075	0.025	-0.025	0.000	0.025	-0.075	-0.050	-0.125
49.2	49.2	0.450	0.400	0.150	0.025	-0.050	-0.175	-0.250	-0.225
87.6	87.6	0.350	0.425	0.200	0.000	-0.075	-0.300	-0.450	-0.675
128.4	128.4	1.250	0.200	0.000	-0.100	-0.150	-0.425	-0.875	-1.000
149.3	149.3	2.075	0.075	-0.075	-0.200	-0.175	-0.550	-0.825	-1.275
171.2	171.2	2.900	0.075	-0.125	-0.250	-0.200	-0.625	-0.775	-1.475
171.8	171.8	2.900	-0.025	-0.125	-0.275	-0.250	-0.650	-1.025	-1.450

BEAM CFT-T3S LONGITUDINAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	141-151	142-152	143-153	144-154	145-155	146-156	147-157	148-158
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.8	15.8	0.025	0.025	0.000	-0.025	1.225	-0.025	-0.050	-0.050
41.0	41.0	0.300	0.125	-0.025	-0.025	1.250	-0.175	-0.175	-0.250
73.6	73.1	0.625	0.525	0.075	-0.025	1.225	-0.275	-0.225	-0.525
110.1	107.0	1.275	0.925	0.750	0.425	1.250	-0.325	-0.525	-0.750
130.1	124.9	1.275	0.925	0.725	0.400	1.300	-0.350	-0.550	-0.850
152.5	144.0	1.225	0.925	0.775	0.425	1.225	-0.450	-0.675	-0.975
160.1	143.1	0.950	0.600	0.650	0.325	1.150	-0.475	-0.700	-0.975
162.5	146.3	0.900	0.525	0.625	0.325	1.125	-0.500	-0.675	-0.975

BEAM CFT-T3S TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	91- 93	92- 94	93- 95	94- 96	95- 97	96- 98	101-103	102-104	103-105	104-106	105-107	106-108
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60.2	61.5	0.100	0.050	0.125	-0.150	-0.050	0.050	0.025	0.000	0.075	0.175	0.025	0.075
110.4	108.4	0.025	0.125	0.175	-0.075	0.050	0.200	0.050	0.000	0.075	0.150	0.025	0.075
165.2	161.2	-4.925	0.225	0.425	0.200	0.050	0.450	1.000	-0.125	0.025	0.125	0.050	0.175
202.7	186.6	0.050	0.200	0.600	1.600	0.025	0.725	1.650	-0.200	-0.050	0.175	0.125	0.275
220.7	216.7	-0.075	0.175	0.725	0.450	-0.025	1.525	2.650	-0.300	-0.025	0.125	0.175	0.525
240.1	215.4	-0.075	0.225	1.125	0.850	0.000	1.625	3.650	-0.275	-0.025	0.175	0.125	0.625
243.5	219.4	-0.025	0.225	1.225	0.875	-0.125	1.650	3.900	-0.400	-0.025	0.150	0.125	0.700

BEAM CFT-T3S TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	111-113	112-114	113-115	114-116	115-117	116-118	121-123	122-124	123-125	124-126	125-127	126-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.8	15.8	0.100	0.075	-0.025	0.050	0.075	0.250	0.025	0.050	0.000	0.075	0.225	0.200
57.4	55.3	0.050	0.150	0.075	0.025	0.100	0.175	0.000	0.025	-0.025	0.025	0.250	0.250
95.6	93.9	0.125	0.350	0.225	-0.050	0.150	0.250	0.050	0.000	-0.075	0.050	0.150	0.275

BEAM CFT-T3S TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

LOAD D	LOAD S	131-133	132-134	133-135	134-136	135-137	136-138
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000
15.9	15.9	-0.050	-0.025	-0.050	-0.025	-0.025	0.025
50.8	47.2	-0.050	-0.125	-0.100	-0.075	-0.075	0.025
84.8	84.1	0.000	-0.075	-0.150	-0.025	-0.025	0.050

BEAM CFT-T3S TRANSVERSE STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	141-143	142-144	143-145	144-146	145-147	146-148	151-153	152-154	153-155	154-156	155-157	156-158
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110.1	107.0	0.000	0.000	1.575	0.650	-0.350	0.200	0.250	0.050	0.225	0.075	0.175	0.175
130.1	124.9	0.075	0.050	2.000	3.750	-0.250	0.250	0.525	0.200	1.150	1.100	0.050	0.300
152.5	144.0	0.000	0.025	2.250	1.575	-0.225	0.275	0.925	0.250	1.525	1.375	0.025	0.275
160.1	143.0	0.000	-0.075	2.350	1.650	-0.275	0.225	1.125	0.300	1.525	1.250	-0.025	0.175

BEAM CFT-T3S DIAGONAL STRAINS-SIDE FACE

STRAINS *10**-3

MOMENT D	MOMENT S	91-103	92-104	93-105	94-106	95-107	96-108	101- 93	102- 94	103- 95	104- 96	105- 97	106- 98
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60.2	62.2	0.548	0.329	0.066	0.044	-0.044	-0.088	0.263	0.307	0.241	0.044	0.132	0.088
110.4	108.4	1.118	0.702	0.351	0.110	-0.066	-0.285	0.526	0.219	0.154	-0.197	-0.175	-0.307
165.2	161.9	2.000	1.042	1.118	0.570	-0.219	-0.526	0.943	0.285	0.022	-0.329	-0.395	-0.660
202.7	186.6	2.199	2.344	1.645	0.899	-0.329	-0.614	1.228	0.439	-0.154	-0.548	-0.768	-0.855
220.7	214.7	4.559	3.399	2.105	0.987	-0.504	-0.811	1.623	0.132	-0.395	-0.943	-1.272	-1.053
240.1	214.7	5.006	3.947	13.034	1.116	-0.680	-0.943	1.513	-0.175	-0.395	-0.987	-1.316	-0.953
243.5	219.4	5.235	4.015	2.938	1.206	-0.658	-0.943	1.469	-0.329	-0.548	-1.075	-1.469	-0.899

BEAM CFT-TJ3 TRANSVERSE STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	231-233	232-234	233-235	234-236	235-237	236-238	241-243	242-244	243-245	244-246	245-247	246-248
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
202.7	188.6	0.125	2.350	2.825	0.225	-0.300	0.250	-0.050	0.050	0.075	0.350	0.525	0.350
226.7	215.4	0.050	3.475	4.050	0.150	-0.325	0.450	-0.025	0.125	0.150	0.625	0.675	0.600

BEAM CFT-TJ3 DIAGONAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3											
D	S	231-243	232-244	233-245	234-246	235-247	236-248	241-243	242-244	243-245	244-246	245-247	246-248
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
202.7	188.6	0.724	-0.086	-4.254	-0.526	-0.373	-0.967	-0.241	2.522	1.754	1.162	0.373	-0.614
226.7	214.0	0.030	-0.175	-0.548	-0.811	-0.653	-1.162	-0.285	3.533	2.478	1.667	0.636	-0.304

BEAM CFT-TJ6 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	251-261	252-262	253-263	254-264	255-265	256-266	257-267	258-268
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22.8	22.1	0.075	0.075	0.025	-0.012	-0.025	-0.050	0.050	-0.150
72.8	68.4	0.588	0.500	0.387	0.163	-0.012	-0.012	-0.188	-0.525
121.4	119.2	1.187	1.000	0.713	0.333	-0.037	-0.125	-0.437	-0.975
181.7	176.0	2.000	1.575	1.212	0.563	-0.050	-0.537	-1.125	-1.750
222.9	206.0	2.612	2.013	1.737	0.750	-0.137	-0.933	-1.750	-2.500
251.3	239.6	4.512	3.275	3.050	1.512	-0.012	-1.437	-2.762	-3.675
264.1	238.4	9.162	6.912	6.688	3.787	0.675	-2.875	-6.487	-8.400
267.3	241.3	15.600	10.425	10.213	5.687	1.062	-4.350	-9.775	*-13.538

BEAM CFT-TJ6 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	271-291	272-292	273-293	274-294	275-295	276-296	277-297	278-298
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.3	19.4	0.275	0.113	0.037	0.025	-0.012	-0.075	-0.087	-0.050
64.3	60.1	0.700	0.375	0.188	0.125	-0.012	-0.138	-0.313	-0.387
105.7	104.7	1.337	0.850	0.412	0.212	-0.025	-0.338	-0.575	-0.787
159.7	156.5	2.075	1.625	0.850	0.387	-0.037	-0.537	-1.050	-1.425
199.9	181.0	2.575	2.037	1.325	0.612	-0.050	-0.750	-1.463	-2.038
221.1	210.8	3.150	3.575	1.750	0.837	-0.025	-0.975	-1.900	-2.712
232.1	209.5	3.967	4.762	1.750	0.700	-0.175	-1.100	-2.025	-2.775
235.3	212.1	4.462	5.200	1.562	0.612	-0.350	-1.212	-2.150	-2.850

BEAM CFT-TJ6 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	291-301	292-302	293-303	294-304	295-305	296-306	0-307	298-308
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.3	16.7	0.175	0.087	0.025	0.000	0.050	-0.062	-0.012	-0.037
53.2	51.6	0.400	0.200	0.113	0.063	-0.025	-0.150	-0.237	-0.375
92.0	90.3	0.825	0.475	0.387	0.212	-0.012	-0.250	-0.450	-0.725
137.7	134.9	1.475	1.150	0.713	0.337	0.050	-0.400	-0.675	-1.125
168.7	156.1	1.887	1.550	0.738	0.337	-0.037	-0.475	-0.887	-1.400
190.0	180.0	2.250	1.425	0.850	0.400	-0.112	-0.588	-1.087	-1.762
200.1	180.0	2.950	1.575	0.812	0.350	-0.150	-0.625	-1.137	-1.825
202.9	182.0	2.975	1.563	0.713	0.287	-0.212	-0.663	-1.162	-1.825

BEAM CFT-TJ6 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	301-311	302-312	303-313	304-314	305-315	306-316	307-317	308-318
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.3	14.3	0.113	0.063	0.137	0.113	0.050	0.000	-0.037	0.012
43.4	43.5	0.275	0.225	0.212	0.113	-0.075	-0.175	-0.225	-0.225
77.3	75.6	0.650	0.425	0.375	0.163	-0.025	-0.200	-0.324	-0.512
115.6	115.3	1.150	0.825	0.275	0.088	-0.012	-0.350	-0.625	-0.787
141.7	130.6	1.375	0.250	0.200	-0.037	0.137	-0.362	-0.733	-1.037
160.1	151.7	1.575	0.200	0.163	-0.050	0.125	-0.450	-0.862	-1.187
168.1	158.8	1.562	0.150	0.150	0.000	0.100	-0.487	-0.850	-1.238
173.4	155.6	1.463	0.137	0.100	-0.025	0.012	-0.537	-0.963	-1.288

BEAM CFT-TJ6 LONGITUDINAL STRAINS-SIDE FACE

MOMENT		STRAINS *10**-3							
D	S	271-281	272-282	273-283	274-284	275-285	276-286	277-287	278-288
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.7	20.7	0.125	0.050	-0.025	-0.125	-0.075	-0.125	-0.150	-0.175
66.2	62.2	0.925	0.475	0.300	0.125	-0.050	-0.325	-0.450	-0.550
110.4	108.4	1.975	1.350	0.650	0.400	-0.050	-0.425	-0.725	-0.975
165.2	160.5	3.250	2.150	0.875	0.800	0.425	-0.700	-1.275	-1.750
202.7	186.6	4.025	2.950	0.600	1.350	0.025	-0.925	-1.775	-2.450
226.7	214.7	4.925	3.175	0.600	1.725	0.000	-1.200	-2.300	-3.200
240.1	214.7	6.775	5.050	0.425	1.500	-0.225	-1.350	-2.500	-3.350
243.3	219.4	8.050	6.150	0.375	1.400	-0.375	-1.450	-2.550	-3.375
243.3	209.4	8.025	6.025	0.400	1.250	-0.425	-1.450	-2.575	-3.350

BEAM CFT-T38 DIAGONAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 121-133	122-134	123-135	124-136	125-137	126-138	131-123	132-124	133-125	134-126	135-127	136-128
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.6	16.1	0.197	0.197	0.197	0.197	0.154	0.044	0.175	0.263	0.197	0.154	0.154	0.154
55.0	49.6	0.307	0.219	0.154	0.022	0.044	-0.132	0.329	0.417	0.197	0.000	0.110	0.066
88.5	80.7	0.351	0.175	0.088	0.022	-0.044	-0.329	0.351	0.329	0.088	0.022	0.044	-0.066

BEAM CFT-T38 DIAGONAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 141-153	142-154	143-155	144-156	145-157	146-158	151-143	152-144	153-145	154-146	155-147	156-148
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110.1	107.9	1.294	1.118	1.075	0.724	-0.482	-0.088	0.395	0.219	-0.110	0.263	-0.504	-0.417
135.1	124.9	1.272	1.404	1.864	1.404	-0.395	0.022	0.307	-0.066	-0.175	0.197	-0.768	-0.724
152.5	144.9	1.867	1.997	2.261	1.754	-0.329	-0.066	0.197	-0.285	-0.175	0.110	-0.855	-0.658

BEAM CFT-T38 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 201-211	202-212	203-213	204-214	205-215	206-216	207-217	208-218
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.5	14.0	-0.125	0.063	-0.112	-0.037	-0.150	-0.188	-0.150	-0.188
40.4	44.5	0.113	0.100	0.100	0.012	-0.150	-0.262	-0.313	-0.438
77.5	76.5	0.400	0.300	0.262	0.175	-0.150	-0.537	-0.488	-0.637
115.6	113.6	0.475	0.675	0.400	0.462	-0.062	-0.425	-0.683	-0.900
141.9	131.1	0.713	-0.067	0.325	0.612	-0.137	-0.563	-0.812	-1.137
160.1	152.6	1.150	-0.137	0.287	0.662	-0.125	-0.662	-0.987	-1.325
168.1	161.7	1.400	-0.163	0.287	0.537	-0.138	-0.650	-0.900	-1.325
173.4	165.6	1.312	-0.163	0.212	0.475	-0.313	-0.725	-1.025	-1.363

BEAM CFT-T38 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 211-221	212-222	213-223	214-224	215-225	216-226	217-227	218-228
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17.3	16.7	0.025	-0.037	-0.037	-0.062	-0.087	-0.163	-0.112	-0.200
55.2	53.0	0.400	0.175	0.100	-0.037	-0.112	-0.300	-0.325	-0.450
92.0	91.0	0.637	0.512	0.350	0.100	-0.100	-0.412	-0.487	-0.738
137.7	135.4	1.400	1.075	0.725	0.300	-0.075	-0.450	-0.713	-1.100
168.9	156.1	1.425	1.350	0.912	0.350	-0.163	-0.650	-0.925	-1.437
190.6	181.7	1.475	1.387	1.062	1.637	-0.225	-0.725	-1.137	-0.400
200.1	180.6	1.575	1.550	1.050	0.313	-0.300	-0.787	-1.187	-1.725
202.9	182.6	1.525	1.437	0.862	0.250	-0.375	-0.875	-1.238	-1.750

BEAM CFT-T38 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 221-241	222-242	223-243	224-244	225-245	226-246	227-247	228-248
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.0	19.4	0.000	0.037	-0.052	-0.050	-0.037	-0.125	-0.112	-0.188
64.0	61.4	0.175	0.300	0.150	0.037	-0.075	-0.237	-0.375	-0.462
106.7	105.4	0.462	0.750	0.37	0.150	-0.075	-0.338	-0.600	-0.875
159.7	156.0	1.200	1.000	0.93	0.462	0.037	-0.462	-0.963	-1.475
195.9	161.0	1.762	1.000	1.250	0.575	0.037	-0.650	-1.325	-1.987
221.1	210.6	2.462	2.700	1.637	0.862	0.075	-0.825	-1.687	-2.500
232.1	209.5	2.687	2.675	1.775	0.787	-0.100	-0.987	-1.850	-2.662
233.5	212.1	2.550	2.662	1.712	0.675	-0.225	-1.112	-1.950	-2.750

BEAM CFT-T38 LONGITUDINAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 231-241	232-242	233-243	234-244	235-245	236-246	237-247	238-248
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20.7	20.7	0.125	0.125	0.000	0.000	0.150	-0.100	-0.100	-0.075
66.2	66.2	0.175	0.375	0.100	0.000	0.150	-0.225	-0.325	-0.425
110.4	108.4	0.575	0.575	0.125	-0.075	0.225	-0.325	-0.650	-0.825
163.2	160.5	0.975	0.750	0.325	0.900	0.550	-0.500	-1.100	-1.625
202.7	166.6	1.175	0.750	-0.325	1.325	0.625	-0.675	-1.400	-2.125
223.7	214.7	1.000	0.750	-0.175	1.775	0.725	-0.875	-1.800	-2.725
240.1	214.7	0.850	0.425	-0.350	1.700	0.375	-1.075	-2.025	-2.900
243.5	217.4	0.550	0.425	-0.225	1.575	0.275	-1.175	-2.075	-2.925
243.5	207.4	0.550	0.575	-0.375	1.475	0.200	-1.175	-2.050	-2.900

BEAM CFT-T38 TRANSVERSE STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 201-203	202-204	203-205	204-206	205-207	206-208	211-213	212-214	213-215	214-216	215-217	216-218
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
141.9	130.6	1.750	2.075	1.325	-0.875	0.175	0.125	1.725	0.050	-0.100	0.350	0.275	0.500
168.1	151.2	2.250	2.750	1.575	-0.250	0.150	0.125	1.250	0.025	0.050	0.500	0.400	0.350

BEAM CFT-T08 TRANSVERSE STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 271-283	272-284	283-285	284-286	285-287	286-288	301-303	302-304	303-305	304-306	305-307	306-308	311-313	312-314	313-315	314-316	315-317	316-318
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
163.2	160.5	0.400	0.400	-0.025	-0.025	0.000	0.150	0.000	0.000	0.000	0.000	0.150	0.000	0.000	0.000	0.000	0.000	0.000	0.000
202.7	186.6	0.650	0.625	-0.100	-0.100	0.075	0.350	0.000	0.000	0.000	0.000	0.350	0.000	0.000	0.000	0.000	0.000	0.000	0.000
228.7	215.4	0.925	1.050	-0.050	0.125	0.225	0.750	0.025	0.000	0.000	0.000	0.750	0.025	0.000	0.000	0.000	0.000	0.000	0.000

BEAM CFT-T03 TRANSVERSE STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 301-303	302-304	303-305	304-306	305-307	306-308	311-313	312-314	313-315	314-316	315-317	316-318
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
141.7	130.6	4.650	-0.150	-0.075	0.075	0.000	0.150	-0.125	0.050	2.025	2.100	0.000	0.100
160.1	150.0	4.650	-0.200	-0.025	0.125	0.125	0.350	-0.025	0.050	2.950	3.025	0.050	0.125

BEAM CFT-T03 DIAGONAL STRAINS-SIDE FACE

MOMENT D	MOMENT S	STRAINS *10**-3 271-283	272-284	283-285	284-286	285-287	286-288	281-273	282-274	283-275	284-276	285-277	286-278
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
163.2	161.2	2.610	2.237	0.658	0.219	-0.235	-0.439	0.285	-0.132	-0.307	-0.329	-0.763	-1.184
202.7	186.6	3.158	3.596	1.316	0.739	-0.197	-0.461	0.461	-0.383	-0.461	-0.548	-0.965	-1.469
228.7	215.4	3.070	4.690	1.732	0.921	-0.263	-0.570	0.526	-0.154	-0.351	-0.482	-1.140	-1.557

BEAM CFT-T03 LONGITUDINAL STRAINS-TOP FACE

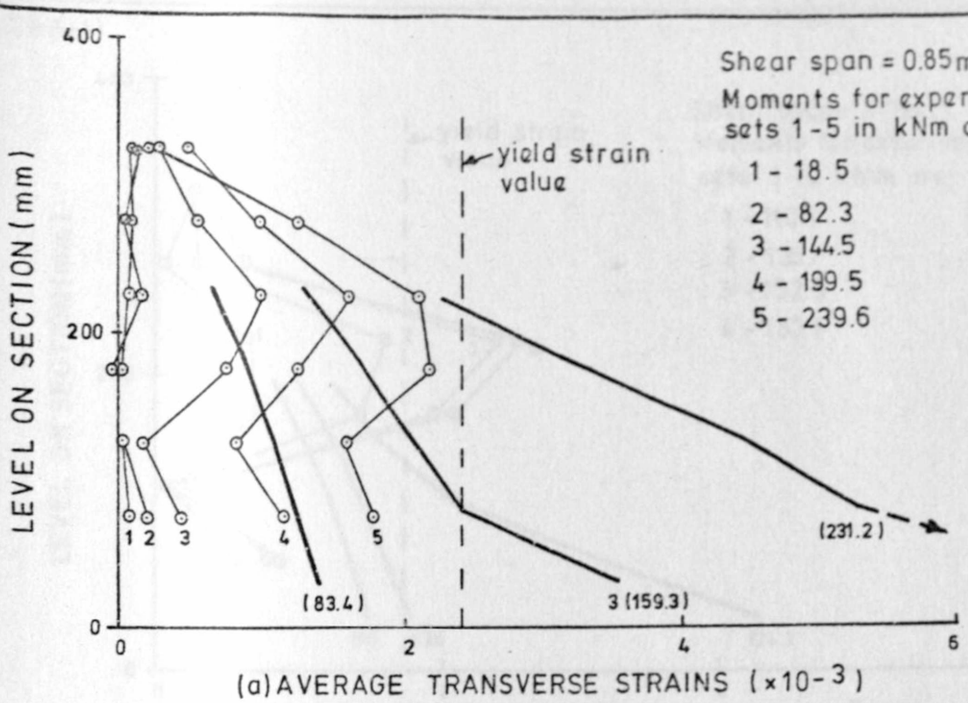
MOMENT D	MOMENT S	STRAINS *10**-3 ECT1	ECT2	ECT3	ECT10	ECT11	ECT12
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000
14.5	14.5	-0.012	-0.112	-0.075	0.000	-0.112	0.025
46.4	45.5	-0.362	-0.237	-0.375	-0.338	-0.325	-0.150
77.3	75.6	-0.700	-0.612	-0.638	-0.612	-0.725	-0.650
115.6	112.8	-1.100	-0.775	-1.112	-0.963	-1.075	-1.012
141.9	130.6	-1.350	-1.300	-1.363	-1.137	-1.325	-1.175
160.1	151.7	-1.562	-1.450	-1.537	-1.262	-1.437	-1.337
168.1	158.3	-1.637	-1.525	-1.587	-1.000	-1.463	-1.350
170.4	158.6	-1.637	-1.525	-1.537	-1.000	-1.463	-1.350

BEAM CFT-T03 LONGITUDINAL STRAINS-TOP FACE

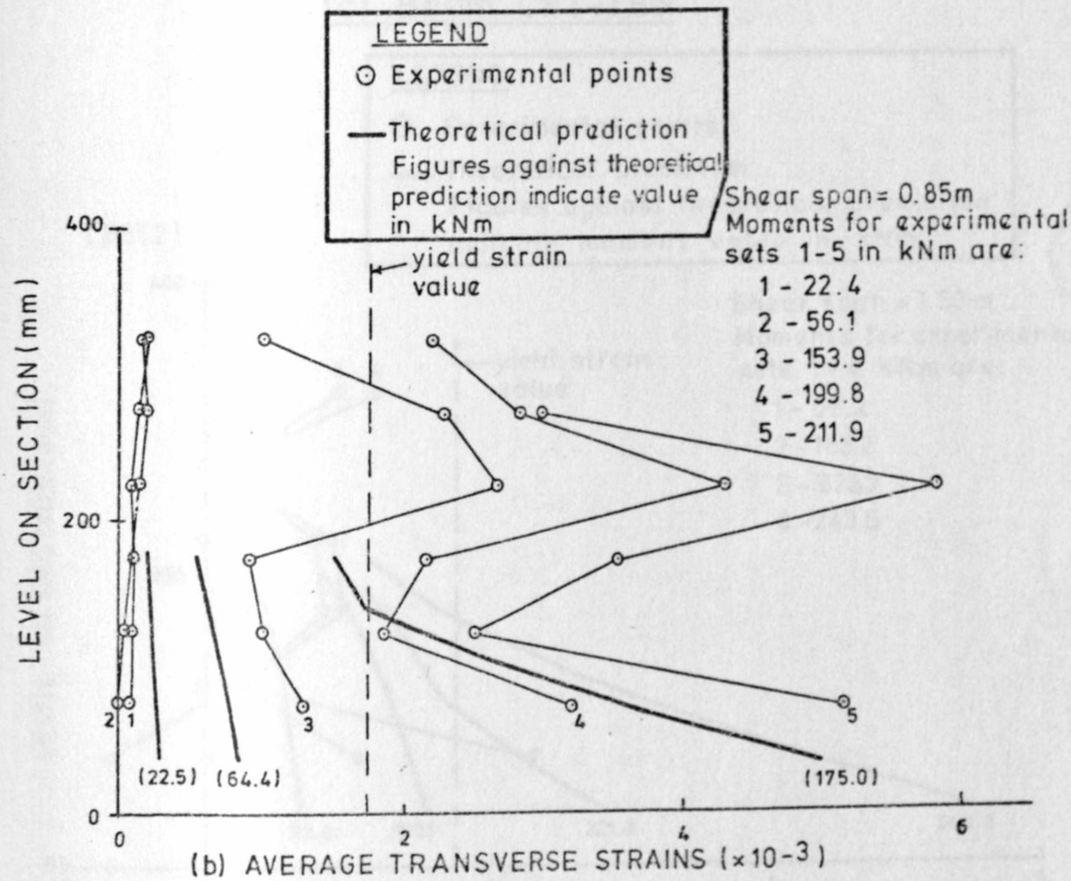
MOMENT D	MOMENT S	STRAINS *10**-3 ECT4	ECT5	ECT6	ECT7	ECT8	ECT9
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000
17.3	17.3	-0.125	-0.138	-0.037	-0.075	-0.037	-0.137
53.2	51.3	-0.450	-0.525	-0.487	-0.350	-0.362	-0.412
92.0	90.3	-0.900	-0.950	-0.775	-0.738	-0.713	-0.762
137.7	134.3	-1.450	-1.337	-1.350	-1.150	-1.212	-1.250
163.9	155.5	-1.837	-1.637	-1.712	-1.300	-1.400	-1.463
190.6	180.0	-2.288	-2.000	-2.125	-1.675	-1.725	-1.775
200.1	178.9	-2.333	-2.062	-2.125	-1.875	-1.800	-1.800
202.9	182.8	-2.425	-2.100	-2.187	-1.775	-1.825	-1.925
202.9	174.5	-2.500	-2.125	-2.212	-1.863	-1.800	-1.875

C.5 Further Plots from Measured Strains

Further plots similar to those in Chapter 5 are presented in Figures C.3 - C.8.

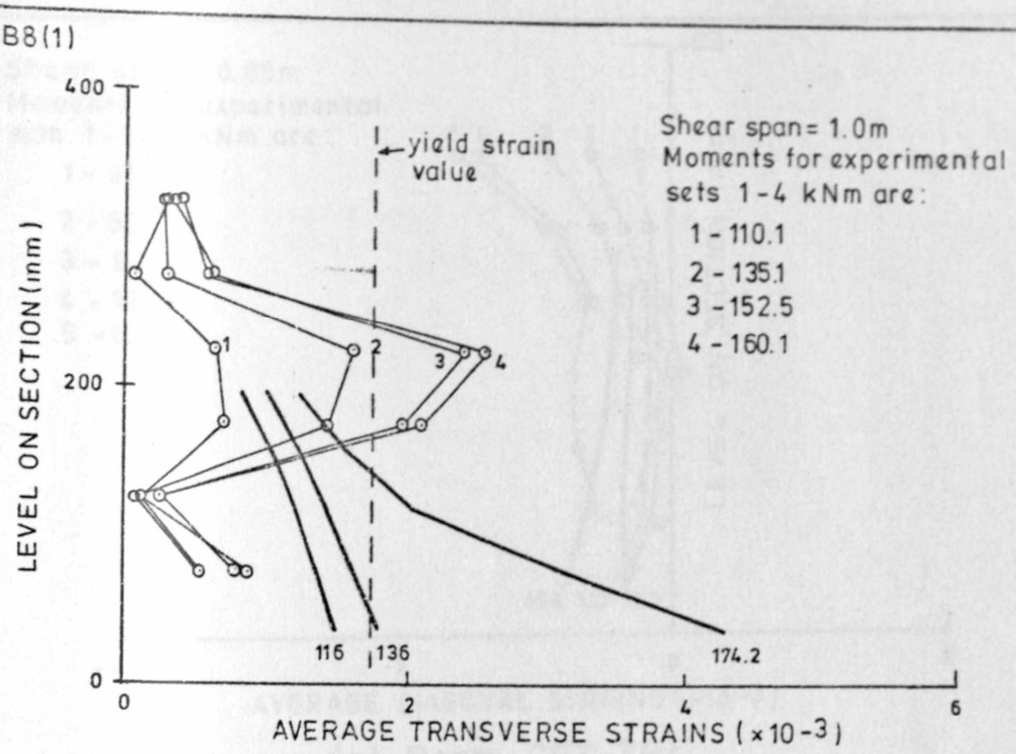


(a) Beam CFT-TB5



(b) Beam CFT-TB6

Fig. C.3 : Transverse strains profiles

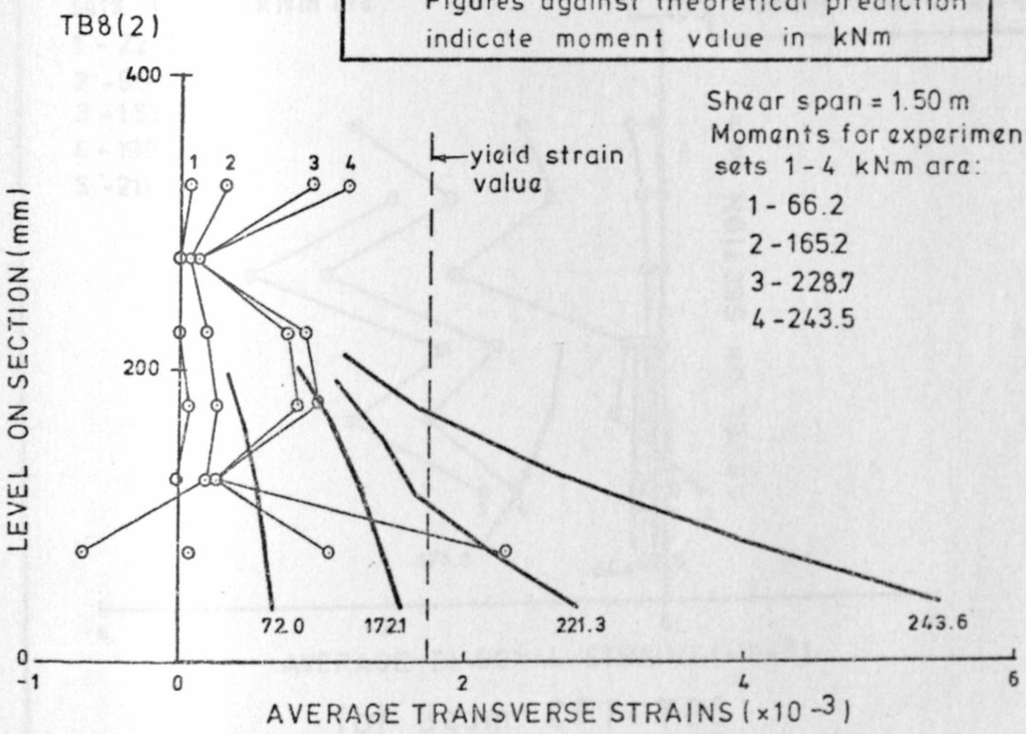


(c) Beam CFT-TB8

LEGEND

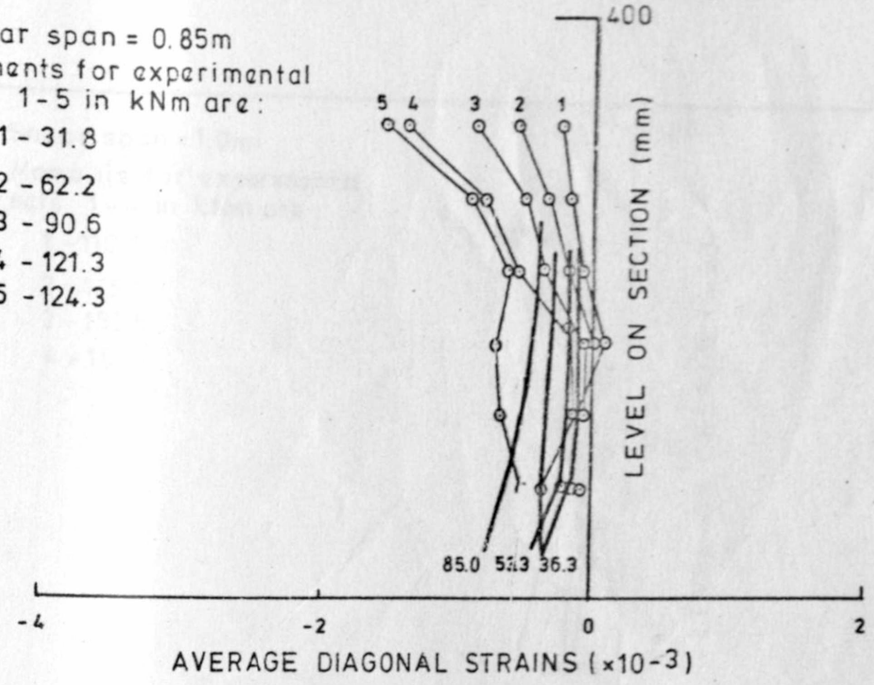
⊙ Experimental points

— Theoretical prediction
Figures against theoretical prediction indicate moment value in kNm

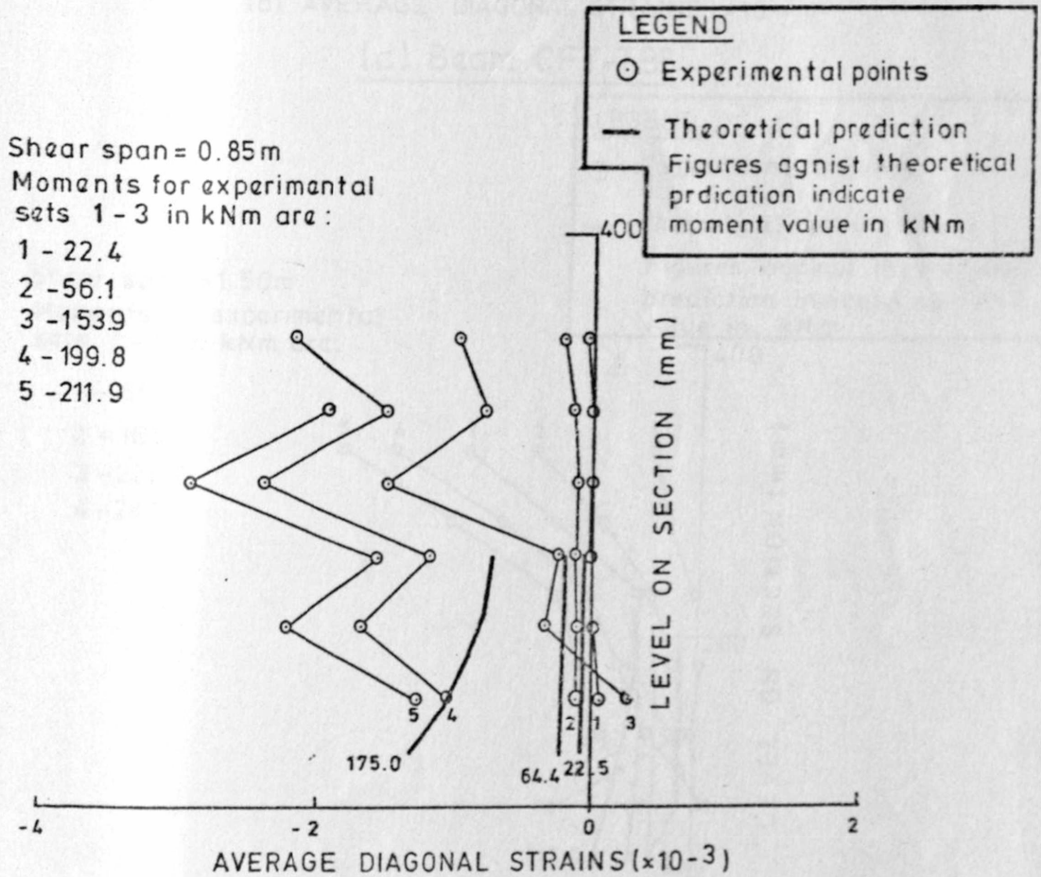


(d) Beam CFT-TB8

Fig. C.3 : Transverse strain profiles

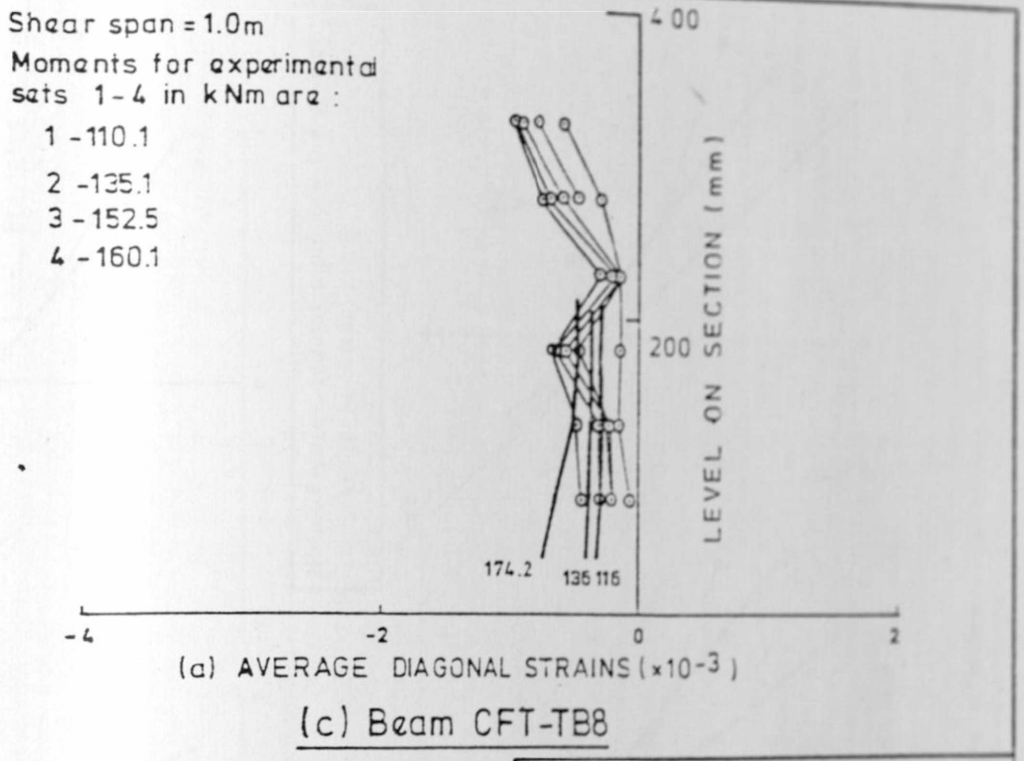


(a) Beam CFT-TB4

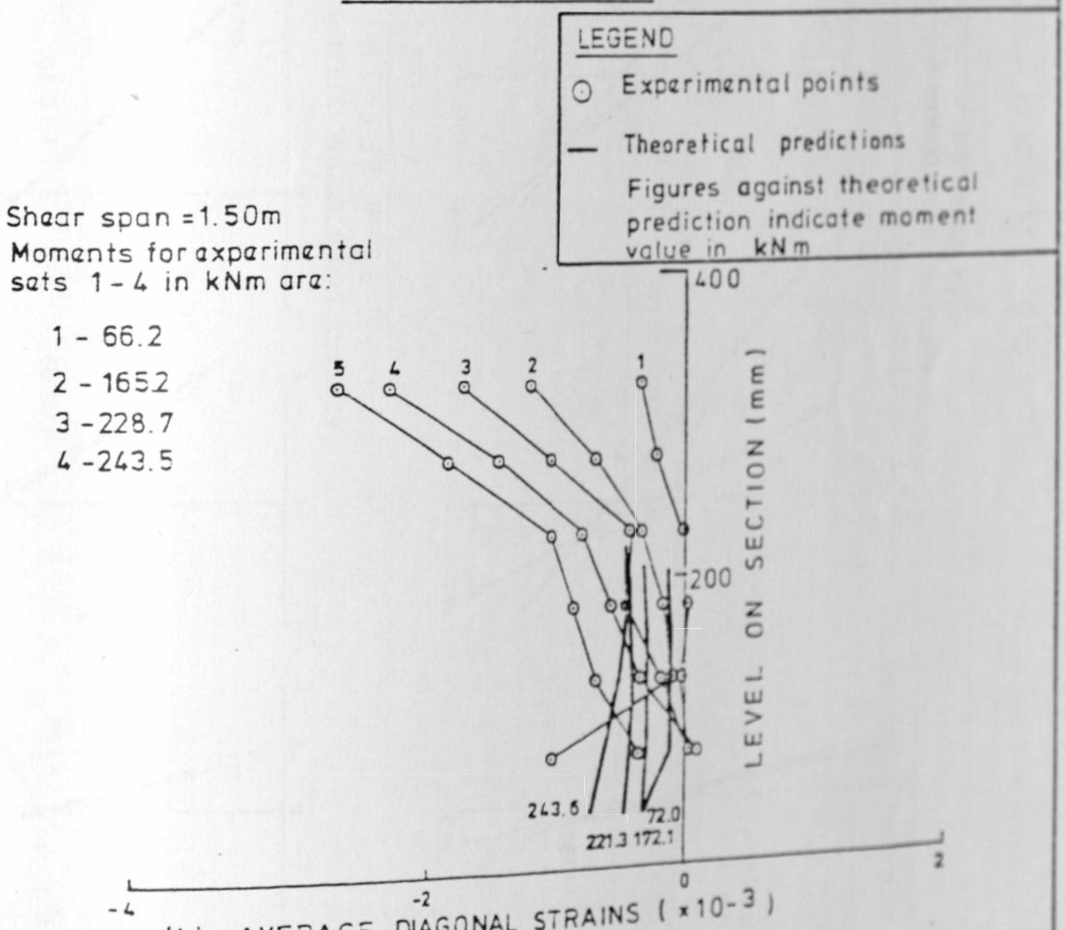


(b) Beam CFT-TB6

Fig. C.4 : Principal compression strains profiles

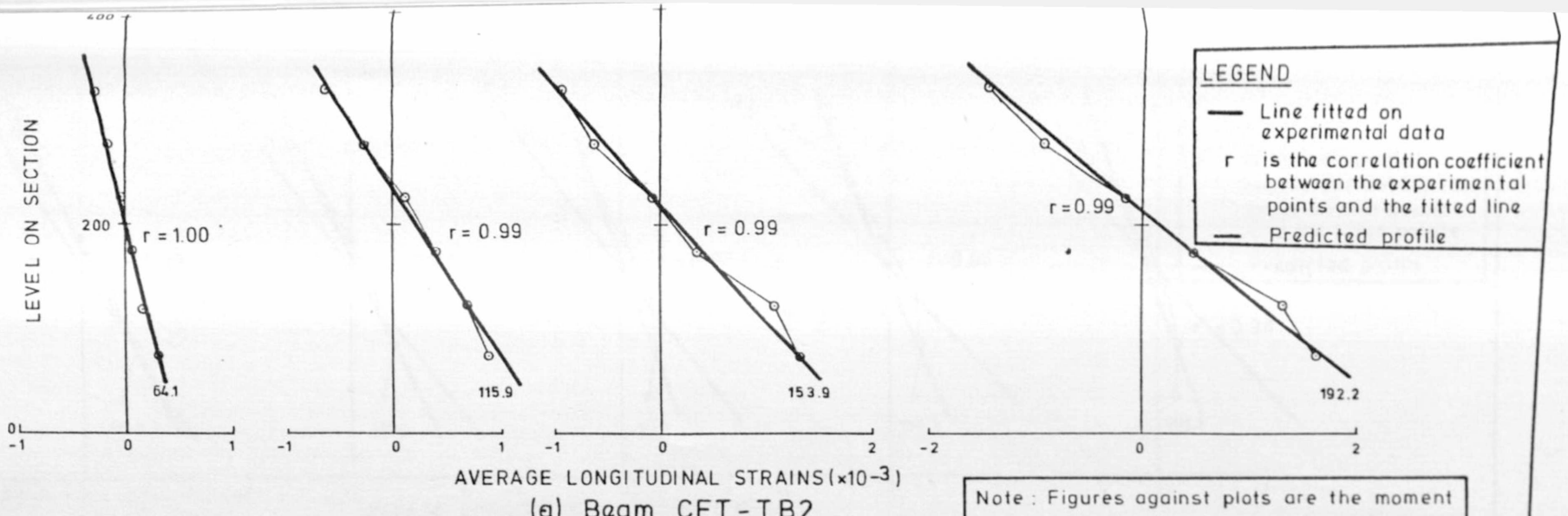


(c) Beam CFT-TB8

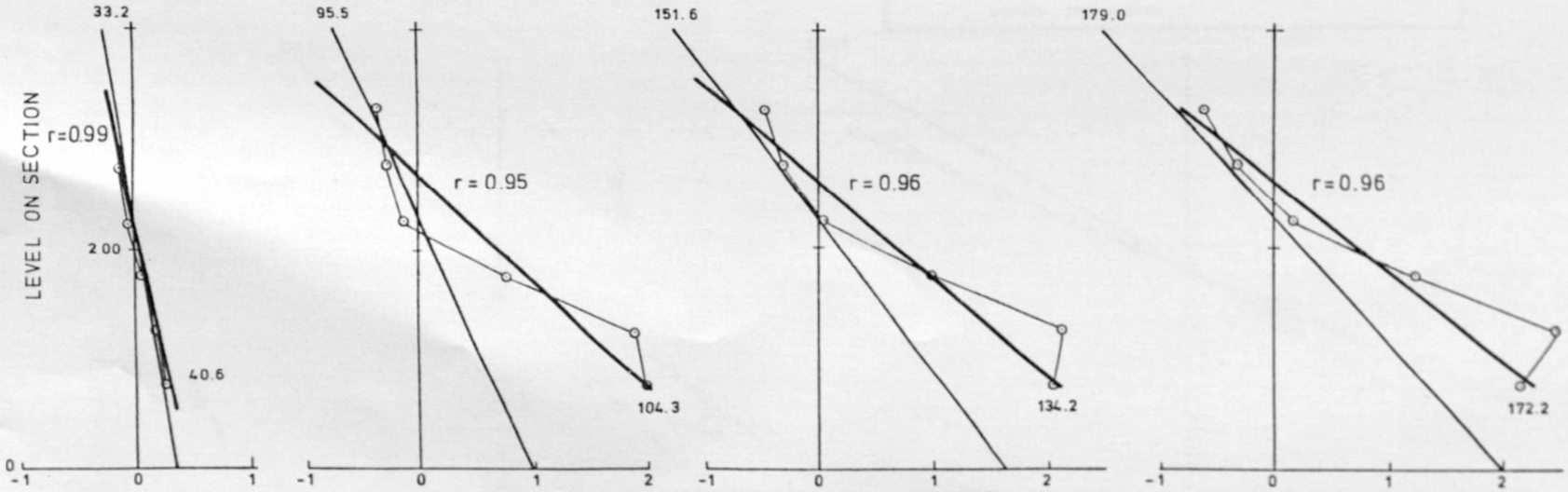


(d) Beam CFT-TB8

Figure C4 : Principal Compression Strains Profiles



(a) Beam CFT-TB2



(b) Beam CFT-TB3

Figura C.5 : Longitudinal strains profiles

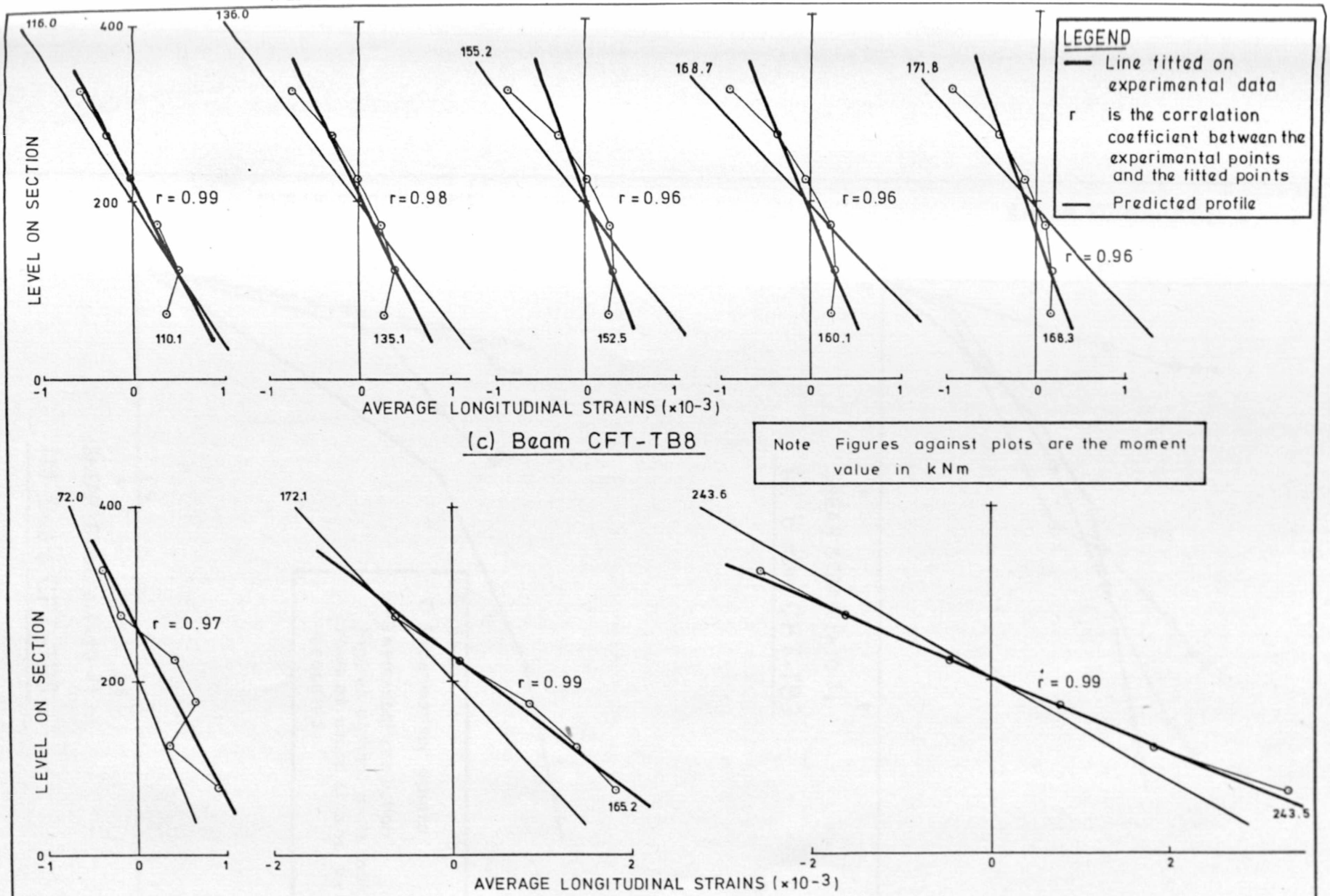
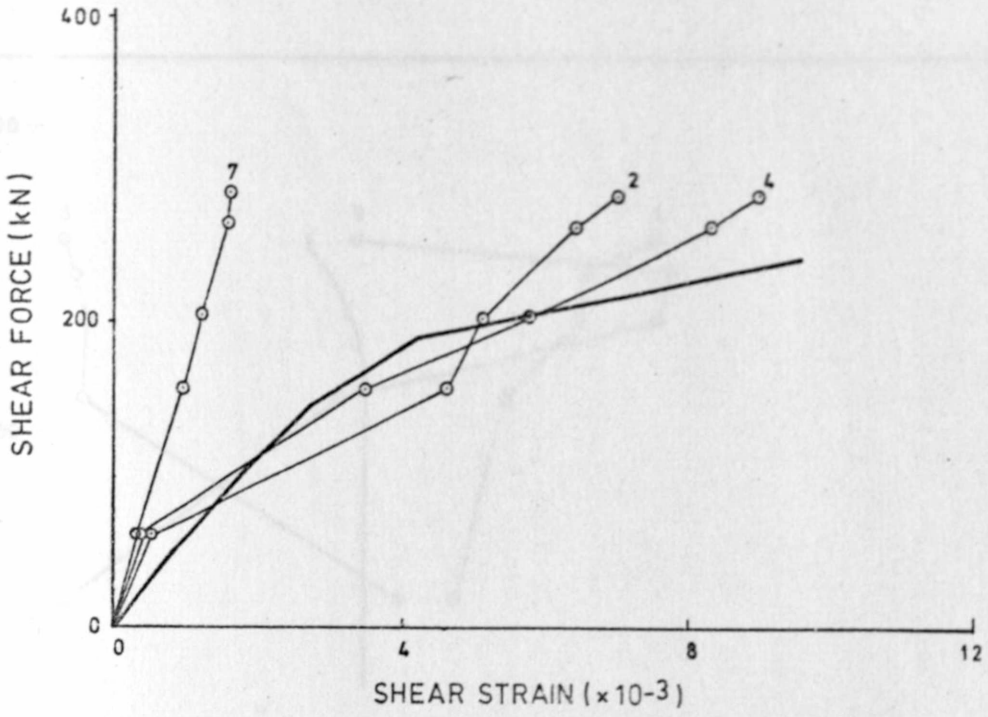
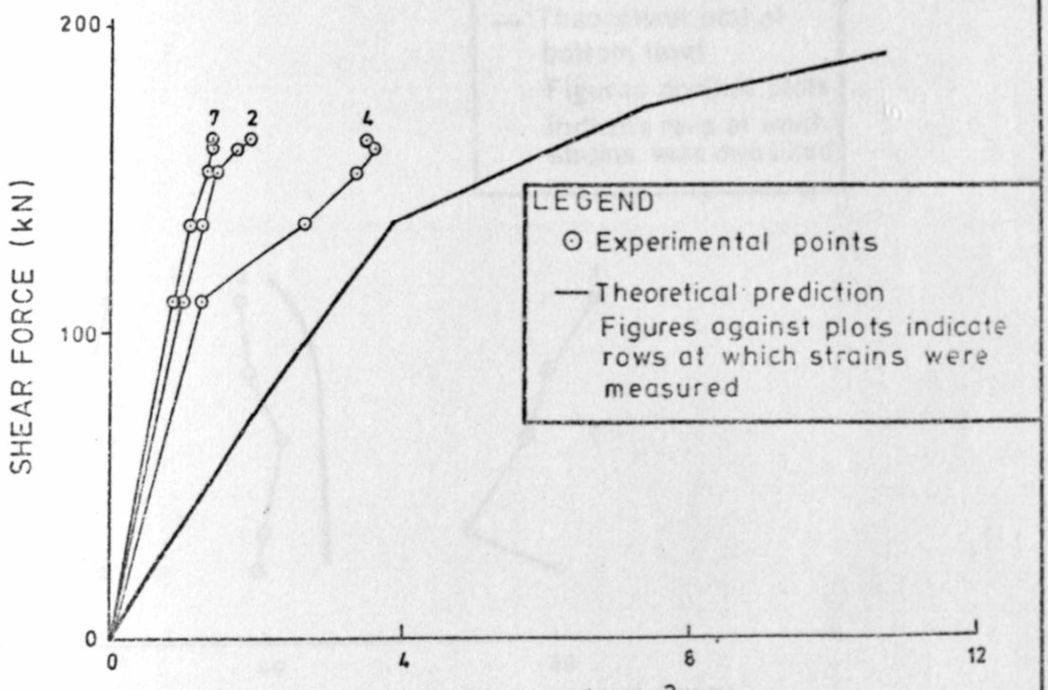


Figure C.5: Longitudinal strains profiles

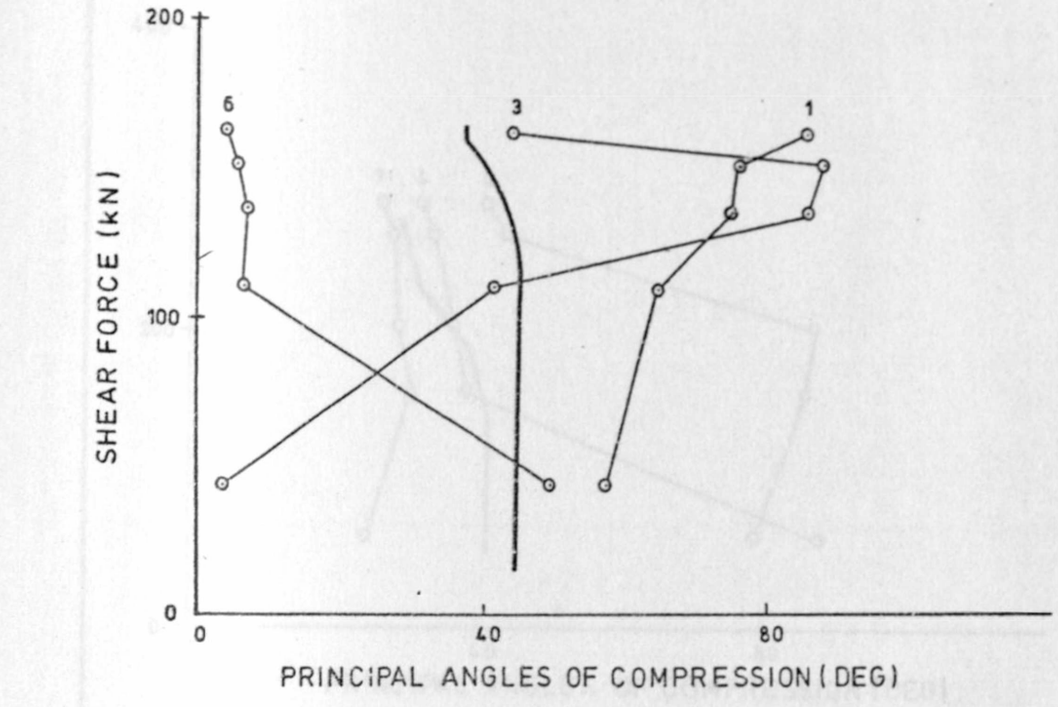


(a) Beam CFT-TB3

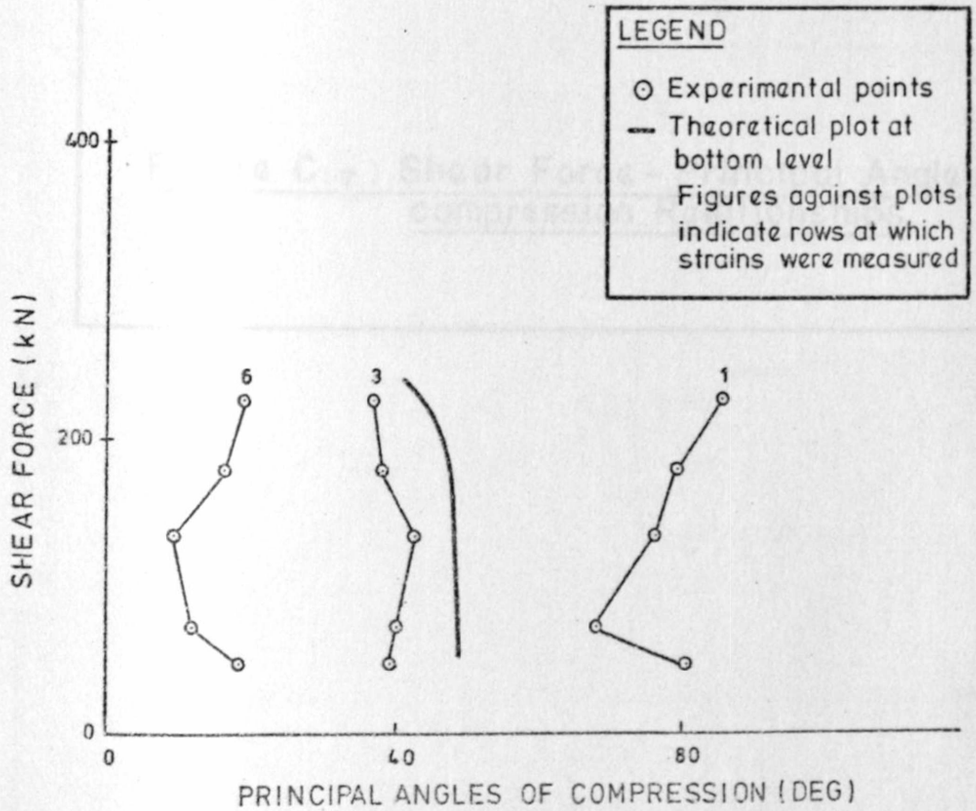


(b) Beam CFT-TB8

Figure C.6: Variation of Shear strain

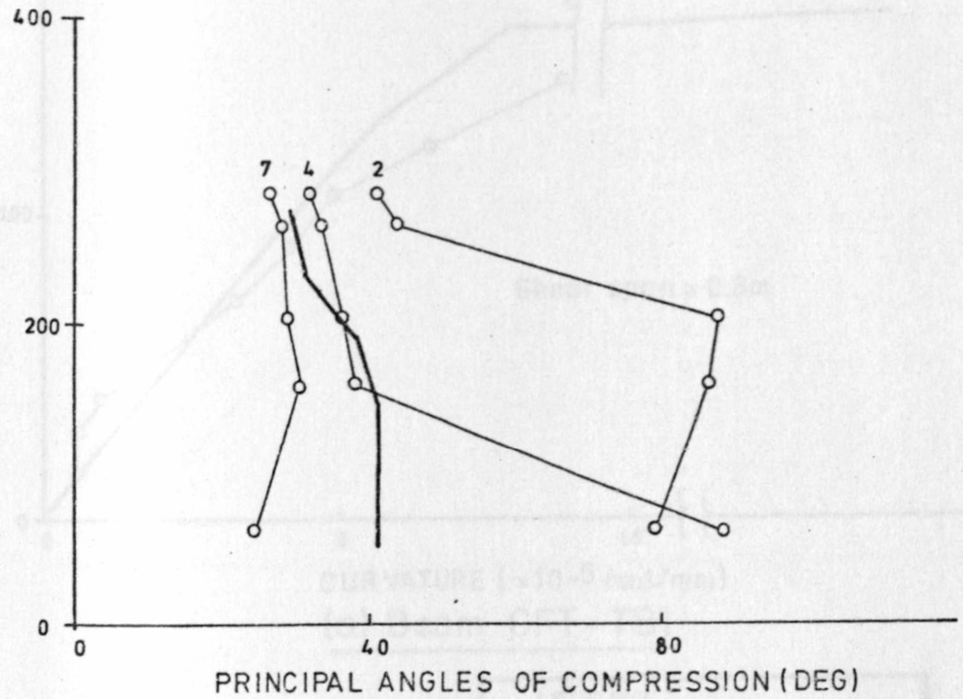


(a) Beam CFT-TB8



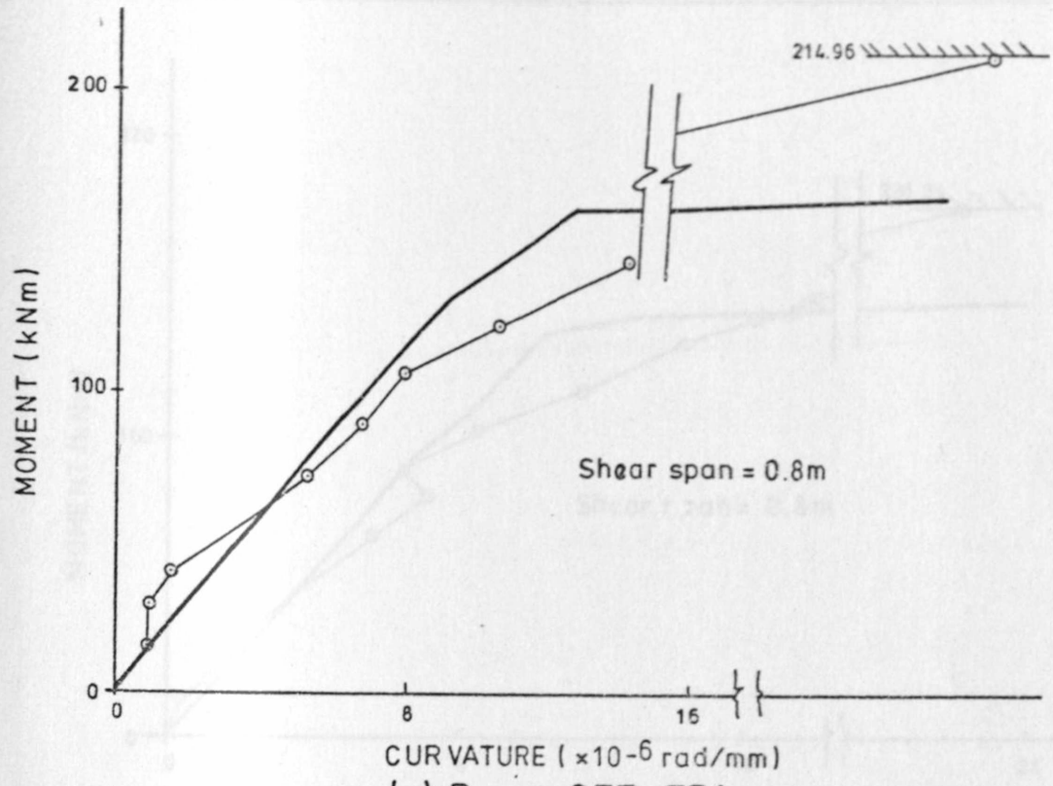
(b) Beam CFT-TB7

Figure C.7: Shear Force - Principal Angles of compression Relationships

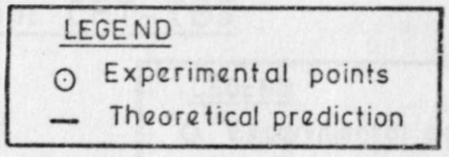


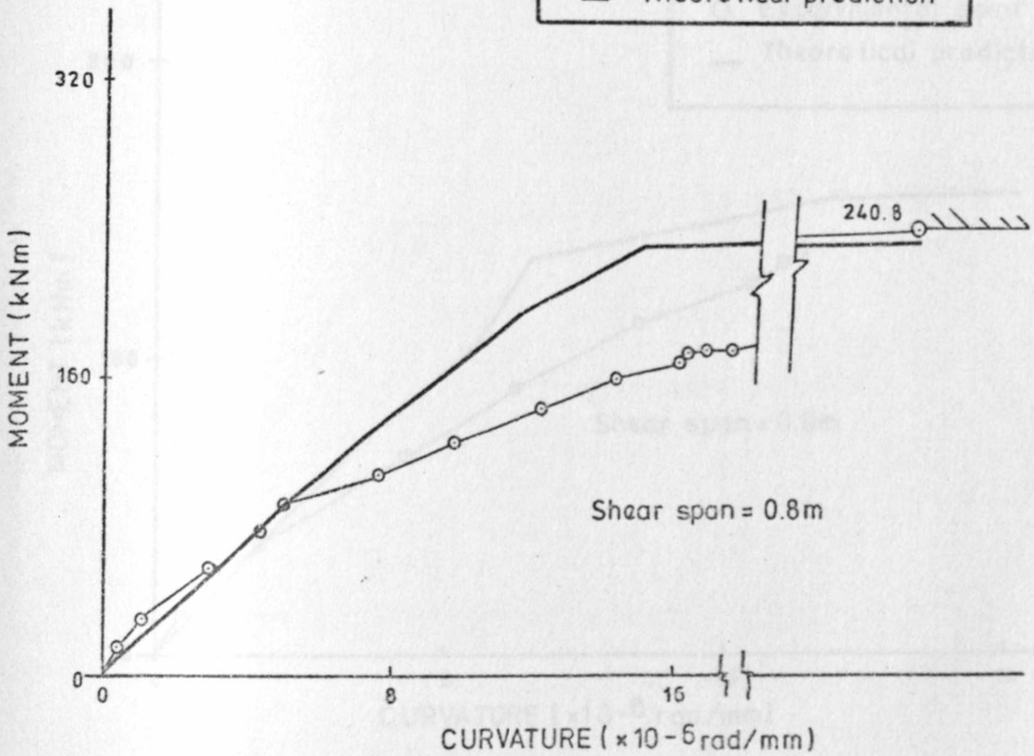
(c) BEAM CFT-TB3

Figure C.7 : Shear Force - Principal Angles of compression Relationships



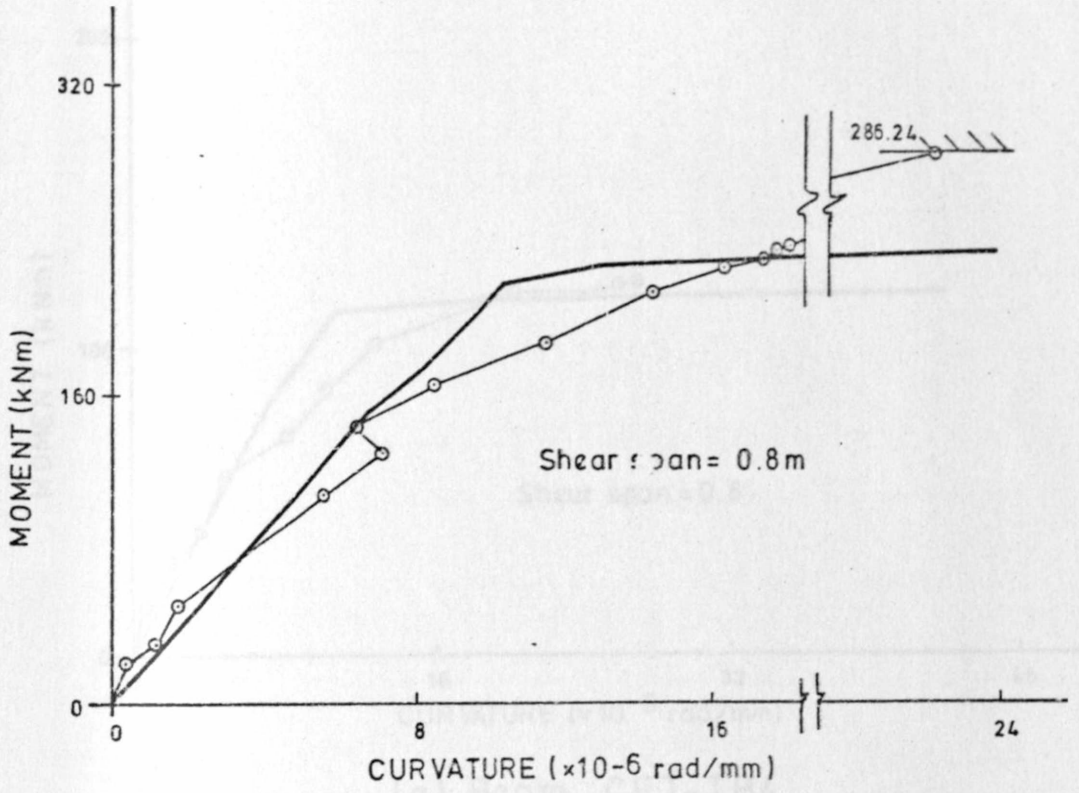
(a) Beam CFT-TB1



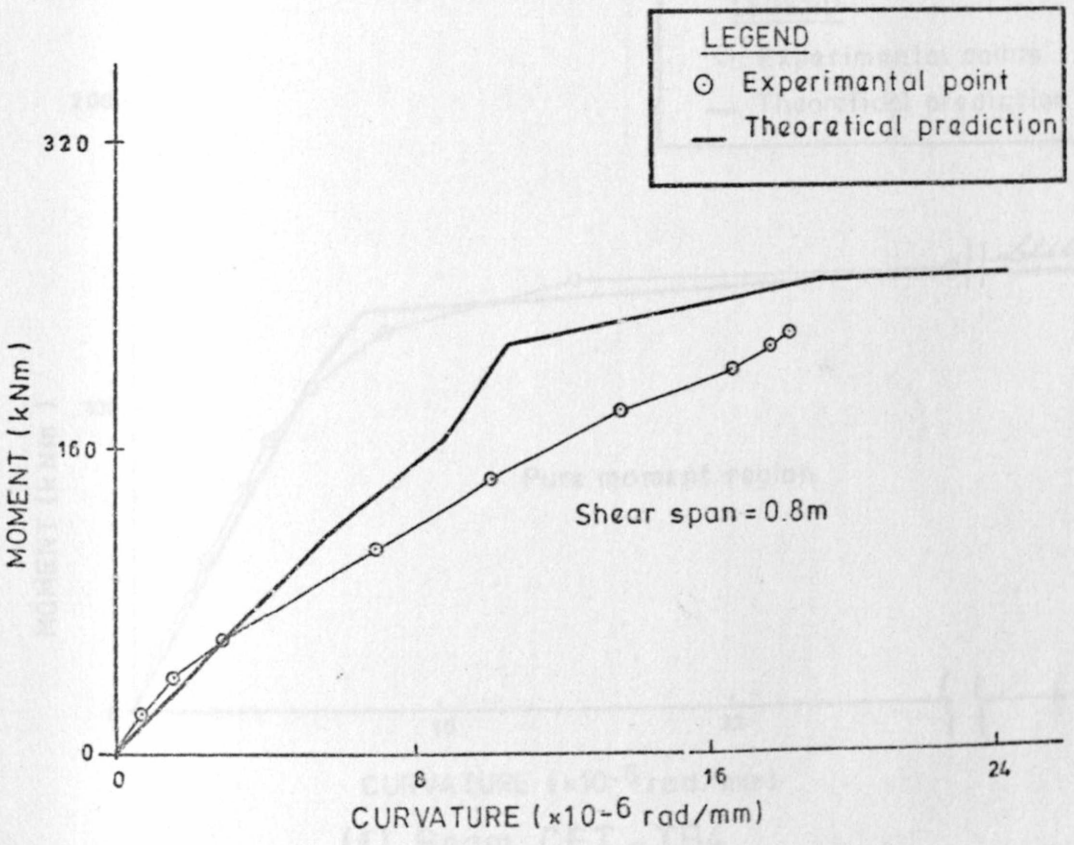


(b) Beam CFT-TB2

Figure C_8 : Moment - Curvature Relationships

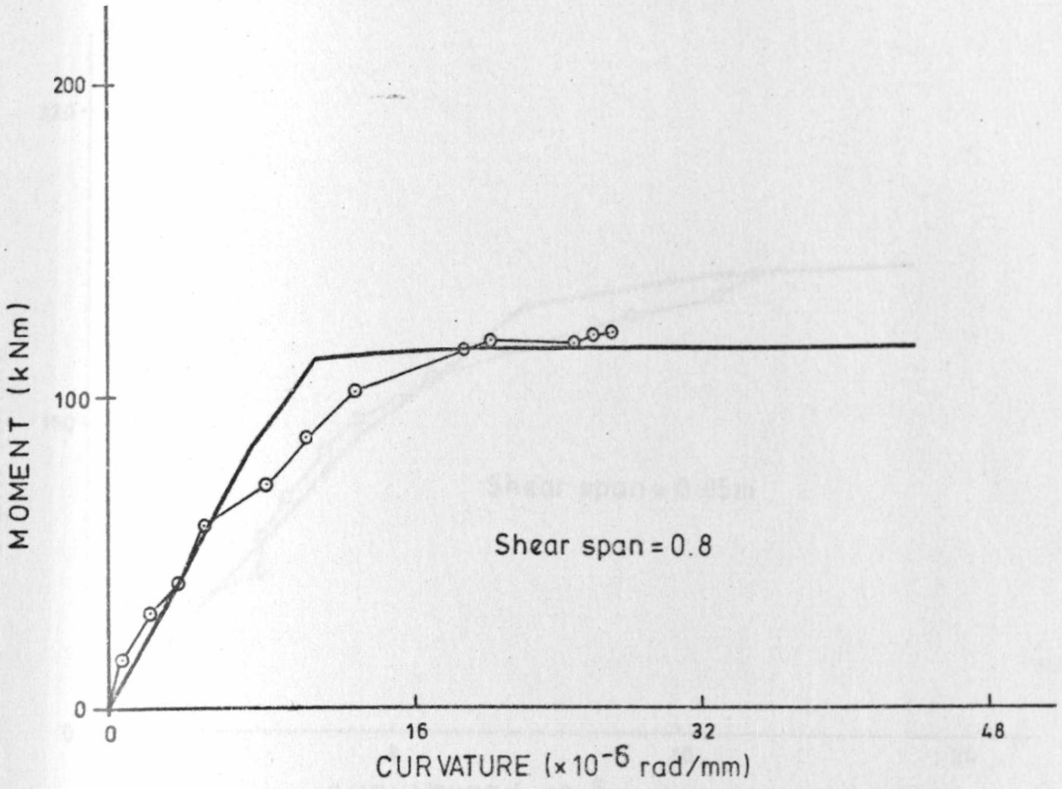


(c) Beam CFT-TB3

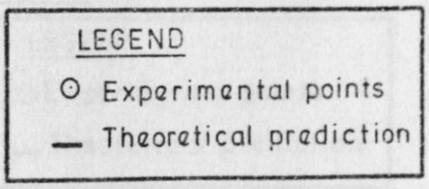


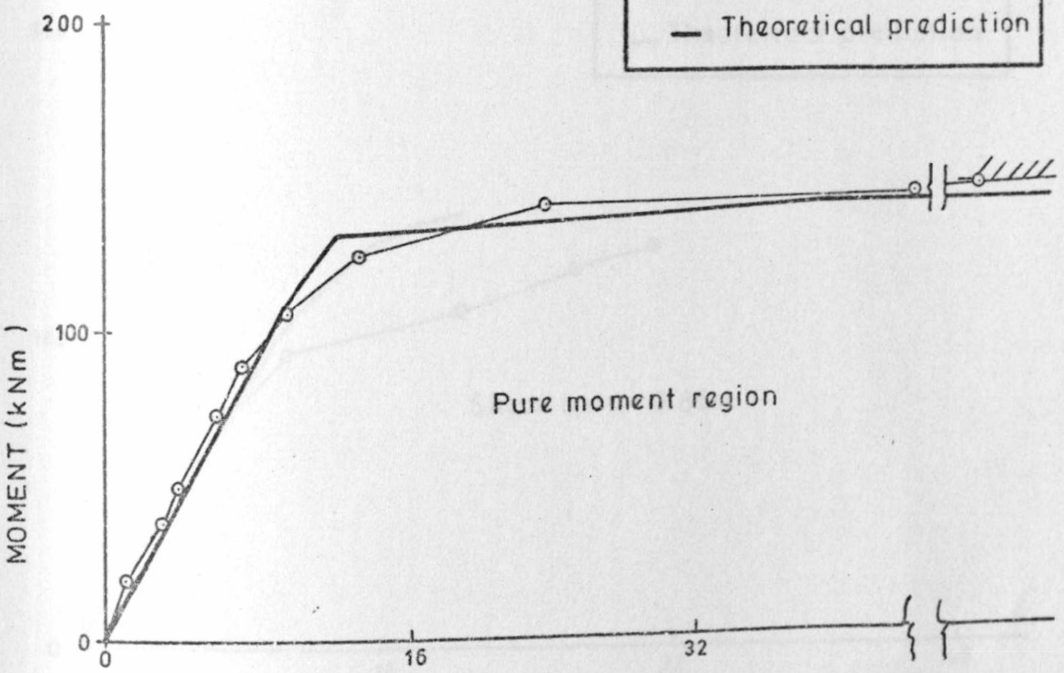
(d) Beam CFT-TB7

Figure C.8 : Moment-Curvature Relationships



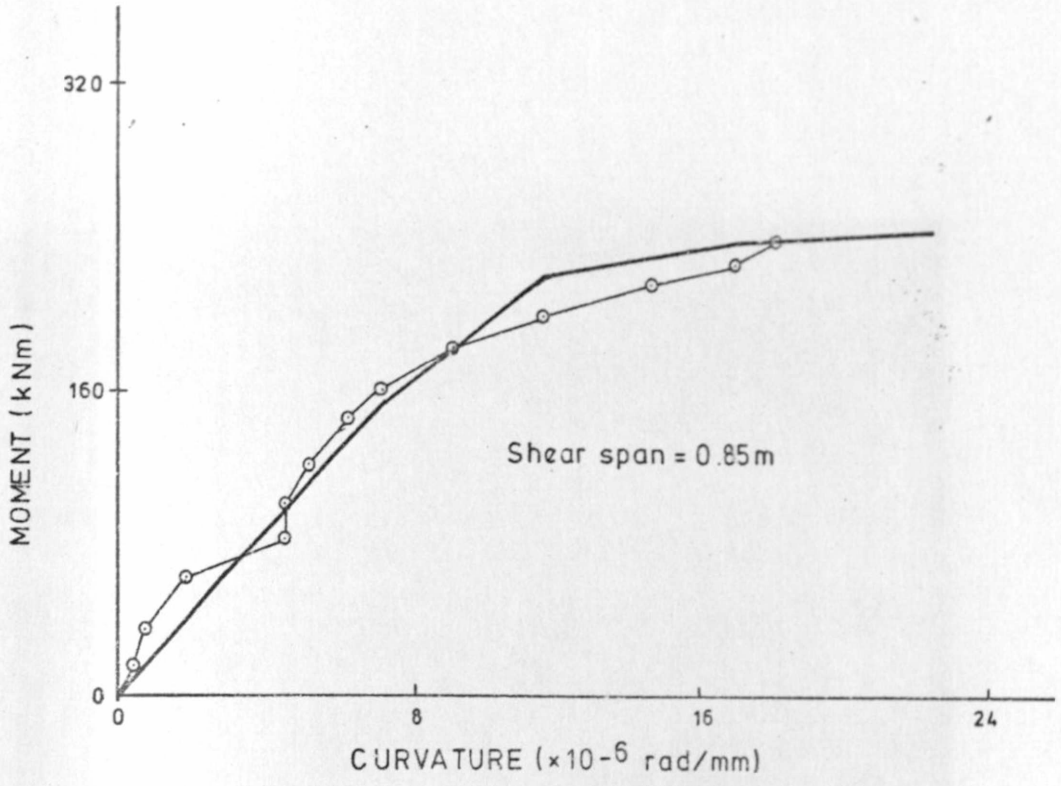
(e) Beam CFT-TB4



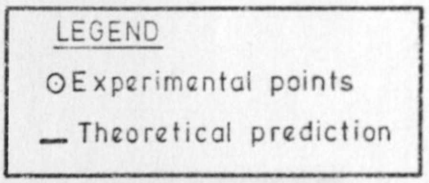


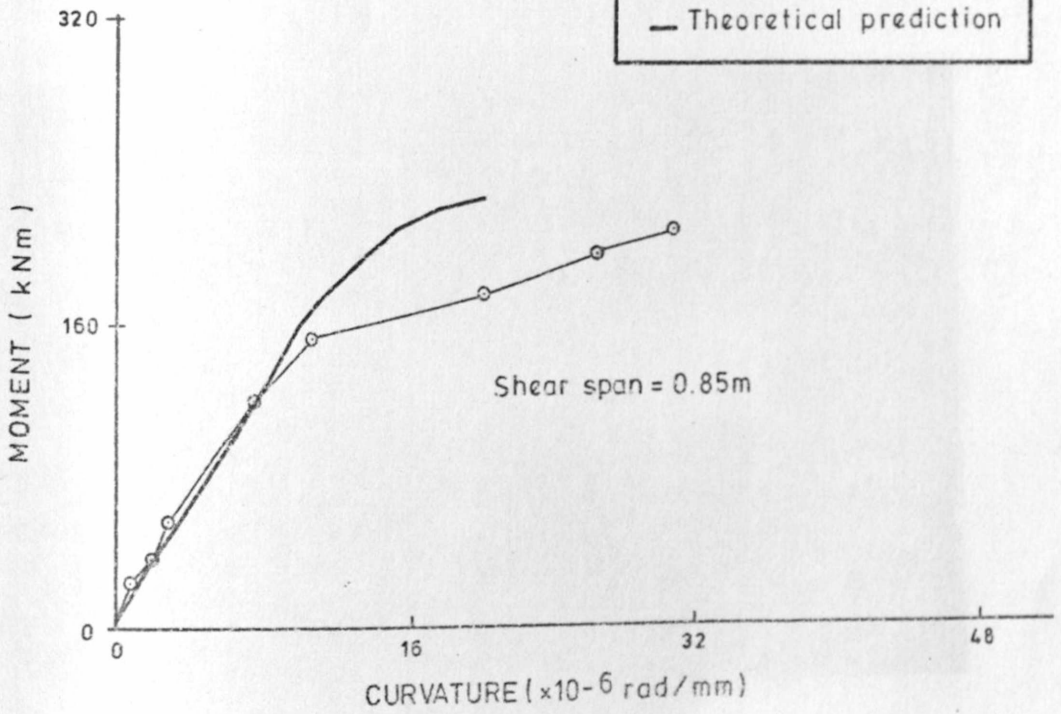
(f) Beam CFT-TB4

Figure C.8 : Moment-Curvature Relationships



(g) Beam CFT-TB5





(h) Beam CFT-TB6

Figure C.8 : Moment - Curvature Relationships

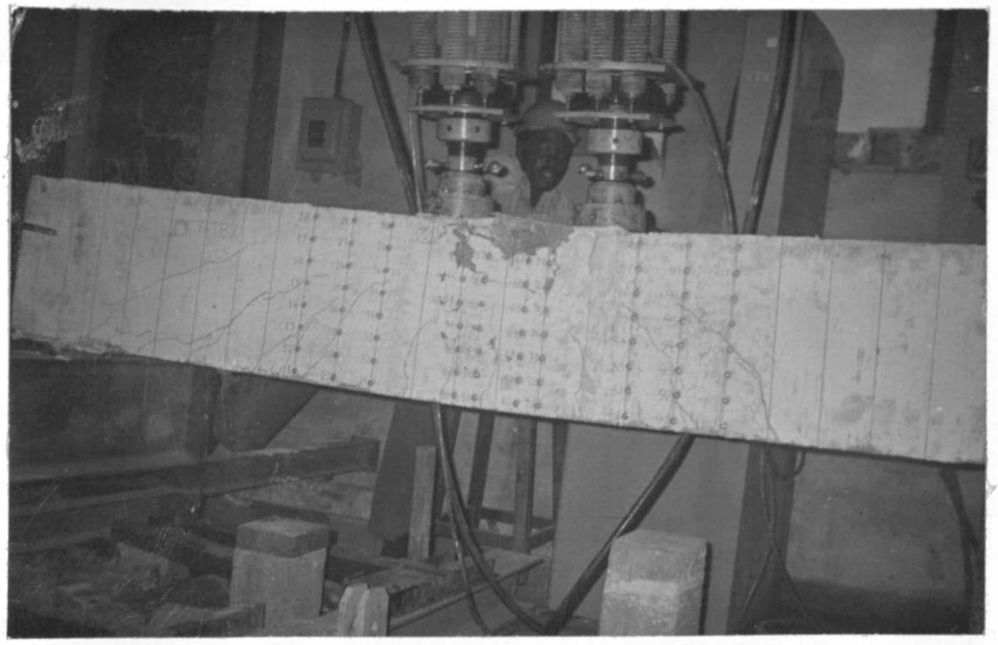


Plate C.1: Failure, Beam CFT-TB2

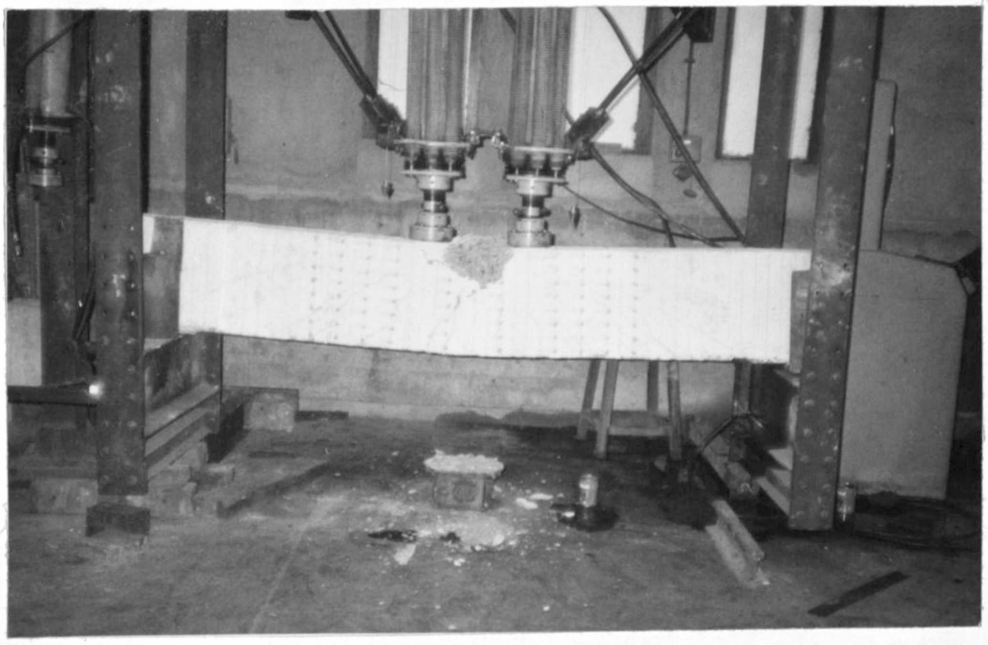


Plate C.2: Failure, Beam CFT-TB3

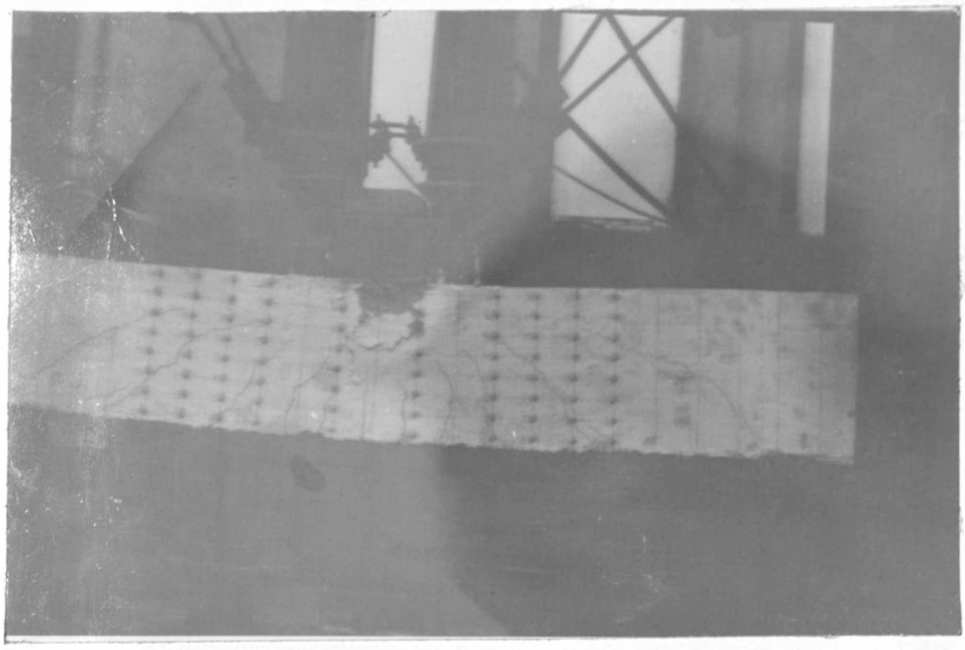


Plate C.3 : Failure, Beam CFT-TB7

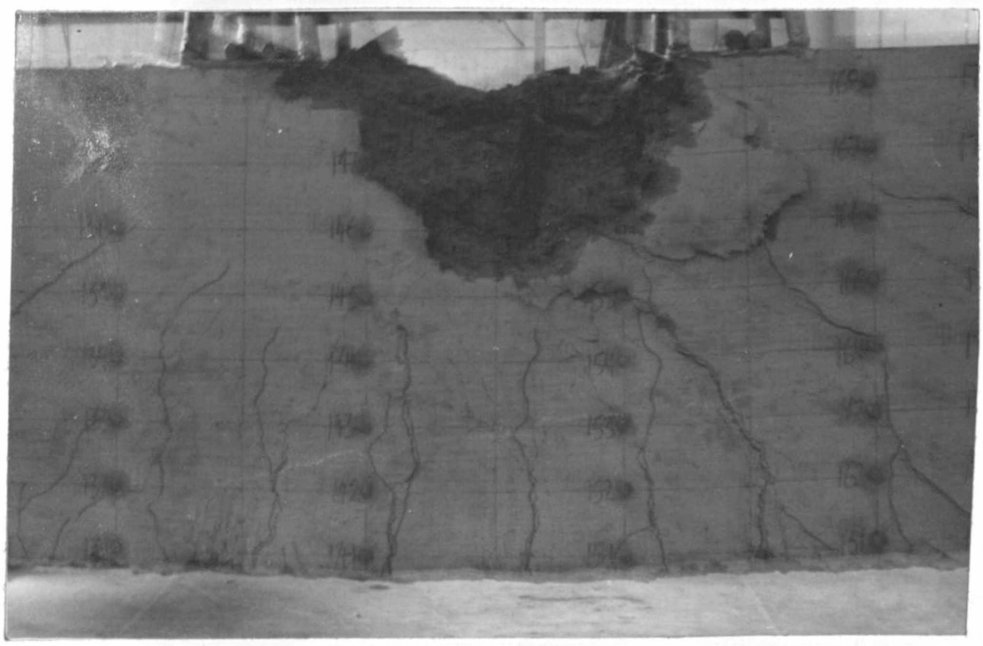


Plate C.4 : Failure, Beam CFT-TB 8

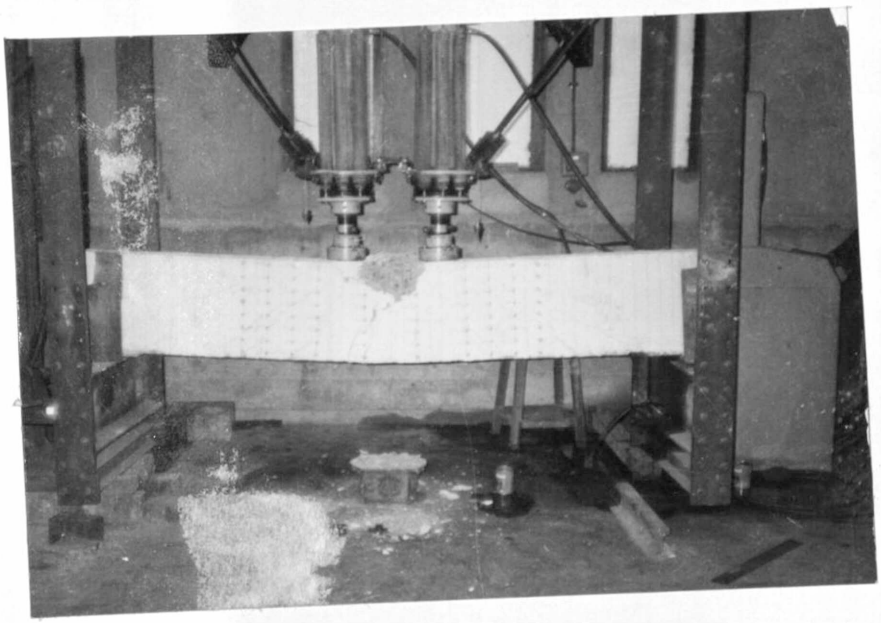


Plate C.5 : Failure, Beam CFT TB5

APPENDIX D

EVALUATION OF SHEAR FLOW AT COMPRESSION STEEL LEVEL

D.1 Shear Flow Distribution for Sections with High Top Longitudinal Steel Content

As was pointed out in Chapter 3, the suggested shear flow distribution for the development of the theory applies only to cases with nominal longitudinal steel content in the compression zone. A high top longitudinal steel content will significantly affect the shear flow distribution. The shear flow value at the top steel level may be calculated in such cases by consideration of Figure D.1.

The compression force, C_t, on the element shown in Figure D.1(c)is balanced by the resultant, $T-C_{AB}$ of the compression force on the rest of the section and the tension force in the bottom steel. The distance of the point of action, $j_T d_1$, from the extreme compression fibre is given by:-

$$(T - C_{AB})\, j_T d_1 + C_{AB} j_c d_1 - T d_1 = 0$$

$$j_T d_1 = \frac{T d_1 - C_{AB} j_c d_1}{T - C_{AB}} \quad \ldots\ldots\ldots\ldots \text{(D.1)}$$

The symbols are as defined on Figure D.1

The elemental moment on the section due to the force C_t is given by:-

$$M_t = C_t j_T d_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(D.2)}$$

Differentiating,

$$\frac{\partial M_t}{\partial x} = \frac{\partial C_t}{\partial x} j_T d_1 + C_t d_1 \frac{\partial j_T}{\partial x} \quad \ldots\ldots \text{(D.3)}$$

But $\frac{\partial C_t}{\partial x} = q_t$ and $\frac{\partial M_t}{\partial x} = V_t$, the shear due to change in moment on the free body diagram of Figure D.1(c).

Hence using equation (D.3)

$$V_t = q_t j_T d_1 + C_t d_1 \frac{\partial j_T}{\partial x}$$

Assuming $C_t d_1 \frac{\partial j_T}{\partial x}$ is negligible,

$$q_t = \frac{V_t}{j_T d_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(D.4)}$$

Now, the shear force, V, is proportional to the moment, M.

$$V = \frac{M}{a} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(D.5)}$$

The compression force, C_t, on element is due to steel and the concrete over depth d_2.

Denote contribution from steel C'_s and concrete C_{ct}. Then

$$C_t = C'_s + C_{ct}$$

$$C'_s = A'_\ell f'_\ell \text{ or } A'_\ell f'_{\ell y} \text{ for post yield range}$$

$$C_{ct} = \alpha\beta f'_c b d_2$$

For steel in elastic range

$$M_t = \alpha\beta f'_c b d_2 \left(j_T d_1 - \frac{d_2}{2}\right) + A'_\ell f'_\ell \left(j_T d_1 - d_2\right)$$

and from equation (D.5)

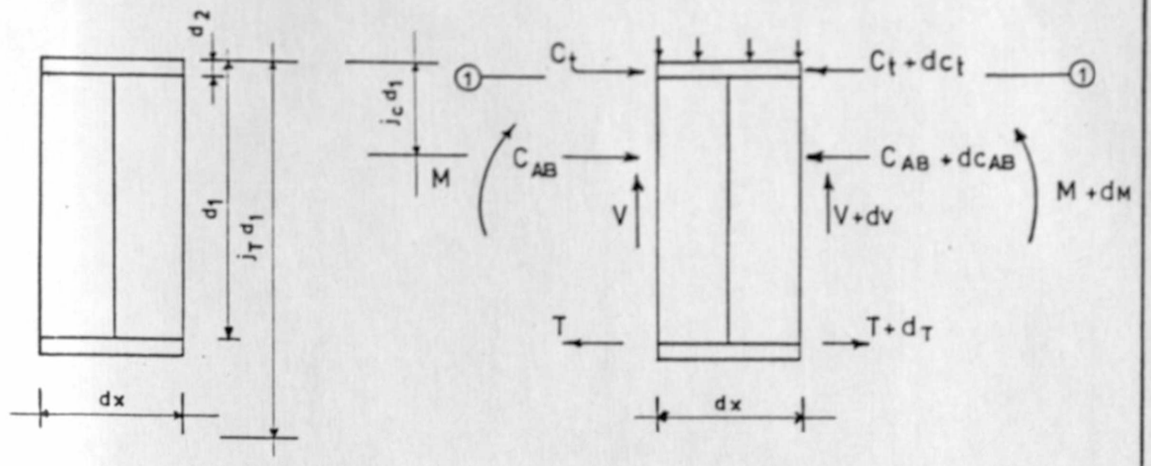
$$V_t = \frac{\alpha\beta f'_c b d_2 \left(j_T d_1 - \frac{d_2}{2}\right) + A'_\ell f'_\ell \left(j_T d_1 - d_2\right)}{a}$$

From equation (D.4)

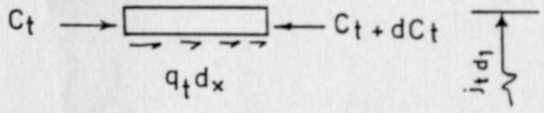
$$q_t = \frac{\alpha\beta f'_c b d_2 \left(2j_T d_1 - d_2\right) + 2A'_\ell f'_\ell \left(j_T d_1 - d_2\right)}{2a j_T d_1} \quad \text{... (D.6)}$$

Hence q_t can be calculated, j_T being obtained from equation (D.1).

The bottom shear flow can now be determined in the manner illustrated in Figure 3.4 (d) and then proceeding as in section (3.2), the shear flow at the neutral axis is calculated by consideration of shear equilibrium leading to four ordinates between which linear variation is assumed. This is illustrated in Figure D.2.



(a) Length of Beam, dx (b) Forces



(c) Determination of Shear Flow at ①-①

C_t = Compression Force over depth d_2

C_{AB} = Total compression Force on section less C_t

Figure D.1: Determination of Shear Flow

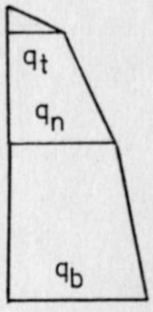


Figure D.2: Shear Flow Distribution