1. GENERAL

1.1 *SCOPE*

This Code of Practice deals with the structural use of concrete in buildings. In the case of service reservoirs and tanks used for the storage of aqueous liquids the recommendations of this code should be modified by the specific requirements given in BS 5337. This code covers the structural use of reinforced concrete, prestressed concrete and precast concrete, the component materials of which are explicitly specified in the Building (Construction) Regulations. Two design options, namely the working stress method as specified in this Code or the limit state method as given in the alternative recommendations of Clause 7. However, recommendations for the limit state method should not be used with recommendations for working stress design in the same building unless compatibility of the two designs can be demonstrated.

It has been assumed in the drafting of this Code that the design of reinforced, prestressed and precast concrete is entrusted to registered structural engineers, for whose guidance it has been prepared, and that the execution of the work is carried out under proper supervision.

1.2 *BRITISH STANDARDS AND CODES OF PRACTICE*

Any reference to a British Standards Institution publication should be construed as follows:—

(1) where a date is included in the reference, the reference is to the edition of that date, together with any amendments, supplements and addenda published at 30th June, 1986;

(2) where no date is included in the reference, the reference is to the edition current at 30th June, 1986 together with any amendments, supplements and addenda published at that date;

(3) any reference to any publication is a reference to so much only as is relevant in the context in which such a publication is quoted.

2. DESIGN: OBJECTIVES AND GENERAL RECOMMENDATIONS

The purpose of design is to ensure an adequate factor of safety against the structure that is being designed becoming unfit for the use for which it is being designed.

2.1 *BASIC REQUIREMENTS*

2.1.1 STABILITY

The strength of the structure should be sufficient to withstand the design loads taking due account of the possibility of overturning or buckling caused by elastic or plastic instability, having due regard to the effects of sway when appropriate.

The structure should be designed to support loads caused by normal function, but there should be a reasonable probability that it will not collapse catastrophically under the effect of misuse or accident. The layout of the structure on plan, and the interaction between the structural members, should be such as to ensure a robust and stable design. No structure can be expected to be resistant to excessive loads or forces that could arise due to an extreme cause, but it should not be damaged to an extent disproportionate to the original cause.

In addition, due to the nature of a particular occupancy or use of a structure it may be necessary in the design concept or a design reappraisal to consider the effect of a particular hazard and to ensure that, in the event of an accident, there is an acceptable probability of the structure remaining after the event, even if in a damaged condition.

2.1.2 STIFFNESS

Structural members should possess adequate stiffness to prevent such deflection or deformation as might impair the strength or efficiency of the structure, or produce cracks in finishes or in partitions. The structure as a whole should possess adequate stiffness such that the maximum lateral deflection due solely to wind forces does not exceed 1/500 of the building height.

2.1.3 FIRE RESISTANCE

Structural members should possess the following properties when subjected to fire: retention of structural strength, resistance to penetration of flames, and resistance to heat transmission.

2.1.4 DURABILITY

The concrete cover to the reinforcement and the cement content of the concrete should meet the durability requirements of the structures. Where exceptionally severe environments are encountered, however, additional precautions may be necessary, and specialist literature should be consulted with respect to each particular environment.

2.1.5 VIBRATION

Where there is a likelihood of a structure being subjected to vibration from causes such as wind forces or machinery, measures should be taken to prevent discomfort or alarm, damage to the structure or interference with its proper function. Limits to the level of vibration that may be acceptable are described in specialised literature. In certain circumstances, it may be necessary to isolate the source of vibration or, alternatively, to isolate a part or the whole of the structure. Special consideration may be necessary for flexible elements of the structure.

2.1.6 EFFECTS OF TEMPERATURE, CREEP, SHRINKAGE AND DIFFERENTIAL MOVEMENT

Where the environment or the material of a structure so demands, due consideration should be given to the effects of temperature, creep, shrinkage and differential movement.

2.1.7 FATIGUE

When the imposed load on a structure is predominantly cyclic in character, it may be necessary to consider the effects of fatigue.

2.1.8 OTHER REQUIREMENTS

Structures designed for unusual or special functions should comply with any additional requirements pertaining to the proper functioning of the structures.

2.1.9 BASIS OF DESIGN

The method of design should accord with the laws of mechanics and the general principles relating to the design of reinforced or prestressed concrete. Due account should be taken of the worst combination of loads, stresses and deformations at different construction stages.

2.2 *LOADS*

The design dead, imposed and wind loads should be in accordance with the Building (Construction) Regulations. Other loads such as floatation and earth pressure should be adequately designed for.

For ordinary construction the density of reinforced or prestressed concrete may be taken as 2 400 kg/m^3, but where the amount of steel exceeds 2% some greater weight may be more appropriate.

2.3 *MATERIALS*

The material properties used for the purpose of design should be obtained from Fig. 2.1 to Fig. 2.3 and Table 2.1. Idealised properties adopted in subsequent clauses may also be used.

Table 2.1 Short term elastic modulus of concrete

Strength of Concrete at the Appropriate Age or Stage Considered MPa	Modulus of Elasticity E_c MPa
20	18 900
25	20 200
30	21 700
35	22 900
40	24 000
45	26 000

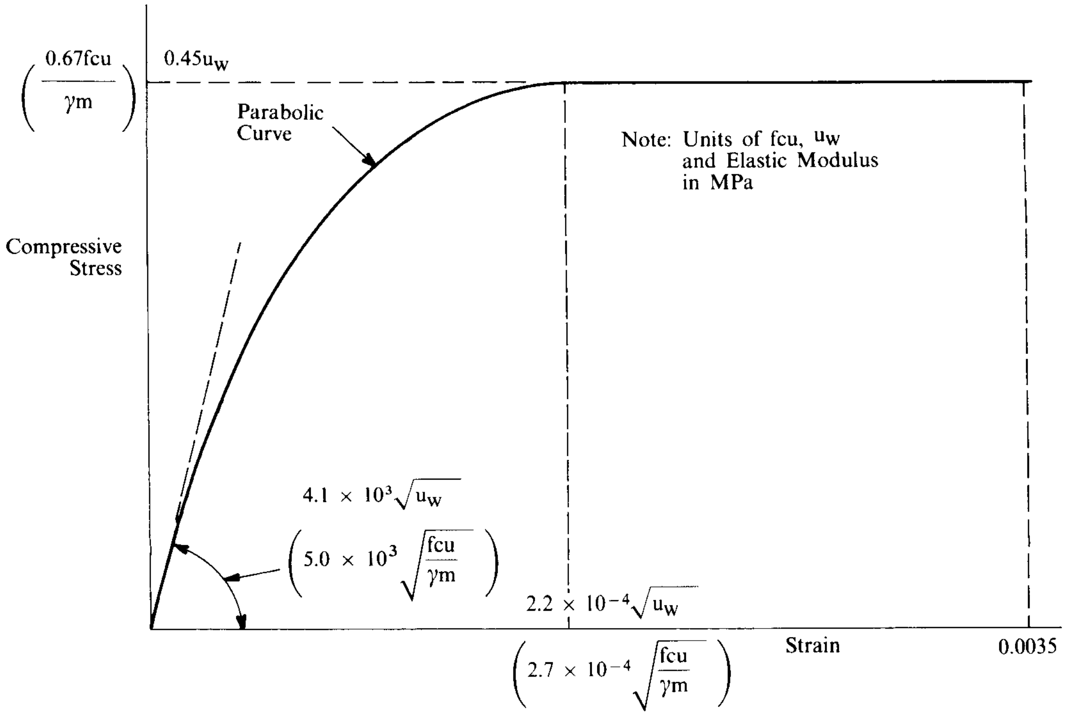

Fig. 2.1 Short term stress-strain curve for normal weight concrete (bracketed values apply to Clause 7)

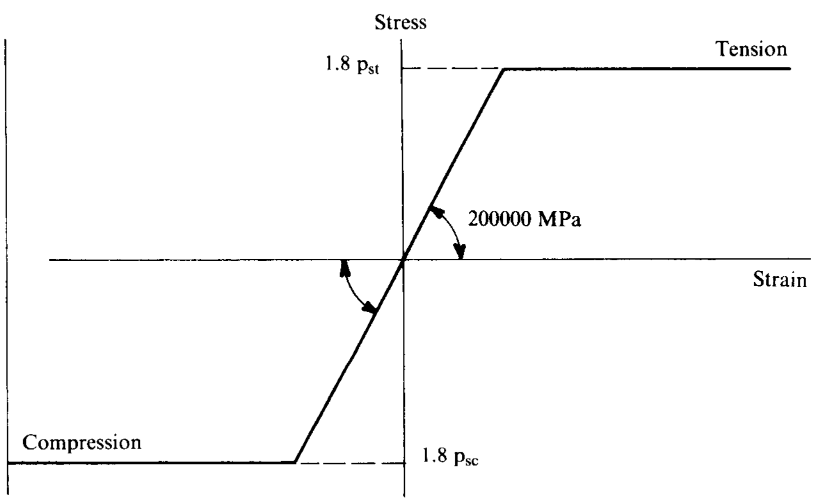

Fig. 2.2 Short term design stress-strain curve for reinforcement

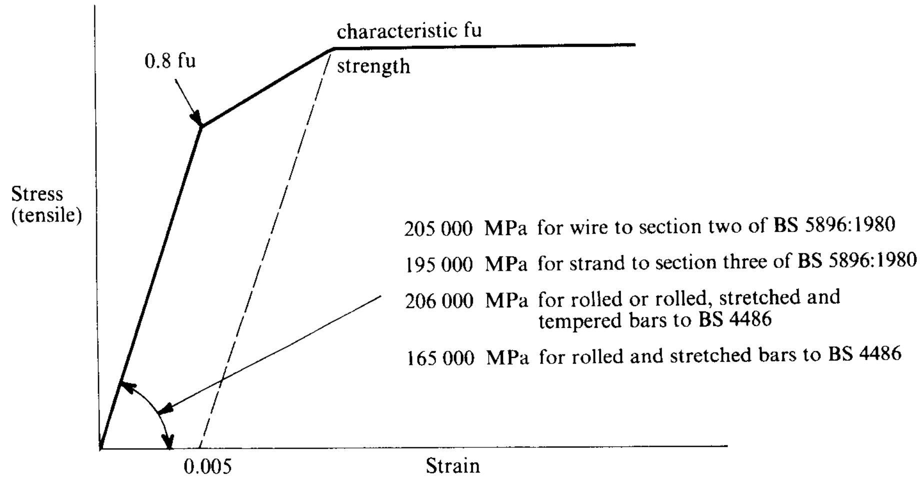

Fig. 2.3 Short term design stress-strain curve for prestressing tendons

3. DESIGN AND DETAILING: REINFORCED CONCRETE

3.1 *GENERAL*

3.1.1 SCOPE

This section gives methods of analysis and design which will in general ensure that, for reinforced concrete structures, the objectives set out in Section 2 are met. Other methods may be used provided that they can be shown to be satisfactory for the type of structure or member considered. In certain cases, the assumptions made in this Section may be inappropriate and a more suitable method should be adopted having regard to the nature of the structure in question.

3.1.2 NOTATION

The notations used in this Code have the following meanings unless otherwise defined:

b is the breadth of the compression flange,

d is the overall depth of the section,

E_c is the modulus of elasticity of concrete,

E_s is the modulus of elasticity of steel,

m is the modular ratio $= E_s/E_c$,

M_r is the moment of resistance of the section,

u_w is the specified grade strength of concrete,

u_t is the specified minimum cube strength at transfer for concrete cubes made in accordance with the requirements of BS1881, but cured under similar conditions to the concrete in the works.

3.1.3 ELASTIC METHOD AND LOAD FACTOR METHOD OF DESIGN OF MEMBERS SUBJECT TO BENDING AND DIRECT FORCE

The elastic theory is concerned with the equilibrium at working stresses of the forces and moments due to the actual loads, the working stresses being the ultimate stresses reduced by a factor of safety.

The load factor method is concerned with the equilibrium at ultimate stresses of the forces and moments due to the actual loads multiplied by a load factor. In order to avoid the confusion of having loads and stresses different from the elastic method, the load factor method was modified and introduced in terms of working stresses specified for the elastic theory with the difference that the plastic stress-strain relations for ultimate conditions were to be assumed in place of the elastic relation of Hooke's law appropriate to working loads in the elastic theory.

The method of design should accord with the laws of mechanics and the general principles relating to the design of reinforced concrete.

It may be assumed that:

(1) at any cross-section plane sections remain plane, and

(2) all tensile stresses are taken by the reinforcement except that the concrete may be assumed to resist diagonal tension within the limits of shear stress specified for concrete in Clause 3.1.4.