### BUILDING (CONSTRUCTION) REGULATIONS

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BUILDING (CONSTRUCTION) REGULATIONS

(Cap. 123, section 38)

[7 February 1975.]

PART I

PRELIMINARY

1. These regulations may be cited as the Building (Construction) Regulations.

2. In these regulations, unless the context otherwise requires—

   “B.S.” means the relevant British Standard published by the British Standards Institution;

   “base” in relation to a wall, means the under side of that part of the wall which immediately rests on the footings or foundation or other structure by which the wall is carried;

   “bulk excavation” means all excavation except excavation for ground investigation, public utility trenches, drains, sewers, piles or caissons;

   “caisson” means a foundation structure achieved by sinking a shell through ground or water for the purpose of placing the foundation at the required depth and shall include deep piers and bored piles exceeding 900 mm in diameter;

   “chimney” means a construction enclosing a flue and attached to or forming part of a building;

   “chimney shaft” means a construction not bonded into a building, enclosing a vertical flue extending to a height above its topmost lateral support greater than 6 times its least horizontal dimension measured at—

   (a) the base of the chimney shaft where it is not supported above the base; or

   (b) the level of the topmost lateral support;

   “chimney stack” means such part of a chimney (or combination of 2 or more chimneys) as is not within a building;

   “cladding” means a structure for the purpose of facing or architectural decoration additional to the external walls of any building;

   “C.P.” means the relevant British Standard Code of Practice published by the British Standards Institution;

   “dead load” means the weight of walls, floors, roofs, partitions and other permanent construction;
"dividing wall" means a wall which is required to be taken into account in pursuance of regulation 51 in deeming another wall to be divided into distinct lengths;

"external wall" means an outer wall of a building not being a party wall, even though adjoining a wall of another building;

"flue" means a duct through which smoke or other products of combustion or fumes from any cooking apparatus or stove or oven, or vitiated air, pass or are intended to pass for the purpose of reaching the open air;

"imposed load" means load other than dead load and includes wind pressure;

"incombustible material" means a material which neither burns nor gives off inflammable vapours in sufficient quantity to ignite at a pilot flame when heated in the manner specified in the appropriate provisions of B.S. 476:1932 and "combustible material" shall be construed accordingly;

"lateral support" in relation to a wall or pier means support which resists movement in the direction of the thickness of the wall or in the direction of the thickness or width of a pier;

"load bearing" in relation to any part of a building (including the foundation) means any such part bearing a load other than that due to its own weight and to wind pressure on its own surface;

"load factor" means the ratio of ultimate load of a member to its working load;

"partition wall" means any internal wall not being a dividing wall, external wall or party wall;

"party wall" means a wall forming part of a building and used or constructed to be used for the separation of adjoining buildings belonging to different owners or occupied or constructed or adapted to be occupied by different persons;

"plain concrete" means concrete complying with the provisions of regulation 19 in which no reinforcement is included for structural purposes but in which reinforcement may be provided for the purpose of restraining shrinkage or other movement;

"prestressed concrete" means concrete in which predetermined stresses are induced to counteract the stresses due to dead and imposed loads for the purpose of eliminating or decreasing the tensile stresses in concrete due to bending and shear;

"public building" means a building used or intended to be used either ordinarily or occasionally as—

(a) a place of public worship or for instruction other than a place so used and being part of a domestic building;

(b) a hospital:
(c) a restaurant having a seating capacity for more than 100 persons; and

(d) a place of public entertainment or assembly to which persons are admitted by ticket or otherwise;

"reinforced concrete" means concrete not inferior to that designated Grade III in regulation 19 and reinforced by reinforcement which complies with the provisions of regulation 20;

"safe bearing capacity" means the intensity of the loading due to the weight and imposed loads of any proposed building works including earth works (if any) that the ground under a foundation will safely carry without risk of shear failure irrespective of any consolidation settlement that may result;

"shell lime" means lime formed by burning sea shells or other like marine calcium deposits;

"storey-height" for the purposes of regulations 64 to 67 means the height of that part of a wall or pier which is between the level of one lateral support and the level of the lateral support next above or (if there is no such lateral support above) the top of such wall or pier;

"ultimate bearing capacity" means the value of the net loading intensity in the ground on any horizontal plane at which the ground fails in shear.

3. All materials used in the construction of any building shall—

(a) be of a suitable nature and quality for the purposes for which they are used;

(b) be adequately mixed or prepared; and

(c) be applied, used or fixed so as adequately to perform the functions for which they are designed.

4. The Building Authority may permit in writing subject to such conditions as he may endorse thereon the use of any type of material or any method of mixing or preparing materials or of applying, using or fixing materials which conforms with a British Standard Specification or a British Standard Code of Practice prescribing the quality of material or standards of workmanship:

Provided that in the event of more than one such Standard or Code having been issued, the type of material or method used shall conform with the latest edition and any published amendments thereto unless in these regulations a specific edition of Standard or Code is required to be adopted.

5. Every building shall be so designed and constructed as to be capable of sustaining safely and transmitting all the dead and imposed loads without exceeding the appropriate limitations of permissible stresses.
6. Where load is transmitted through plain concrete, brickwork or other similar material, the angle of dispersion of the load through that material shall be taken as not more than 45° with the direction of the load.

7. No building shall be subjected to load beyond its proper bearing capacity:

Provided that this regulation shall not apply with respect to any load which may be required or permitted by the Building Authority for the purpose of testing.

8. Where demolitions or other building works are carried out which may affect adversely any adjoining or other building or street, such building or street shall be provided with adequate support.

PART II

MATERIALS

9. (1) Every brick and building block shall be composed of hard well-burned clay, natural or cast stone, concrete or other incombustible material of like hardness and durability and shall possess resistance to crushing not less than those respectively specified in Table I.

(2) Cast stone and concrete blocks shall be cured at normal temperatures until they attain the strengths specified in Table I and in any case for not less than 4 weeks.

(3) Every brick and building block shall be of such size, shape and surface as to permit of proper bonding and jointing.

(4) Where bricks and building blocks are formed with cavities, hollows or perforations—

(a) the volume of such cavities, hollows or perforations shall not exceed \( \frac{1}{2} \) the total volume of the brick or building block;

(b) such cavities, hollows or perforations shall be so disposed that the aggregate width of solid material measured at right angles horizontally to the face of such brick or building block shall be not less than \( \frac{1}{3} \) of the width thereof at any one place;

(c) no wall of any cavity, hollow or perforation shall be less than 20 mm;

(d) such bricks or building blocks shall be so laid as not to provide harbourage for vermin;

(e) no chase or recess shall be formed in such bricks or building blocks;

L.N. 294/76.
such bricks or building blocks may be used in load bearing walls only—

(i) in single storey buildings;
(ii) in 2-storey domestic buildings; or
(iii) for enclosing the top storey of a building.

**TABLE 1**

**Bricks and building blocks**

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<thead>
<tr>
<th>Description of brick or building block</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Resistance to crushing in MPa of gross horizontal area</td>
</tr>
<tr>
<td>External or internal (load bearing)</td>
<td>solid</td>
</tr>
<tr>
<td>External or internal (load bearing)</td>
<td>hollow</td>
</tr>
<tr>
<td>External (panel) (non-load bearing)</td>
<td>solid or hollow</td>
</tr>
<tr>
<td>Internal (partition) (non-loading bearing)</td>
<td>solid or hollow</td>
</tr>
</tbody>
</table>

10. Cement shall be—

(a) ordinary Portland cement in conformity with the appropriate provisions of B.S. 12:Part 2:1971; or

(b) rapid hardening Portland cement in conformity with the appropriate provisions of B.S. 12:Part 2:1971; or

(c) Portland blast-furnace cement in conformity with the appropriate provisions of B.S. 146:Part 2:1973; or

(d) any other cement approved by the Building Authority.

11. Stone lime shall consists of—

(a) quicklime formed by burning a natural rock or other suitable material at such a temperature that it will slake when brought into contact with water; or

(b) dry hydrated lime in the form of a fine dry powder produced by treating quicklime so as to produce a dry, sound product:

Provided that the calcium and magnesium compounds present in the lime as oxides shall be not less than 70 per cent by weight.
12. (1) Sand shall—

(a) consist of naturally occurring sand, crushed stone or a combination of both;

(b) be hard, clean and free from adherent coatings;

(c) contain no appreciable amount of clay balls or pellets;

(d) contain no greater proportion of fine clay, silt or fine dust (being such clay, silt or dust as will pass through a 25 μm sieve) than—

(i) 5 per cent by mass in the case of naturally occurring sand; and

(ii) 10 per cent by mass in the case of crushed stone.

(2) Sand shall contain no harmful material in sufficient quantity adversely to affect the hardening strength or durability of the mortar, plaster or concrete, or, in the case of reinforced concrete, to attack the reinforcement.

13. Red earth shall consist of decomposed rock containing not more than 15 per cent of clay. It shall contain no harmful material in sufficient quantity adversely to affect the hardening strength or durability of the mortar or plaster.

14. Water shall be clean fresh water free from harmful matter.

15. (1) Cement mortar shall be composed of cement and sand in the proportion of one volume of cement to not less than 2 nor more than 4 volumes of sand.

(2) Lime or red earth may be added to such cement mortar in the proportion of not more than 25 per cent of the cement in volume.

16. Cement-lime mortar shall be composed of cement, sand and stone lime or shell lime, mixed by volume in the proportions shown in Table II.

### TABLE II

<table>
<thead>
<tr>
<th>Cement</th>
<th>Lime: 1</th>
<th>Sand: 4</th>
<th>Lime: 1</th>
<th>Sand: 2</th>
<th>Lime: 1</th>
<th>Sand: 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min.</td>
<td>2</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Max.</td>
<td>3</td>
<td>Min.</td>
<td>Max.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Maximum ratio of the volume of cement to the volume of sand

Table: 1:12 where stone lime is used.
1:9 where shell lime is used.

Note: Not more than 25 per cent of the volume of sand may be replaced by an equal volume of red earth.
17. (1) Lime mortar shall be composed of stone lime or shell lime, sand or red earth mixed by volume in the proportions shown in Table III.

(2) Lime mortar with a base of shell lime shall not be used in the construction of any load bearing wall.

<table>
<thead>
<tr>
<th>TABLE III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime mortar</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Stone lime</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Note: Not more than 25 per cent of the volume of sand may be replaced by an equal volume of red earth.

18. (1) Aggregate for plain concrete shall consist of sand, well-burnt brick, well-burnt tile, well-burnt clinker, stone or any other material of which the Building Authority may approve. It shall be so graded as to make a sound concrete.

(2) Aggregate for reinforced concrete shall—

(a) consist of sand and crushed stone;

(b) be hard, strong and durable and reasonably clean and free from clay, organic or other harmful matter;

(c) being fine aggregate, be of such size that—
   
   (i) at least 90 per cent by mass will pass a 5 mm mesh screen; and
   
   (ii) not more than 15 per cent by mass will pass a 150 μm mesh;

(d) being coarse aggregate, be of such size that—
   
   (i) not more than 10 per cent by mass will pass a 5 mm mesh screen; and
   
   (ii) at least 95 per cent by mass will pass a mesh of a size 6 mm less than the minimum lateral distance between reinforcing bars, or 6 mm less than the minimum cover, whichever is the smaller, or in the case of solid slabs will pass a 20 mm mesh screen; and

(e) be so graded as to make a dense concrete.
(3) Notwithstanding paragraph (2) but subject to paragraph (2)(d)(ii). aggregate for reinforced concrete shall conform with the appropriate provisions of B.S. 882: Part 2:1973:

Provided that fine aggregate of grading zone 4 as given in Table II of B.S. 882: Part 2:1973 may be used only in special and designed concrete mixes.

Concrete.

19. (1) Concrete shall be composed of aggregate mixed with cement and water.

(2) The fine aggregate and coarse aggregate shall be measured separately.

(3) The proportions of cement to aggregate shall be those specified in Tables IV, V and VI for the appropriate grade of concrete:

Provided that—

(a) the use of any admixture shall be subject to the approval of the Building Authority;

(b) where the Building Authority approves the use of a cement under regulation 10(d) the proportions of cement of aggregate shall be those approved by the Building Authority; and

(c) where the Building Authority is of the opinion that in any particular case other proportions will produce a suitable grade of concrete, he may permit such proportions for that case.

(4) (a) Concrete designated as Grades I—V in column 1 of Table IV and having the resistance to crushing specified for such grades in the last column of that Table shall be known as “ordinary” concrete.

(b) Concrete designated as Grades IA—IIB in column 1 of Table V and having the resistance to crushing specified for such grades in the last column of that Table shall be known as “Quality A” concrete.

(5) The quantity of water used for making concrete shall not exceed that required to ensure that the concrete is uniformly mixed, can be readily placed and worked into position, and will make a sound concrete.

(6) Concrete shall

(a) be deposited before setting has commenced and without segregation of the materials;

(b) be adequately consolidated by tamping or any other means, including vibrating, approved by the Building Authority:
(c) remain undisturbed after consolidation until hardened sufficiently to withstand safely any stresses to which it may be subjected; and

(d) be adequately protected from the weather, from premature drying, or other causes of damage until it has hardened.

(7) Notwithstanding the provisions of paragraph (3) but subject to the provisions of regulations 157 to 165 and the First and Second Schedules, concrete mixes may be designed to possess a resistance to crushing within the ranges specified in Table VI subject to the mix limitations in that Table being complied with and such mixes shall be known as special mixes or designed mixes.

(8) In the application of Tables IV and V—

(a) (i) cement shall be measured by weight;
    (ii) aggregate may be measured by weight;
    (iii) the weight required shall be determined from the volume given in the Tables and the mass per cubic metre of the aggregate; and
    (iv) the proportions given in the tables are for dry aggregates and where the aggregates are moist due allowance must be made for bulking; and

(b) (i) concrete shall satisfy the requirement for resistance to crushing at 28 days after mixing;
    (ii) the resistance to crushing at 7 days after mixing may be used as a control but a sufficient number of tests at 28 days after mixing shall be made to confirm that the gain in strength between 7 and 28 days is satisfactory; and
    (iii) the respective ratio of resistances to crushing at 7 and 28 days shown in the Tables are appropriate for ordinary Portland cement and where rapid hardening Portland cement alters the ratio it is to be adjusted accordingly.

(9) In the application of Table VI—

(a) the weights of aggregate given in the Table are based on the density of crushed granite, and should be adjusted accordingly for aggregate with a density different from crushed granite; and

(b) the ratio of the resistance to crushing within 7 days after mixing to the resistance to crushing within 28 days after mixing shall be taken as 1:1.3 for intermediate resistances within the limits specified in Table VI.

(10) High alumina cement concrete shall not be used in general building works except with the written approval of the Building Authority.
TABLE IV

Ordinary concrete: grades I to V

<table>
<thead>
<tr>
<th>Designation</th>
<th>Nominal mix</th>
<th>Total volume of aggregate per 45 kg of cement</th>
<th>4 Aggregate</th>
<th>5 Cement</th>
<th>6 Fine</th>
<th>7 Coarse</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>1–1–2</td>
<td>0.1</td>
<td>1</td>
<td>0.03</td>
<td>0.07</td>
<td>15</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.04</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade II</td>
<td>1–1 ½–3</td>
<td>0.14</td>
<td>1</td>
<td>0.05</td>
<td>0.09</td>
<td>13.5</td>
<td>17.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.06</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade III</td>
<td>1–2–4</td>
<td>0.19</td>
<td>1</td>
<td>0.06</td>
<td>0.13</td>
<td>12</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.08</td>
<td>0.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade IV</td>
<td>1–3–6</td>
<td>0.29</td>
<td>1</td>
<td>0.1</td>
<td>0.19</td>
<td>8.6</td>
<td>11.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.12</td>
<td>0.17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade V</td>
<td>1–4–8</td>
<td>0.38</td>
<td>1</td>
<td>0.13</td>
<td>0.25</td>
<td>6.5</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.15</td>
<td>0.23</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Sum of volumes of fine and coarse aggregates measured separately.

TABLE V

Quality A concrete: grades IIA to IIIA

<table>
<thead>
<tr>
<th>Designation</th>
<th>Nominal mix</th>
<th>Total volume of aggregate per 45 kg of cement</th>
<th>4 Aggregate</th>
<th>5 Cement</th>
<th>6 Fine</th>
<th>7 Coarse</th>
<th>8 Preliminary tests</th>
<th>9 Works tests</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade IIA</td>
<td>1–1–2</td>
<td>0.10</td>
<td>1</td>
<td>0.03</td>
<td>0.07</td>
<td>32</td>
<td>41</td>
<td>24</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.04</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade IIIA</td>
<td>1–1 ½–3</td>
<td>0.14</td>
<td>1</td>
<td>0.05</td>
<td>0.09</td>
<td>26</td>
<td>34</td>
<td>20</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.06</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade IIIA</td>
<td>1–2–4</td>
<td>0.19</td>
<td>1</td>
<td>0.06</td>
<td>0.13</td>
<td>21</td>
<td>27</td>
<td>16</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>0.08</td>
<td>0.11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Sum of volumes of fine and coarse aggregates measured separately.
TABLE VI

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Designation</strong></td>
<td><strong>Mix proportions</strong></td>
<td><strong>Minimum resistance to crushing in MPa</strong></td>
<td><strong>Method of test</strong></td>
</tr>
</tbody>
</table>
| **Special mixes** | not leaner than 45 kg cement to 360 kg total aggregate nor richer than 45 kg cement to 130 kg total aggregate | within 7 days after mixing—  
(i) preliminary tests 15 to 34;  
(ii) works tests 12 to 26 | First Schedule Parts I & IV |
| &nbsp; | within 28 days after mixing—  
(i) preliminary tests 20 to 45;  
(ii) works tests 15 to 34 | &nbsp; | &nbsp; |
| **Designed mixes** | not leaner than 235 kg cement per cubic metre of finished concrete nor richer than 530 kg cement per cubic metre of finished concrete | within 7 days after mixing—  
12 to 32 | First Schedule Parts I & V |
| &nbsp; | within 28 days after mixing—  
15 to 41 | &nbsp; | &nbsp; |

20. Reinforcement for concrete shall be—

(a) hot rolled steel bars in conformity with the appropriate provisions of B.S. 4449:1969;

(b) hard drawn mild steel wire in conformity with the appropriate provisions of B.S. 4482:1969;

(c) cold worked steel bars in conformity with the appropriate provisions of B.S. 4461:1969;

(d) steel fabric in conformity with the provisions of B.S. 4483:1969; or

(e) such other reinforcement as the Building Authority may approve as being suitable, having regard to the particular circumstances of the case.

21. All structural and rivet steel used in building shall, before fabrication—

(a) comply with either—

(i) Grade 43, B.S. 4360 relating to mild steel for general structural purposes; or

(ii) Grade 50, B.S. 4360 relating to high yield stress (welding quality) structural steel, whichever is appropriate; or

(b) be such structural and rivet steel as the Building Authority may approve.
22. (1) Structural timber shall be---
   (a)  (i) Oregon Douglas Fir (*Pseudotsuga taxifolia* (Poiret) Britton);
        (ii) Longleaf Pine or Pitch Pine (*Pinus palustris* Miller);
        (iii) Shortleaf Pine or Pitch Pine (*Pinus echinata* Miller); or
        (iv) Keruing (*Dipterocarpus* Spp.),
   which for the purpose of these regulations shall be known as Class A timber;
   (b)  (i) Canadian Spruce (*Picea glauca* (Moench) Voss);
        (ii) European Larch (*Larix decidua* Miller), Red Pine
            (*Pinus resinosa* Aiton);
        (iii) Western Hemlock (*Tsuga heterophylla* (Rehanske) Sargent),
            Common Spruce or White Fir (*Picea abies* (Linnaeus) Karsten); or
        (iv) Red Meranti/Red Seraya/Red Luaun (*Shorea* Spp.),
   which for the purpose of these regulations shall be known as Class B timber; or
   (c)  such other timber as the Building Authority may approve
        as being suitable, having regard to the particular circumstances of the case.

23. Materials for damp-proofing shall consist of---
   (a) sheet lead or sheet copper;
   (b) asphalt;
   (c) self finished bitumen impregnated felt laid in bitumen;
   (d) a core of sheet lead and bituminized hessian cloth between
       2 layers or coats of bitumen surfaced with talc or other
       suitable material;
   (e) a core of sheet lead between 2 layers of bituminized felt
       fibre coated with bitumen and surfaced with talc or other
       suitable material; or
   (f) any other suitable material or combination of materials,
       which the Building Authority may approve as being durable,
       impervious to moisture and in all other respects suitable for their purpose,
       having regard to the particular circumstances of the case.
PART III

LOADS

24. (1) Every building, including its foundations, shall be designed to the satisfaction of the Building Authority to resist the combined effects, as well as the separate effects, of dead and imposed loads and wind loads on walls and roofs, including internal wind pressures, for winds from any direction.

(2) A building shall be deemed to be designed in accordance with paragraph (1) in respect of wind load if its design complies with the Code of Practice on Wind Effects published from time to time by the Building Authority.

L.N. 268/83.

25. (1) In calculating dead load, the unit weights of the materials shall be deemed to be—

(a) those specified in B.S. 648:1964 in the case of material therein mentioned; and

(b) in the case of any other materials, such unit weights as may be ascertained to the satisfaction of the Building Authority.

L.N. 294/76.

(2) The dead load of any partitions whereof the positions are not definitely located in the design of the building, shall be deemed to be a uniformly distributed load \( m^2 \) of the floor on which the partitions are to be created of 30 per cent of the estimated dead weight per metre run of those partitions but no less than 1 kPa/m² if that floor or part of a floor is used for office purposes.

(3) In all cases the imposed loads to be provided for shall be ascertained to the satisfaction of the Building Authority but, subject to the provisions of this regulation—

(a) the minimum imposed loads (not including induced wind loads) for the floors, roofs, stairs and landings and corridors and cantilever steps of the types specified in Table VII and for slabs forming part of, and for beams supporting such floors, roofs, stairs and landings and corridors and cantilever steps, shall be—

(i) the loads specified in column 3 of Table VII; or

(ii) the loads specified in column 4 or 5, as the case may be, of Table VII,

whichever shall be the heavier;

(b) for the purpose of ascertaining the reactions to be allowed for in calculating the loads on columns, piers, walls or foundations, the minimum imposed loads (not including induced loads from wind effects) shall be either—

(i) the loads specified in column 3 of Table VII; or

(ii) as ascertained to the satisfaction of the Building Authority,

whichever shall be the heavier; and
(c) the imposed loads to be provided for types of floors, roofs, stairs and landings and corridors and cantilever steps not mentioned in Table VII shall be ascertained to the satisfaction of the Building Authority.

<table>
<thead>
<tr>
<th>Class No.</th>
<th>Types of floors, roofs, stairs etc.</th>
<th>Slabs kN uniformly distributed over the span per metre width</th>
<th>Beams kN uniformly distributed over span</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Floors for—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>domestic buildings of not more than 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>storeys, in I occupation;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dormitories; hospital wards,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>bedrooms, toilet rooms;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>hotel and motel private sitting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rooms, bedrooms, toilet rooms</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.......................................</td>
<td>2.0</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>.......................................</td>
<td>11.5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Floors for—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>domestic buildings (other than those of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>class No. 1); hospital dining— rooms,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>operating theatres, consulting</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rooms, X-ray rooms (equipment to be</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>determined, but not less than);</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>workrooms, light, without central</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>power driven machines and storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.......................................</td>
<td>2.5</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>.......................................</td>
<td>14.3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Floors for—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>college and school classrooms,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>lecture theatres; college and school</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>laboratories (equipment to be</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>determined, but not less than);</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>offices above the entrance floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>.......................................</td>
<td>3.0</td>
<td>7.0</td>
</tr>
<tr>
<td></td>
<td>.......................................</td>
<td>17.0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Floors for—</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>assembly areas with fixed seating;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>banking halls; chapels, churches</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>and places of worship (with fixed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>seating); garages for vehicles</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>not exceeding 2½ tonnes gross weight;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>kitchens other than in domestic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>buildings (equipment to be</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>determined, but not less than);</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>laundries other than in domestic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>buildings (equipment to be determined, but not less than); office entrance floors and office floors below the entrance floor; retail shops for display and sale of merchandise; workrooms with central power driven machines</td>
<td>4.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Class No.</td>
<td>Types of floors, roofs, stairs etc.</td>
<td>Slabs kPa uniformly distributed over the span per metre width</td>
<td>Beams kN uniformly distributed over span</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------</td>
<td>------------------------------------------------------------</td>
<td>------------------------------------------</td>
</tr>
</tbody>
</table>
| 5 | Floors for—
  art galleries;
  assembly areas without fixed seating;
  dance halls;
  department stores;
  grandstands with fixed seating;
  hotel and motel bars, vestibules;
  lounges and dining-rooms;
  libraries (excluding library stack rooms);
  office for storage and normal filing purposes;
  public halls and lounges;
  restaurants and night clubs;
  theatres;
  warehouses, workshops and factories and other buildings or parts of buildings of similar category for light-weight loads | 5.0 | 12.0 | 28.5 |
| 6 | Floors for—
  boiler rooms (equipment to be determined but not less than);
  motor rooms, fan rooms and the like (equipment to be determined, but not less than);
  stages;
  warehouses, workshops, factories and other buildings or parts of buildings of similar category for medium weight loads;
  garages for vehicles not exceeding 4 tonnes gross weight | 7.5 | (For garage floors only) 1.5 × maximum wheel load or 9 kN whichever is the greater, considered to be distributed over a floor area 750 mm square. |
| 7 | Floors for—
  book stores, stationery stores, library
  stack rooms and the like;
  warehouses, workshops, factories and other buildings or parts of buildings of similar category for heavy weight loads | 10.0 | — | — |
| 8 | Flat roofs—
  (a) where no access is provided to the roof (other than such access as may be necessary for cleaning and repair work) | 0.75 | — | — |
  (b) where access (in addition to such access as may be necessary for cleaning and repair work) is provided to the roof | 1.5 | 3.5 | 8.5 |
### 9. Types of floors, roofs, stairs etc.

<table>
<thead>
<tr>
<th>Class No.</th>
<th>Types of floors, roofs, stairs etc.</th>
<th>Slabs kN uniformly distributed over the span per metre width</th>
<th>Beams kN uniformly distributed over span</th>
</tr>
</thead>
</table>
| 9         | *Pitched roofs (where no access is provided to the roof) having an inclination to the horizontal*  
(a) of 30 degrees or less  
(i) with corrugated roof sheeting of metal or asbestos cement  
(ii) with other types of roofing  
(b) of 75 degrees or more  
(c) more than 30 degrees and less than 75 degrees | 0.5 | — |
|           |                                    | 0.75 | — |
|           |                                    | Nil  | — |
|           | to be determined by interpolation according to the pitch. |             |                          |

### 10. Types of stairs and landings, corridors and cantilever steps

| (a) stairs, ramps, landings and corridors used in connexion with floors of class No. 1, 2 or 3 | 3.0 | — |
| (b) stairs, ramps, landings and corridors used in connexion with floors of class No. 4 or 5 | 5.0 | — |
| (c) stairs, ramps, landings and corridors used in connexion with floors of class No. 6 or 7 | 10.0 | — |
| (d) structurally independent cantilever steps | 1.5 kN point load at the unsupported end of each step, or a uniformly distributed load as appropriate to (a), (b) or (c), whichever is the greater. |

### 11. Areas to be used by tourist coaches, goods delivery vans, and other commercial vehicles not exceeding 12 tonnes gross weight

80% of Type HA loading as specified in Appendix A to B.S. 153:Part 3A:1972.

**Note:** *Specified loading is applied vertically.*

### (4) In calculating the total imposed load (not including induced wind loads) on any column, pier, wall or foundation, the minimum imposed loads for every floor carried thereby may be deemed to be subject to the reductions specified in Table VIII:

Provided that, in factories and workshops whereof the minimum imposed load is more than 7.5 kPa, or is more than 6.0 kPa but not more than 7.5 kPa, the total imposed load shall be not less than that obtained if all the floors had been designed for an imposed load of 7.5 kPa or 6.0 kPa respectively without the reductions specified in Table VIII.
TABLE VIII
Reductions of minimum imposed loads

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of floors carried by member under consideration</td>
<td>Percentage reduction of minimum imposed load on all floors above the member under consideration</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>5 or more</td>
<td>40</td>
</tr>
</tbody>
</table>

(b) Where a single span of beam supports not less than 45 m² of floor at any one level, the minimum imposed load (not including induced wind load), for the purpose only of determining the design of the beam, may be deemed to be subject to a reduction of 5 per cent for each complete 45 m² of that floor so supported but not more than 20 per cent in all.

(c) The reduction specified in sub-paragraph (a) or (b), whichever is the greater, may be taken into account in calculating the total load on any column, pier, wall or foundation.

(d) The reductions specified in sub-paragraphs (a), (b) and (c) shall not apply with respect to—

(i) the floors of factories and workshops whereof the minimum imposed load per m² is 6 kN or less;

(ii) the floors of warehouses, of garages, and floors used for storage purposes; or

(iii) induced wind load.

(5) Parapets, handrails and balustrades, together with the connexions and members which give them immediate structural support, shall be designed for the following minimum horizontal static loads (which shall be assumed to act at handrail or coping level) or for wind effects (where applicable)—

(a) stairways, landings and balconies for domestic buildings in single occupancy—0.35 kN/m;

(b) balustrades, parapets, handrails and barriers in places of assembly or in garages—2.2 kN/m;

(c) all other stairways, landings and balconies and all parapets, handrails and balustrades to roofs and retaining walls—0.75 kN/m.

(6) No building or part of a building shall be deemed to comply with paragraph (5) with respect to any moving load or loads from machinery inducing vibration unless adequate provision for all dynamic effects has been made to the satisfaction of the Building Authority.
26. (1) The test load for any structure or part of a structure, excepting for piles and foundations, shall be such that the total load during the test includes the full dead load plus \(1\frac{1}{4}\) times the imposed load (not including induced wind load), for which that structure or that part thereof has or should have been designed. This load shall be maintained for a period of 24 hours before removal.

(2) During the test adequate struts strong enough to take the whole of the dead load and test load shall be placed in position leaving a gap under the members to be tested. The test load shall not be applied to a reinforced concrete structure until at least 28 days after the date of concreting.

(3) The structure or that part thereof under test shall be deemed to be satisfactory if all the following conditions are met within their limits—

(a) no structural defects, signs of weakness or faulty construction can be observed; and

(b) the maximum deflexion during the test shall not exceed \(\frac{1}{360}\) of the span \(\frac{1}{180}\) of the span for cantilevered members; and

(c) within 24 hours after removal of the applied test load, the recovery of deformation shall be not less than—
   (i) in the case of a reinforced concrete or steel framed structure, 75 per cent; and
   (ii) in the case of a timber structure, 50 per cent,

of the maximum deflexion during the test.

(4) The Building Authority may require a re-test of a structure or part of a structure to be carried out with the same loading, and conditions where the recovery is—

(a) in the case of a reinforced concrete or steel framed structure, less than 75 per cent but not less than 50 per cent; or

(b) in the case of a timber structure, less than 50 per cent but not less than 40 per cent.

(5) If on re-test of a structure or part of a structure under paragraph (4) the recovery is at least—

(a) in the case of a reinforced concrete or steel framed structure, 75 per cent; or

(b) in the case of a timber structure, 50 per cent,

of the maximum deflexion during the re-test, the structure or part shall be deemed to be satisfactory.

27. (1) In every storey of every building with a designed imposed load (not including wind load) of 5 kPa and over, there shall be exhibited by the owner, at each staircase or at some other appropriate place, permanently and conspicuously, a notice in
English and Chinese incised or embossed, of metal, plastic or other suitable material, in letters and figures not less than 15 mm high, stating the imposed load for which the floor has been designed, in the following form—

**BUILDINGS ORDINANCE**

*(Chapter 123)*

**NOTICE**

The imposed load on this floor is not to exceed ................................ kilograms per square metre.

(2) Where floors of different rooms or different parts of floors have been designed for different imposed loads, a notice in the form in paragraph (1) shall be suitably displayed in each room or on each part of the floor, as the case may be, indicating the variations.

**PART IIIA**

**SITE FORMATION WORKS**

27A. (1) Site formation works shall be designed and constructed so that during construction and thereafter there is an adequate margin of safety of the works and the remainder of the site.

(2) The carrying out of site formation works shall not render inadequate the margin of safety of, or cause damage to, any building, structure or land.

**PART IIIB**

**BULK EXCAVATION**

27B. Bulk excavation in the scheduled area shall not be carried out below levels to be determined by the Building Authority.

**PART IIIC**

**GROUND INVESTIGATION**

27C. All ground investigation in the scheduled area shall be designed and carried out to the satisfaction of the Building Authority.
PART IV

FOUNDATIONS

28. The foundations of every building shall be designed and constructed so as to be capable of sustaining and transmitting safely all the dead and imposed loads to the ground without impairing the stability of that or of any other building, street, hillside or slope, nullah or service.

29. Foundations shall be—

(a) constructed of plain or reinforced concrete; and

(b) at a depth below the surface of the ground sufficient to—
   (i) secure adequate bearing capacity of the ground;
   (ii) avoid interference with drains, nullahs, sewers or other services in adjacent streets, roads or lanes;
   (iii) avoid overloading the foundations of adjacent buildings or the ground supporting such foundations; and
   (iv) avoid creating unstable conditions in hillsides or slopes;

(c) of such thickness, not being less than 150 mm. and of such width as may be necessary to comply with the provisions of regulations 5 and 6:

Provided that where the foundation rests on sound hard rock the thickness of concrete need be no more than is necessary to provide a suitable level surface on which to construct the building; and

(d) symmetrically under the centre of action of the load:

Provided that where the foundation is subjected to bending moment or eccentric loading, it shall be so designed, as to comply with regulations 5 and 33.

30. (1) Where foundations are proposed to be constructed an investigation of the site shall be undertaken to establish, to the satisfaction of the Building Authority, the type and character of the ground on which the foundations are to be placed.

(2) Where the initial investigation does not establish beyond doubt that the ground is in all respects suitable for the purpose of supporting the foundations without the risk of undue settlement instability, further tests must be undertaken appropriate to the ground conditions and the size and complexity of the building works and to the satisfaction of the Building Authority.

(3) Soil tests carried out under paragraph (2) shall be conducted in accordance with the relevant provisions of C.P.: 2001 (1957), Site Investigation.

(4) In all cases the data obtained from adjoining sites may be used in support of the investigation undertaken.
31. (1) In the design of foundations, consideration shall be
given to—

(a) the probable differential settlement of the building; and

(b) the probable total settlement of the building.

(2) Where appreciable variations in ground conditions occur
on a site on which a new building or an extension to an existing
building is proposed to be erected special consideration shall be
given to probable differential settlement and, if the Building
Authority so requires, calculations of the estimated settlements shall
be provided.

(3) The estimated differential settlement shall in no case induce
an estimated angular distortion in excess of \(\frac{1}{300}\) in any part of
the proposed structure unless the Building Authority is satisfied that in
the special circumstances of the case an estimated angular distortion
in excess of \(\frac{1}{300}\) is acceptable.

32. (1) The safe bearing capacity of the ground shall have a
factor of safety of not less than 3 on the ultimate bearing capacity.

(2) Unless adequate tests are carried out to justify higher
values the safe bearing capacity adopted shall not exceed that
specified in Table IX for the appropriate type of ground.

33. (1) The pressure on the ground under any foundation
shall not exceed the allowable bearing pressure which shall be the
safe bearing capacity or such lesser value as may be necessary for the
control of settlement or for the safety of adjacent cuttings or slopes,
to the satisfaction of the Building Authority.

(2) Where it is proposed to exceed the values in Table IX, the
allowable bearing pressure for rock—

(a) shall be determined with due regard to all the circum-
stances, including the depth of foundations, the jointing of
the rock and the spacing, dip, thickness and degree of
weathering of the joints; and

(b) shall not exceed the permissible bearing pressure of the
material of the foundation.

(3) For decomposed granite and decomposed volcanics where
approved tests show that the safe bearing capacity exceeds the values
specified in Table IX, the allowable bearing pressure for shallow
foundations shall not exceed 2 times the value specified in Table IX
or such lesser value as may be required under paragraph (1).

(4) For cohesive soils where approved tests show that the safe
bearing capacity exceeds the values specified in Table IX, the
allowable bearing pressure shall not exceed \(1\frac{1}{2}\) times the value
specified in the Table IX or such lesser value as may be required
under paragraph (1).

(5) For non-cohesive soils—

(a) whenever there is a risk of the ground water level rising to
a depth below the base of the foundation of less than the
width of that foundation, the allowable bearing pressure shall not exceed the submerged bearing capacity or such lesser value as may be required under paragraph (1):

(b) where the foundation is less than 1 metre in width, the allowable bearing pressure shall not exceed the safe bearing capacity multiplied by the actual width of the foundation measured as a decimal fraction of a metre or such lesser value as may be required under paragraph (1):

(c) the allowable bearing pressure may be increased by 5 per cent for each 0.3 m of depth below the lowest ground surface adjacent to the foundation:

Provided that it shall not exceed 2 times the safe bearing capacity specified in Table IX or such lesser value as may be required under paragraph (1).

(6) The allowable bearing pressure used in the design of foundations for resisting the combined effect of dead and imposed loads may be increased by not more than 25 per cent where such increase is solely due to wind loads.

### TABLE IX

<table>
<thead>
<tr>
<th>Type of ground</th>
<th>Safe bearing capacity kPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rock (granite and volcanics)—</td>
<td></td>
</tr>
<tr>
<td>(a) massive crystalline rock in hard sound condition (core recovery greater than 85%)</td>
<td>5 000</td>
</tr>
<tr>
<td>(b) medium hard rock (core recovery greater than 50%)</td>
<td>3 000</td>
</tr>
<tr>
<td>(c) soft rock (core recovery of 50% and less)</td>
<td>1 000</td>
</tr>
<tr>
<td>(d) closely jointed and heavily shattered rock</td>
<td>To be assessed after inspection and testing.</td>
</tr>
<tr>
<td>2. Cohesive soils (for individual footings only)—</td>
<td></td>
</tr>
<tr>
<td>(a) stiff clay (cannot be moulded in the fingers)</td>
<td>250</td>
</tr>
<tr>
<td>(b) medium clay (can be moulded by strong pressure in the fingers)</td>
<td>150</td>
</tr>
<tr>
<td>(c) soft clay (easily moulded in the fingers by firm pressure)</td>
<td>50</td>
</tr>
<tr>
<td>3. Intermediate soils (decomposed granite and decomposed volcanics)—</td>
<td></td>
</tr>
<tr>
<td>(a) compact</td>
<td>300</td>
</tr>
<tr>
<td>(b) loose (dry)</td>
<td>200</td>
</tr>
<tr>
<td>(c) loose (wet)</td>
<td>100</td>
</tr>
<tr>
<td>Dry</td>
<td>Submerged</td>
</tr>
<tr>
<td>4. Non-cohesive soils—</td>
<td></td>
</tr>
<tr>
<td>(a) compact gravel and sand-gravel mixtures</td>
<td>400 200</td>
</tr>
<tr>
<td>(b) loose gravel and sand-gravel mixtures and compact coarse sand</td>
<td>300 150</td>
</tr>
<tr>
<td>(c) loose coarse sand and compact fine sand</td>
<td>200 100</td>
</tr>
<tr>
<td>(d) loose fine sand</td>
<td>100 50</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>---</td>
<td>------------------------</td>
</tr>
<tr>
<td></td>
<td>Type of ground</td>
</tr>
<tr>
<td>5</td>
<td>Made ground and fill</td>
</tr>
</tbody>
</table>

Note: In the above table, the terms used shall be deemed to have the following meanings—
compact — a soil which requires the use of a pick for removal;
loose — a soil which is readily removable by shovelling only;
dry — that the ground-water level is at a depth of not less than 1 m or the width of the foundation, whichever is the greater, below the base of the foundation;
core recovery (rock) — the actual length of the core of rock, taken by means of rotary drills fitted with a coring bit, expressed in percentage of every 1.5 m interval of depth the coring is advanced into the rock.

34. The pressure on plain or reinforced concrete in foundations shall not exceed those specified in Table X.

### TABLE X

**Pressure on concrete or reinforced concrete foundations**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Designation as specified in regulation 19</td>
</tr>
<tr>
<td>Grade IA</td>
<td>7 800</td>
</tr>
<tr>
<td>II A</td>
<td>6 500</td>
</tr>
<tr>
<td>III A</td>
<td>5 300</td>
</tr>
<tr>
<td>Grade I</td>
<td>5 400</td>
</tr>
<tr>
<td>II</td>
<td>4 700</td>
</tr>
<tr>
<td>III</td>
<td>4 200</td>
</tr>
<tr>
<td>IV</td>
<td>2 100</td>
</tr>
<tr>
<td>V</td>
<td>1 600</td>
</tr>
</tbody>
</table>

35. (1) All piling used in connexion with the foundations of any building shall, to the satisfaction of the Building Authority, be of adequate load bearing capacity and of an approved type and each pile shall—

(a) be of material of such quality as to be durable and strong enough to carry its load without exceeding the appropriate limitations of permissible stresses and, where plain or reinforced concrete piles are used, the average compressive stress on the nominal cross sectional area shall not exceed 5 MPa;

(b) comply with regulation 5 and be designed so as to be capable of sustaining the working load with a safety factor appropriate to the type of pile and the method of design adopted;
(c) be driven or constructed, in accordance with the design of the foundation and type of pile, to the satisfaction of the Building Authority and, in the case of driven piles, be driven in such a manner so as not to damage the material of the pile or any adjacent piles;

(d) be spaced from adjacent piles at not less than the perimeter of the pile or 1 m, measuring in each case from centre to centre, whichever is the greater:

Provided that—

(i) in the case of piles bearing on rock, the spacings may be reduced to not less than 750 mm or 2 times the least width of the pile, whichever is the greater; and

(ii) where any pile has been placed incorrectly, any displacement of the pile exceeding 75 mm in plan from the designed position shall be taken into account in the foundation design;

(e) in the case of precast reinforced concrete piles, be designed and constructed so that the handling stresses do not exceed the permissible stress in bending for concrete and reinforcement specified in Table XXVII and XXIX respectively and so that the driving stresses do not exceed 2 times the permissible stress in direct compression specified in Table XXVII;

(f) if of timber, be—

(i) stripped of bark and treated with an approved preservative process; and

(ii) after driving and before the capping is placed, be cut to sound wood at the top end so that the cut off level is below the probable permanent ground water level;

(g) be capped with plain or reinforced concrete of quality not inferior to that designated Grade III in regulation 19; and

(h) be adequately restrained against lateral movement at the top of the pile.

(2) Piled foundations shall be designed and constructed so as to carry safely all dead and imposed loads on the foundations and any lateral loading to which the foundations may be subjected.

(3) Where 5 or more piles are placed in such proximity that the capacity of the piles to sustain loading may be affected by other piles a pile group shall be deemed to exist and the allowable load on any group of piles shall not—

(a) exceed the sum of the safe bearing capacities of the piles in the group multiplied by a group reduction factor of 0.85:

Provided that—

(i) in special circumstances and having regard to the nature of the ground and the size of the group, the group reduction factor may be increased with the approval of
the Building Authority, and the Building Authority may require the group reduction factor to be decreased;

(ii) no group reduction factor shall be applied where the piles bear on rock of category 1(a), (b) or (c) of Table IX; or

(b) cause the average vertical pressures in the ground penetrated by, or underlying the piles, to exceed the allowable bearing pressures of such ground.

(4) (a) Where piles are driven through subsiding fills or other subsiding strata and derive support from underlying firmer materials, consideration shall be given to the downward frictional forces which may be imposed on the piles by the subsiding upper strata, and the bearing capacity of each pile as determined by test or calculated by formula shall be reduced by the amount of the total downward frictional force.

(b) For the purposes of this paragraph, the total downward frictional force may be estimated as the cohesion of remoulded specimens of the soils multiplied by the surface area of the pile or the full weight of the ground between and around the piles in the subsiding strata, whichever is the lesser.

(5) Where any doubt exists as to the capacity of any pile to sustain adequately and without undue settlement the load for which it has been designed the pile shall be tested by means of the imposition of a test load, which load shall be 2 times the load for which the pile was designed and which shall be maintained for 72 hours and if the total settlement recorded exceeds 15 mm the pile shall be deemed to be unsatisfactory:

Provided that in any particular case the Building Authority may direct the pile to be tested by any other method to the satisfaction of the Building Authority, in which case the standard of acceptance shall be determined to the satisfaction of the Building Authority.

(6) The authorized person or registered structural engineer shall keep or cause to be kept accurate records of materials and principal dimensions of each pile and other data relevant to the particular type of pile used and shall submit 2 copies of such records to the Building Authority.

36. Where the ground adjacent to any building exerts pressure upon or causes the application of load to any part of that building, such building shall be constructed so as to be capable of sustaining safely and transmitting that pressure or load without exceeding the appropriate limitations of permissible stresses.

37. Where footings are required to spread loads from walls to foundations, the bricks or building blocks below the base of such walls shall increase downwards by regular offsets not exceeding \( \frac{1}{3} \) the thickness of the brick or building block on 1 or both sides of such walls. Such bricks or building blocks shall, where possible, be laid as headers.
38. (1) All caissons shall be constructed of plain or reinforced concrete not inferior to that designated as Grade IIIA in regulation 19.

(2) Where underground water is encountered during concreting the permissible unit compressive stress under the maximum load from the superstructure, and all other loads, including negative frictional forces, shall not exceed 80 per cent of the permissible direct compressive stresses of concrete as specified in regulation 116 or 157.

(3) Where dewatering is to be undertaken the procedure for carrying out this operation and any precautionary measures to avoid settlement of any adjoining buildings, streets or land shall be to the satisfaction of the Building Authority.

(4) Excavation for caissons shall be carried out with due precautions to prevent the migration of subsoil.

(5) Where any doubt exists as to the capacity of any caisson to sustain, adequately and without undue settlement, the load for which it has been designed the caisson shall be tested—

(a) by means of core drilling of the completed in-situ concrete, in which case—

(i) the core drilling shall be taken through the full depth of the caisson;

(ii) the core drilling shall be carried down to not less than 600 mm into the ground upon which the caisson is founded;

(iii) the completed core so taken shall be properly marked and arranged in order for inspection on site by representatives of the Building Authority; and

(iv) the necessary crushing tests shall be carried out by an independent testing authority; or

(b) by any other method to the satisfaction of the Building Authority, in which case, the Building Authority shall determine the standard of acceptance to be adopted.

(6) The authorized person or registered structural engineer shall keep or cause to be kept accurate records of—

(a) materials used in, and principal dimensions of, each caisson constructed;

(b) soil layers excavated; and

(c) all tests carried out on the bearing strata or the concrete laid,

and shall submit 2 copies of such records to the Building Authority.

39. (1) Where improvement of ground bearing capacity under the foundation is to be achieved by grouting the ground under the foundation with cement or other mixtures, adequate proof of the suitability of the method and materials to be used shall be given to the satisfaction of the Building Authority.
(2) Where grouting treatment has been carried out, adequate tests of the treated ground, to the satisfaction of the Building Authority, shall be made.

(3) Where the grout or the pressure from the grout may affect adjoining or nearby buildings, drainage, nullahs, sewers, streets, slopes or hillsides adequate precautionary measures, to the satisfaction of the Building Authority, shall be taken.

PART V
SITES AND FLOORS

40. (1) The ground surface within the external walls of every building shall be covered with a layer of concrete, not inferior to that designated Grade V concrete in regulation 19, finished smooth on the upper surface. Such concrete shall have a thickness of—

(a) not less than 150 mm of Grade V concrete where the concrete is laid on ground;

(b) not less than 100 mm where it is—
   (i) not inferior to Grade V concrete and is laid on a consolidated bed consisting of clinker, broken bricks or other similar materials not less than 75 mm thick; or
   (ii) not inferior to Grade III concrete; or
   (iii) reinforced to comply with regulation 5.

(2) Paragraph (1) shall not apply to any building which is—

(a) to be used solely—
   (i) as a foundry or blacksmith's shop;
   (ii) for the milling or storage of timber;
   (iii) for the storage of acids and chemicals which are injurious to concrete;

(b) of 1 storey—
   (i) open on 2 or more sides; or
   (ii) intended to be used solely for the storage of builder's materials or plant; or
   (iii) intended to be used solely as a greenhouse, or tool shed, and does not communicate by any door, window or other opening with any building to which paragraph (1) applies.

(3) Where in any part of a building the layer of concrete required by paragraph (1) is also a floor of the building, that layer shall be constructed of concrete not inferior to Grade III, not less than 100 mm thick, and laid on a consolidated bed not less than 75 mm thick constructed of clinker, broken bricks or other similar materials.
(4) Where in any part of a building the floor next above the ground is constructed of plain or reinforced concrete, constructed so as to leave between it and the ground an air space, ventilated in accordance with paragraph (5) and enclosed so as to prevent its use for any other purpose, such floor may be deemed to be the layer of concrete required by paragraph (1).

(5) (a) An enclosed space under a floor shall be ventilated on at least 2 sides with air-bricks or otherwise, having an open area of not less than the equivalent of 4000 mm²/m of external wall. No single opening in any such air-brick or ventilator shall exceed 5 mm in its least dimension.

(b) Where the flow of air may be obstructed in places by solid construction, ducts of a total area equal to not less than 2 times the total area of the opening in the air-bricks or other ventilator in the external walls shall be formed in such solid construction.

41. (1) The ground surface of every area, back yard or alleyway of every building (unless exempted as a garden) shall be covered with

(a) a layer of concrete not less than 100 mm thick and not inferior to Grade V;

(b) stone or brick paving bedded and jointed in cement mortar;

(c) a layer of bituminous macadam 75 mm thick finished smooth with a stopping of fine bituminous macadam 25 mm thick; or

(d) a layer of such other impervious material as the Building Authority may approve.

(2) Such surface covering shall be laid to fall at a gradient of not less than 1 in 80 to a gulley trap or drainage channels connected to a surface water drain.

42. The floor of every room to which a water supply is provided shall be constructed of concrete or such other impermeable material as the Building Authority may approve.

43. The level of the floor next above the ground of every building shall be not less than 150 mm above the level of the surface of the external ground, paving or oversite concrete at the entrance to that floor.

44. (1) Where in any part of a building the floor next above the ground is constructed of wood, it shall be so constructed as to leave an air-space not less than 225 mm deep between the level of the underside of the joists and the level of the upper surface of the layer of concrete required by regulation 40(1) and that space shall be so ventilated as to comply with the requirements of regulation 40(5).
(2) The provisions of paragraph (1) shall not apply where a continuous damp-proof membrane complying with the requirements of regulation 23 is provided between the concrete and the floor.

45. (1) Every wood floor shall be constructed of tongued and grooved boards, strips or blocks and shall be—

(a) where of boards or strips, nailed or otherwise securely fixed to floor joists; or

(b) where of blocks, fixed to a screeded concrete sub-floor with asphalitic bitumen or coal tar or other adhesive as the Building Authority may approve.

(2) Every wood block floor bedded on concrete in contact with the ground shall be provided with a continuous damp-proof layer to protect the timber against rising damp, and such damp-proof layer shall not be inferior to a layer of hot bituminous adhesive of sufficient thickness to prevent the wood from coming into contact with the concrete.

46. Every skirting shall be solidly bedded against the wall to which it is attached.

PART VI

WALLS AND PIERS

47. The walls of all buildings shall be constructed of—

(a) bricks or building blocks bonded and solidly put together with mortar;

(b) concrete not inferior to Grade V;

(c) reinforced concrete; or

(d) any of the foregoing materials in combination with a framework of steel or reinforced concrete.

48. Buildings which exceed 4 storeys or 15 m in height shall be constructed—

(a) with a frame work of steel or reinforced concrete;

(b) with load bearing walls of reinforced concrete;

(c) with a combination of (a) and (b); or

(d) by any other method of construction approved by the Building Authority.

49. (1) Except where paragraph (2) applies, walls constructed of bricks, building blocks or plain concrete other than panel walls, shall comply with the provisions of—

Construction of wood floors.

Skirting.

Construction and bonding of walls.

Buildings over 4 storeys or 15 m in height.

L.N. 284/76.

Application of regulations.
(a) regulations 71 and 72; and

(b) (i) regulations 50 to 63; or
(ii) regulations 64 to 67.

(2) In the case of a building where the imposed floor load exceeds 7.5 kPa, the load bearing walls shall be designed and constructed in accordance with regulation 129.

50. (1) For the purposes of regulations 52 and 53, the height of the lowest or only storey shall be measured from the base of the wall, and the height of any other storey shall be measured from the level of the underside of the floor structure of the storey to the level of the underside of the floor structure next above it or, if there is no such storey, then to the highest part of the wall or, in a storey comprising a gable to \( \frac{1}{4} \) the height of the gable.

(2) The height of a party wall comprising a gable shall be measured from its base to the base of the gable; the height of any other wall comprising a gable shall be measured from its base to \( \frac{1}{4} \) the height of the gable; and the height of any wall not comprising a gable shall be measured from its base to its highest part excluding any parapet which does not exceed 1 200 mm in height.

51. (1) For the purposes of regulations 52 and 53, walls shall be deemed to be divided into distinct lengths by piers, buttresses, chimneys or dividing walls. Such piers, buttresses, chimneys or dividing walls shall be bonded into the walls, and—

(a) in the case of a pier or buttress shall—
   (i) extend upwards from the base of the wall to the top of the wall;
   (ii) be, at any height, not less in thickness (measured so as to include the wall) than 3 times the thickness of the wall; and
   (iii) be not less in breadth than 2 times the thickness of the wall;

(b) in the case of a chimney shall have a horizontal sectional area, excluding any fireplace opening or flue, of not less than the area required for a pier or buttress and an overall thickness of not less than 3 times the thickness of the wall it is deemed to divide; and

(c) in the case of a dividing wall shall, if an internal load bearing wall, comply with the requirements of regulation 54(1) and in any case be of a thickness of at least \( \frac{1}{4} \) of that prescribed by regulation 52 or 53 in respect of the wall which it is deemed to divide and shall have a length measured at right angles to the buttressed wall equal to not less than \( \frac{1}{4} \) of its height.
(2) All measurements of length of walls shall be made from the centres of the return walls, dividing walls, piers, buttresses or chimneys.

52. Except as provided in regulations 60 and 68 every external and every party wall built of bricks or building blocks in a building other than a public building or a building of the warehouse class shall be—

(a) of not less thickness than that specified in Table XI;

(b) built in cement mortar or cement-lime mortar containing not more than 6 volumes of sand to 1 volume of cement.

**TABLE XI**

*Thickness of external and party walls of buildings other than public buildings or buildings of the warehouse class*

<table>
<thead>
<tr>
<th>Height of wall</th>
<th>Length of wall</th>
<th>Thickness of wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 m not exceeding</td>
<td>3 m not exceeding</td>
<td>225 mm throughout.</td>
</tr>
<tr>
<td>3.5 m</td>
<td>9</td>
<td>340 mm throughout the lowermost storey; 225 mm throughout the rest of the wall.</td>
</tr>
<tr>
<td>7 m</td>
<td>9</td>
<td>340 mm throughout the lowermost storey; 225 mm throughout the rest of the wall.</td>
</tr>
<tr>
<td>11 m</td>
<td>9</td>
<td>460 mm throughout the lowermost storey; 340 mm throughout the next 2 storeys; 225 mm throughout the rest of the wall.</td>
</tr>
</tbody>
</table>

53. (1) Except as provided in regulation 68 every external and every party wall built of bricks or building blocks in a public building or a building of the warehouse class where the imposed floor load does not exceed 7.5 kPa shall—

(a) be built in cement mortar or cement-lime mortar containing not more than 6 volumes of sand to 1 volume of cement;
(b) have a thickness at the top and for 5 m below the top of not less than 340 mm:

Provided that it may be not less than 225 mm for—

(i) a wall having 1 storey height not exceeding 3.5 m;
(ii) the topmost storey height of a wall where that wall does not exceed 7 m in height.

(2) Every such wall being of the height and length specified in Table XII shall have a thickness at the base not less than that specified in that Table.

(3) The thickness of the intermediate parts of such wall between the base and 5 m below the top shall be of not less thickness than that obtained if the wall were to be built solid throughout the space between straight lines drawn on each side of the wall and joining the thickness at the base to the thickness at 5 m below the top.

(4) Notwithstanding paragraph (1)(b), offsets shall not be made in a wall between the base and the top thereof, except at the level of lateral supports.

| TABLE XII |
|---|---|---|
| Thickness of external and party walls of public buildings and buildings of the warehouse class |

<table>
<thead>
<tr>
<th>Height of wall</th>
<th>Length of wall</th>
<th>Thickness at base</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not exceeding 7 m</td>
<td>Any length</td>
<td>340 mm</td>
</tr>
<tr>
<td>Exceeding 7 m and not exceeding 11 m</td>
<td>Not exceeding 11 m</td>
<td>340 mm</td>
</tr>
<tr>
<td></td>
<td>Exceeding 11 m</td>
<td>460 mm</td>
</tr>
<tr>
<td>Exceeding 11 m</td>
<td>Not exceeding 11 m</td>
<td>460 mm</td>
</tr>
<tr>
<td>Not exceeding 15 m</td>
<td>Exceeding 11 m</td>
<td>575 mm</td>
</tr>
</tbody>
</table>

54. (1) Every internal load bearing wall built of bricks or building blocks (not being a party wall) shall have a thickness not less than \( \frac{1}{4} \) that required under regulation 52 or 53, as the case may be, for an external or party wall of the same height but 2 times the length, and in any case not less than 225 mm.

(2) A non-load-bearing partition wall, adequately restrained laterally on all 4 edges may be of a thickness such that when 3 times its height is added to its length the total does not exceed 200 times its thickness.

55. (1) (a) Notwithstanding the provisions of regulations 52, 53 and 54(1), openings and recesses may be formed in walls to which the provisions of such regulations apply.
(b) No such recess shall reduce the width of any wall to less than 225 mm.

(c) The aggregate width of all recesses and openings formed at any 1 level shall not exceed \( \frac{3}{4} \) the length of the wall at that level.

(d) Where the wall is a buttressing wall, every recess or opening at any level shall be at a distance from the buttressed wall of not less than \( \frac{1}{4} \) the height of the buttressing wall.

(2) An arch or lintel sufficient to support the superstructure shall be built of incombustible material over every recess or opening in any wall.

(3) (a) Openings may be formed in party walls other than those separating parts of the building in different ownership.

(b) Such openings shall be fitted with self-closing doors in frames, the whole so constructed as to be fire resisting for at least \( \frac{1}{2} \) hour.

(c) In any row of houses or terrace exceeding 35 m in length or consisting of more than 6 houses or tenements, party walls without openings shall be provided at a distance apart not exceeding 35 m, or 6 houses or tenements, whichever is the less.

(d) Where openings in party walls are closed, bricks or solid building blocks not less than 225 mm in thickness or reinforced concrete not less than 100 mm in thickness shall be used.

(4) For the purpose of this regulation, the expression "recess" shall include any chase or other reduction in the required thickness of a wall.

56. (1) A wall shall not be subject to loads other than distributed loads:

Provided that any wall may be subject to any concentrated load which is transmitted to that wall by a beam, column, pier or other structural member, having such bearing on the wall and such additional support as shall be necessary to comply with the requirements of regulation 5.

(2) For the purposes of this regulation, joists set at distances apart not exceeding 1 m shall be deemed to compose a distributed load.

57. (1) Subject to the provisions of regulation 55, where any part of any wall overhangs any part beneath it, it shall—

(a) be in addition to the required thickness of that wall; and

(b) be corbeled out or otherwise supported to comply with regulation 5.
(2) The projection of any corbelling shall not exceed \( \frac{1}{4} \) of the thickness of the wall immediately below that corbelling.

58. (1) Where the level of the ground or of the surface of the site concrete is different on 1 side of a wall to that on the other, the width of such wall in a building built of bricks or building blocks shall be not less than \( \frac{1}{4} \) of such difference of level.

(2) If such difference in level exceeds 1.8 m, the wall shall be designed and built as a retaining wall and in accordance with regulation 48 of the Building (Planning) Regulations.

59. (1) Subject to the provisions of paragraph (2)—

(a) a 1-storey building, other than a domestic building, whose width measured in the direction of the span of the roof does not exceed 9 m and the height of whose walls does not exceed 3 m, or

(b) a garage, greenhouse, store, water-closet or other room (attached to a domestic building) not intended to be used for habitation and not exceeding 3 m in height,

may have external walls not less than 100 mm thick.

(2) (a) Where any such wall exceeds 2.5 m either in height or length it shall be bonded into piers, 1 of which shall be placed at each end of the wall, not less than 225 mm square in horizontal section, or of such greater size as may be required to give adequate stability.

(b) Where any such wall exceeds 3 m in length additional such piers shall be placed in the wall so as to divide the same into lengths not exceeding 3 m.

(c) All bedding and jointing in such walls and piers shall be in cement mortar.

(d) Such walls shall bear no load other than the distributed load of the roof, which shall be so constructed that the walls are not subject to any lateral thrust therefrom.

60. (1) A load-bearing external or party wall not exceeding 7 m in height and 9 m in length in a building other than a public building or a building of the warehouse class, and, subject to the provisions of regulation 68 a panel wall in any building, may be constructed as a cavity wall.

(2) No storey in a building of cavity wall construction shall exceed a height of 3.5 m.

(3) Cavity walls shall be constructed of solid bricks or building blocks properly bedded and jointed in cement mortar, and shall comprise 2 leaves, each not less than 100 mm thick and an intervening cavity not less than 50 mm and not more than 75 mm wide.
(4) The 2 leaves shall be united—

(a) by iron ties so shaped as not to transmit moisture across the cavity and not less than 20 x 3 mm in cross-section, well galvanized or otherwise protected from corrosion; or

(b) by ties of such other materials and cross-section as to comply with the relevant current British Standard Specification.

(5) Such ties shall be built into the horizontal bed joints during erection and placed at distances apart not exceeding 900 mm horizontally and 450 mm vertically.

(6) Such ties shall also be placed at distances apart not exceeding 300 mm (measured vertically) within 150 mm of the sides of all openings.

(7) The cavity shall during construction be kept free from mortar droppings.

(8) In the case of load-bearing walls the cavity shall extend downwards at least 150 mm below the level of the lower damp-proof course of the wall and in all walls, wherever the cavity is bridged a damp-proof course or flashing shall be provided to direct moisture away from the inner leaf of the wall.

(9) Adequate drainage shall be provided to all cavities through the outer leaf of the wall. The maximum width of any opening for drainage purposes shall not exceed 5 mm.

61. Where glass block panels are built into walls other than party walls—

(a) the opening into which the glass blocks are built shall be so constructed that no load from the building is transferred to the glass blocks;

(b) the maximum area of a single panel shall be 9 m² and the maximum vertical dimension shall be 4.5 m in external walls or 6 m in internal walls.

62. Every parapet to an external or party wall shall—

(a) where built of bricks or building blocks have—

(i) a thickness of not less than 225 mm; and

(ii) a height not more than 6 times its thickness;

(b) where built of reinforced concrete have a thickness of not less than 100 mm.

63. (1) The boundary round the site of any building adjacent to a street or scavenging lane shall be provided with a boundary wall or fence not less than 1.8 m in height unless exempted by the Building Authority.

(2) Every boundary wall of bricks or building blocks shall—

(a) be built in cement mortar or cement-lime mortar;
(b) if not exceeding 1.8 m in height, be not less than 100 mm thick and built solid or honeycombed; and

(c) be provided with buttresses or piers not less than 225 mm square in horizontal section and not more than 2 m apart centre to centre which shall be placed—

(i) at all angles of such wall; and

(ii) at each end thereof unless such wall is bonded into another wall not less in thickness than the buttresses or piers required;

(d) if exceeding 1.8 m in length but not exceeding 3 m in height, be not less than 225 mm thick.

64. (a) The slenderness ratio of any wall or pier of any storey height shall be—

(i) in the case of a wall, the ratio of the effective height to the thickness of the wall, exclusive of plaster or rendering;

(ii) in the case of a pier, the ratio of the effective height to the least lateral dimension.

(b) The effective height of a storey height of a wall or pier shall be as shown in column 2 below—

<table>
<thead>
<tr>
<th>Support to Wall or Pier</th>
<th>Effective Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Wall with lateral support at the top of that storey height</td>
<td>3/4 of the storey height.</td>
</tr>
<tr>
<td>(ii) wall without lateral support at the top of that storey height</td>
<td>1 1/2 times the storey height.</td>
</tr>
<tr>
<td>(iii) pier with lateral support at the top of that storey height</td>
<td>the storey height.</td>
</tr>
<tr>
<td>(iv) pier without lateral support at the top of that storey height</td>
<td>2 times the storey height.</td>
</tr>
</tbody>
</table>

65. (1) Where, in the case of walls or piers built of bricks or building blocks, the slenderness ratio of any storey height does not exceed 1. the compressive stresses in such storey height shall not exceed those specified in Table XIII for the designated bricks or building blocks opposite the specified mixture of mortar.

(2) Where the slenderness ratio of such storey height exceeds 1, the compressive stresses in that storey height shall not exceed the appropriate stress specified in Table XIII multiplied by the factor specified in Table XIV for the slenderness ratio of such storey height:

Provided that the slenderness ratio shall not exceed 18.

(3) The compressive stress shall be deemed to be the sum of the dead and imposed loads distributed uniformly over the area sustaining such load.
TABLE XIII

Maximum compressive stress in MPa in walls and piers of bricks or building blocks when the slenderness ratio does not exceed 1

<table>
<thead>
<tr>
<th>Mix of mortar</th>
<th>Designation of bricks or building blocks, and minimum crushing strength (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cement</td>
</tr>
<tr>
<td>1</td>
<td>0.1*</td>
</tr>
<tr>
<td>1</td>
<td>0.1*</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

* In accordance with regulation 1S, up to \( \frac{1}{2} \) part of lime may be added to cement-mortar.

TABLE XIV

Reduction factor under paragraph 2, for slenderness ratio of walls and piers of bricks and building blocks

<table>
<thead>
<tr>
<th>Slenderness ratio</th>
<th>Factor</th>
<th>Slenderness ratio</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td>10</td>
<td>0.60</td>
</tr>
<tr>
<td>2</td>
<td>0.96</td>
<td>12</td>
<td>0.50</td>
</tr>
<tr>
<td>4</td>
<td>0.88</td>
<td>14</td>
<td>0.40</td>
</tr>
<tr>
<td>6</td>
<td>0.80</td>
<td>16</td>
<td>0.35</td>
</tr>
<tr>
<td>8</td>
<td>0.70</td>
<td>18</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Note: The factor for intermediate values of the slenderness ratio shall be determined by interpolation.

66. (1) Where, in the case of walls or piers built of concrete, the slenderness ratio of any storey height does not exceed 1, the compressive stresses in such storey height shall not exceed those specified in Table XV for the designated grade of concrete.

(2) Where the slenderness ratio of such storey height exceeds 1, the compressive stresses in that storey height shall not exceed the appropriate stress specified in Table XV multiplied by the factor specified in Table XVI for the slenderness ratio of such storey height:
Provided that the slenderness ratio shall not exceed—

(a) in the case of a pier, 18;

(b) in the case of a wall with the minimum reinforcement specified in paragraph (4), 24.

(3) The compressive stress shall be deemed to be the sum of the dead and imposed loads distributed uniformly over the area sustaining such load.

(4) (a) Shrinkage reinforcement shall be provided in all concrete walls.

(b) The volume of that reinforcement shall be not less than 0.4 per cent of the volume of the concrete in the wall, and half of that reinforcement shall be disposed vertically and half horizontally.

(c) The reinforcement shall be disposed near the wall surface and the spacing of bars shall not exceed 300 mm.

**TABLE XV**

Maximum compressive stress in MPa on walls and piers of concrete.

when the slenderness ratio does not exceed 1

<table>
<thead>
<tr>
<th>Designation of concrete, as specified in regulation 19</th>
<th>Maximum permissible stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MPa</td>
</tr>
<tr>
<td>Grade I</td>
<td>5.3</td>
</tr>
<tr>
<td>Grade II</td>
<td>4.7</td>
</tr>
<tr>
<td>Grade III</td>
<td>4.2</td>
</tr>
<tr>
<td>Grade IV</td>
<td>2.1</td>
</tr>
<tr>
<td>Grade V</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**TABLE XVI**

Factor for slenderness ratio of walls and piers built of concrete

<table>
<thead>
<tr>
<th>Slenderness ratio</th>
<th>Factor</th>
<th>Slenderness ratio</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td>12</td>
<td>0.67</td>
</tr>
<tr>
<td>2</td>
<td>0.97</td>
<td>14</td>
<td>0.61</td>
</tr>
<tr>
<td>4</td>
<td>0.91</td>
<td>16</td>
<td>0.55</td>
</tr>
<tr>
<td>6</td>
<td>0.85</td>
<td>18</td>
<td>0.49</td>
</tr>
<tr>
<td>8</td>
<td>0.79</td>
<td>21</td>
<td>0.40</td>
</tr>
<tr>
<td>10</td>
<td>0.73</td>
<td>24</td>
<td>0.31</td>
</tr>
</tbody>
</table>

**Note:** The factor for intermediate values of the slenderness ratio shall be determined by interpolation.
67. (1) The maximum stresses specified in regulations 65 and 66 may be exceeded by not more than 25 per cent where such excess is caused solely by eccentricity of loading or to lateral forces or to a combination of both.

(2) Additional stresses of a purely local nature, as at girder bearings, column bases and lintels or other concentrated loads, are to be calculated and the maximum stress resulting from these combined with those provided for in regulations 65 and 66 and paragraph (1) shall not exceed the permissible stress given in regulations 65 and 66, as the case may be, by more than 50 per cent.

(3) In the case of walls of bricks or building blocks, no reliance shall be placed on the tensile strength of the bricks or building blocks.

68. (1) Where an external wall is constructed of materials used in combination with a framework of steel or reinforced concrete, any part of that wall which does not sustain and transmit any load other than that due to its own weight and to wind pressure on its own surface may be deemed to be a separate panel wall.

(2) In every panel wall constructed, otherwise than as a cavity wall, of bricks, building blocks or plain concrete—

(a) the thickness shall be not less than 225 mm throughout;

(b) the height shall not exceed 7 m;

(c) either the height or the length (whichever is the less) shall not exceed 18 times the thickness; and

(d) the base shall not overhang the beam upon which it is supported, to a greater extent than \( \frac{1}{3} \) of the thickness of the panel.

(3) In every panel wall constructed as a cavity wall—

(a) the provisions of regulation 60 shall be complied with except that the inner leaf may be constructed of solid or hollow bricks or blocks not less than 100 mm thick;

(b) the height shall not exceed 7 m;

(c) either the height or the length (whichever is the less) shall not exceed 3.5 m;

(d) the area shall not exceed 20 m²; and

(e) the base shall not overhang the beam upon which it is supported, to a greater extent than \( \frac{1}{3} \) of the thickness of the overhanging leaf.

Provided that, if the bottom courses are built solid for the full thickness of the panel wall to a height above its base at least equal to that full thickness, the base may overhang the beam to an extent not exceeding \( \frac{1}{3} \) of that full thickness.
(4) In every panel wall constructed of reinforced concrete—
   (a) the thickness shall be not less than 100 mm; and
   (b) the volume of that reinforcement shall be not less than 0.4 per cent of the volume of the concrete in the wall and 1/3 of that reinforcement shall be disposed vertically and half horizontally.

Cladding.

69. (1) Cladding shall—
   (a) be constructed entirely of non-combustible materials, including the frames and sills of windows and doors;
   (b) have its external face constructed of—
      (i) glass;
      (ii) copper or aluminium alloy sheeting;
      (iii) sheet iron or steel protected by vitreous enamel; or
      (iv) such other materials as the Building Authority may approve.

(2) Cladding shall either—
   (a) abut solidly against—
      (i) the end of any wall partition or any column which forms part of an enclosure to a compartment of the building or which forms part of an enclosure to a staircase or other vertical shaft; and
      (ii) any floor or beam; or
   (b) have any voids in these positions filled with non-combustible material to the satisfaction of the Building Authority.

(3) Cladding shall be fixed to the main structure of the building at intervals not exceeding 3.5 m apart vertically and 1.5 m apart horizontally.

(4) The strength, stiffness, stability and durability of the cladding shall be to the satisfaction of the Building Authority.

(5) All fixings securing the cladding to the main structure shall be of stainless steel, phosphor bronze, aluminium bronze or other materials to the satisfaction of the Building Authority.

Party walls to be carried up to roof.

70. (1) Every party wall shall be carried up to the underside of the roof.

(2) Where the roof is constructed of combustible materials—
   (a) no combustible part of such roof shall be carried across the party wall; and
   (b) the roof covering shall be solidly bedded in mortar direct on the top of the party wall for its whole width and length.

Timber not to be built into walls.

71. No floor or roof joist bond timber or wood plate shall be built into the thickness of any wall.
72. (1) Every wall built of bricks or building blocks shall be constructed with a damp-proof course complying with regulation 23.

(2) Such damp-proof courses shall be constructed—

(a) horizontally through the wall at a height of not less than 150 mm above the highest finished level of the external ground or paving or the surface of any oversite concrete on either side of the wall;

(b) horizontally under the coping of a parapet wall;

(c) vertically on the outer face of a wall where the ground surface on the outside of the wall is higher than any floor of the building, together with a horizontal damp-proof course under the floor:

Provided that such damp-proof course may be omitted where the floor and wall are constructed of properly water-proofed reinforced concrete of not less than 200 mm in thickness;

(d) horizontally through the whole area of the brickwork of a chimney above the roof and be connected to the apron flashing.

PART VII

FIREPLACES, FLUES AND CHIMNEYS

73. (1) Where any fireplace or stove is built or placed on any floor which is constructed of combustible material it shall be provided with a hearth of concrete, stone or other like incombustible material, level with the floor, under and before the fireplace or stove.

(2) Such hearth shall—

(a) be solid for a thickness of not less than 150 mm in every part;

(b) extend not less than 150 mm beyond each side of the fireplace or stove opening;

(c) extend not less than 450 mm in front of the fireplace or stove opening;

(d) if of concrete, be reinforced with not less than 300 mm² of reinforcement per metre width in each direction; and

(e) be adequately supported.

74. (1) Any wall of bricks or building blocks at the back of a fireplace shall be not less than 100 mm thick and in the case of an external or party wall it shall be not less than 225 mm thick.

(2) Such minimum thickness shall be carried up from the level of the hearth to the level of the ceiling of the room in which the fireplace is situated.
[Subsidiary]

Provided that where the flue from that fireplace is back to back with another flue, such thickness shall be carried up to a height of not less than 300 mm above the level of the top of the fireplace opening.

(3) The jambs of every fireplace opening shall be not less than 225 mm wide on each side.

(4) The enclosure and breast of every fireplace opening shall be supported by a lintel of reinforced concrete or steel or an arch of brick or stone.

(5) Every fireplace shall be lined with refractory fire bricks or slabs not less than 50 mm thick set in fireclay.

75. (1) Every fireplace shall be provided with a chimney.

(2) Where solid fuel or oil is burnt every fireplace shall have its own flue.

(3) The flue in every such chimney shall—

(a) where used for a fireplace burning solid fuel or oil be not less than 200 mm across in any direction;

(b) where used for an open domestic gas fire or other gas fire appliance—

(i) be not less than 0.013 m² in cross sectional area; and

(ii) be encased in incombustible material not less than 25 mm thick exclusive of plastering:

Provided that voids may be left in such material enclosing the flue and not connected therewith.

(4) Every such chimney shall—

(a) be rendered or tarred on the inside lined with fireclay, stoneware or other like incombustible material; and

(b) where used for a fireplace burning solid fuel or oil be made of solid bricks or building blocks, be properly bonded and solidly put together with cement mortar, or of plain or reinforced concrete, not less than 100 mm thick:

Provided that soot doors may be inserted in such chimneys.

76. (1) Every chimney stack shall be carried up above the level of the highest point of its intersection with the adjoining roof or gutter to a height of at least—

(a) 450 mm where used in connexion with a gas-fired appliance; or

(b) 900 mm where used in connexion with a fireplace burning solid fuel or oil.
(2) The height of every chimney stack measured from the level of the highest point of its intersection with the adjoining roof or gutter to the top of the stack, shall not exceed 6 times the least horizontal dimension of the stack unless it is adequately secured against over-turning.

(3) The topmost 6 courses of every chimney stack constructed of bricks or building blocks shall be laid in cement mortar, or cement-lime mortar containing not less than 1 volume of cement to every 6 volumes of sand.

(4) (a) Where the height of a chimney stack measured from the level of the highest point of its intersection with the adjoining roof or gutter exceeds 1.5 m, the part of such chimney stack above 1.5 m may be constructed of metal pipes, adequately stayed to resist wind pressure, and with a cross sectional area not less than \( \frac{1}{4} \) of the cross sectional area of the chimney stack below, and in any case not less than 150 mm in internal diameter.

(b) Such pipes shall be constructed—

(i) of cast iron, not less than 5 mm thick at any point; or

(ii) of mild steel plates not less than 5 mm thick; or

(iii) if used with a gas-fired appliance, of steel metal of a thickness not less than 1 mm.

(c) All metal in flue pipes shall be protected against corrosion.

77. (1) No timber (other than wood plugs), or other combustible material shall be placed in any wall or chimney within 225 mm of any flue or the inside of any fireplace opening.

(2) No wood plugs shall be driven into any wall or chimney within 150 mm of any flue or the inside of any fireplace opening.

(3) No woodwork or other combustible material of the surround of any fireplace opening shall be fixed round that opening unless it is—

(a) distant at least 150 mm measured horizontally and 300 mm measured vertically from that fireplace opening; and

(b) solidly backed with incombustible material.

78. (1) Every chimney shaft built of bricks shall comply with the following provisions—

(a) it shall be constructed of suitable solid bricks jointed with suitable mortar;

(b) it shall be square, circular, or of any regular polygonal shape, and the outer face shall be built to a batter of at least 20 mm in every 1 m of height;
(c) the height measured from the base to the top of the chimney shaft shall not exceed the least width of the base multiplied by—
   (i) 10 times if the shaft be square;
   (ii) 12 times if the shaft be circular or polygonal;

(d) the thickness at its top and for 6 m below its top shall be at least 225 mm and it shall be increased by 1/2 brick for every additional 6 m, or part thereof, measured downwards:

   Provided that—
   (i) any cap, cornice, plinth, string course or other departure from plain brickwork; and
   (ii) any internal lining,

shall be additional to the thickness of the brickwork required by this paragraph;

(e) any internal lining shall not be bonded with the brickwork;

(f) any metal used in connexion with the construction of the shaft shall be properly protected against corrosion;

(g) any footings which may be provided at the base of the shaft shall spread all round at base by regular offsets and the space enclosed by such footings shall be filled in solid with concrete.

(2) Every chimney shaft built of reinforced concrete shall comply with the relevant provisions of Part XII for the structural use of reinforced concrete and shall comply with the following provisions—

(a) the concrete shall be not inferior to that designated Grade IIIA in regulation 19;

(b) the reinforcement shall be in accordance with the requirements of regulation 20 and the concrete cover shall be not less than 40 mm thick;

(c) the concrete stresses shall not exceed the maximum permissible stresses in regulation 116 or 157 if special or designed mixes are used;

(d) the stresses in the reinforcement shall not exceed 60 per cent of the maximum permissible stresses in regulation 117 or 158;

(e) due account shall be taken of the effect of temperature stresses; and

(f) any lining which may be provided to the shaft shall not be taken as contributing to the strength of the shaft.

(3) If built of mild steel shall be constructed of steel plates not less than 5 mm thick and properly stayed and protected against corrosion.
(4) The foundations of the shaft shall be so proportioned that the resultant of all loads shall be within the middle third of the foundations, or if on piled foundations shall cause no tension in any pile.

(5) In paragraph (1)(g) "base" means the underside of the course immediately above the footings, if any, or if there are no footings the bottom of the chimney shaft.

79. (1) Every open cooking slab (not being a fireplace and not directly connected to a chimney) constructed or adapted for the use of coal, charcoal or wood as fuel shall be provided with an incombustible hood of sheet metal or other material as the Building Authority may approve, connecting with a chimney.

(2) The bottom edge of such hood shall be not more than 2 m above floor level and shall cover the area of the cooking slab.

80. No floor or roof of combustible material shall be constructed over any fireplace, heating appliance or oven, burning solid fuel or oil fuel, within 1.5 m of the top of such fireplace, heating appliance or oven, unless protected with a lining of incombustible material not less than 5 mm thick, covering a horizontal area of not less than 10 m² and so arranged as to give the most effective protection.

PART VIII

ROOFS

81. (1) The roof of every building and of any minor structure placed above such roof except the doors, and frames of dormers or sky lights shall be covered with tiles, glass, metal or other incombustible material:

Provided that where a roof is constructed entirely of incombustible materials the external covering may consist of—

(a) rock asphalt containing not more than 17 per cent by weight of bitumen; or

(b) a layer or layers of compressed and impervious felt membrane roofing having an aggregate thickness of not more than 10 mm bedded down solidly on the roof by viscous materials.

(2) Where the roof is covered in a manner provided by proviso (b) to paragraph (1) the external layer of such roofing shall be surfaced with hard incombustible mineral matter incorporated during manufacture. 

Provided that asbestos based roofing felt need not be so surfaced where the slope of the roof is not greater than 20 degrees from the horizontal.
82. Every roof shall be—

(a) weatherproof; and

(b) provided with adequate gutters and rain water pipes to prevent the direct discharge of water upon or over any footpath or roadway.

83. Every part of a roof, to which access is provided, shall be protected by parapet walls or railings not less than 1100 mm in height from finished roof level and so constructed as to inhibit climbing and the passage of articles more than 100 mm in their smallest dimension. The lowermost 150 mm of such parapet walls or railings shall be built solid.

84. Where a ceiling is constructed with a space between it and the floor or roof above, such space shall be properly protected against vermin and in the case of a timber floor or roof, such space shall also be adequately ventilated.

PART IX

DUTIES OF REGISTERED STRUCTURAL ENGINEER IN STRUCTURAL USE OF TIMBER, STEEL AND REINFORCED CONCRETE

85. (1) (a) Where any steel framed or reinforced concrete structure is designed in accordance with the provisions of regulation 113 or regulations 157 to 165, the structural details and calculations required by regulation 8(1)(i) of the Building (Administration) Regulations shall be prepared and signed by a registered structural engineer.

(b) The construction of any structure so designed shall be supervised by a registered structural engineer in accordance with regulation 37 of the Building (Administration) Regulations.

(2) Structures may be designed and constructed in prestressed concrete, shall construction or any other methods and materials, subject to—

(a) the production of proof to the satisfaction of the Building Authority regarding the soundness of design; and

(b) the structural details and calculations required by regulation 8(1)(i) of the Building (Administration) Regulations being prepared and signed by a registered structural engineer.

(3) Where the Building Authority is satisfied with the proof of soundness of design of any structure under paragraph (2)(a), the construction shall be supervised by a registered structural engineer in accordance with regulation 37 of the Building (Administration) Regulations.
PART X

STRUCTURAL USE OF TIMBER

86. (1) Every joist, binder, rafter and purlin shall have a finished breadth of not less than 35 mm.

(2) Floor boards and boarding to flat roofs shall have a finished thickness of not less than 16 mm.

87. (1) For the purpose of determining the sizes of ceiling joists, a total load shall be taken of not less than 1 kPa, but for the purpose of designing the construction supporting those joists, the total load may be taken as 0.5 kPa.

(2) For the purpose of determining the required thickness of tongued and grooved floor-boards, an imposed load shall be taken per meter width of the boarding of not less than the load for slabs specified in column 4 of Table VII for the type of floor specified in that Table.

(3) Where plain-edged floorboards are used, each floorboard shall be capable of resisting, without exceeding the maximum permissible stress specified in Table XVII, the load for slabs specified in column 4 of Table VII for the type of floor specified in Table VII, irrespective of the width of the floorboards.

(4) Subject to the provisions of regulation 86(2), the required thickness of floorboards shall be not less than the thickness determined by calculation plus 3 mm for wear.

88. (1) Subject to the provisions of regulation 92, the stresses in structural timber, other than posts and struts, shall not exceed the maximum permissible stresses specified in Table XVII.

<table>
<thead>
<tr>
<th>TABLE XVII</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum permissible stresses in structural timber (other than posts and struts) in MPa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kind of stresses</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexural stress in extreme fibres (other than floorboards) with adequate lateral restraint against warping or buckling</td>
<td>7.0</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Flexural stress in extreme fibres of floorboards</td>
<td>5.5</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Shear stress in direction of grain</td>
<td>0.7</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Compressive stress perpendicular to grain</td>
<td>2.4</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>Tension in direction of grain</td>
<td>10.3</td>
<td>8.3</td>
<td></td>
</tr>
<tr>
<td>Modulus of elasticity (mean)</td>
<td>14 000</td>
<td>8 300</td>
<td></td>
</tr>
<tr>
<td>Modulus of elasticity (minimum)</td>
<td>7 000</td>
<td>5 200</td>
<td></td>
</tr>
</tbody>
</table>
(2) The mean value of the modulus of elasticity shall only be used for rafters and floor and ceiling joists and, in all other cases, the minimum value of the modulus of elasticity shall be used.

(3) Where the direction of the load is inclined to the direction of the member, the permissible compressive stress for the inclined surface shall be determined by the formula:

\[ C_{bi} = \frac{C_h C_h}{C_h \sin^2 \theta + C_{bi} \cos^2 \theta} \]

where \( C_h \) is the permissible compressive stress parallel to the grain,
\( C_{bi} \) is the permissible compressive stress for the inclined surface,
\( C_{bi} \) is the permissible compressive stress perpendicular to the grain, and
\( \theta \) is the angle between the direction of the load and the direction of the grain.

(4) The shear strength at square cornered notches at the ends of a flexural member shall be calculated by using the effective depth \((d_e)\) shown in the following figure:

\[ \text{Beam notched at end} \]

and also a permissible shear stress equal to that specified in Table XVII multiplied by the reduction factor \( K \) where—

\[ K = \frac{\text{effective depth } (d_e)}{\text{total depth } (d)} \]

(5) For the purpose of this regulation, adequate lateral restraint to a flexural member against winding or buckling shall be deemed to have been provided if the distance between the lateral restraints does not exceed 50 times the breadth of the member.

89. (1) Subject to regulation 92, the compressive stress in the direction of the grain of a post or strut shall not exceed the maximum permissible stress specified in Table XVIII for the ratio of effective length \( (l) \) to the least radius of gyration \( (k) \) (or the least lateral dimension \( (b) \) in respect of solid members of rectangular cross-section only) specified in that Table.
(2) In a post or strut the ratio of effective length \((l)\) to—
(a) least radius of gyration \((k)\), shall not exceed 200; or
(b) least lateral dimension \((b)\), shall not exceed 58.

(3) No post or strut shall be so notched as to reduce its dimensions below those found necessary by calculation.

### TABLE XVIII

Maximum permissible compressive stresses in posts and struts in MPa

<table>
<thead>
<tr>
<th>Ratio of effective length to—</th>
<th>Class of timber</th>
<th>Ratio of effective length to—</th>
<th>Class of timber</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3 4</td>
<td>5 6</td>
</tr>
<tr>
<td>Least radius of gyration ((l/k))</td>
<td>Least lateral dimension ((l/k))</td>
<td>Least radius of gyration ((l/k))</td>
<td>Least lateral dimension ((l/k))</td>
</tr>
<tr>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>7.0</td>
<td>5.5</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>6.7</td>
<td>5.4</td>
</tr>
<tr>
<td>20</td>
<td>6</td>
<td>6.6</td>
<td>5.3</td>
</tr>
<tr>
<td>30</td>
<td>9</td>
<td>6.5</td>
<td>5.2</td>
</tr>
<tr>
<td>40</td>
<td>11</td>
<td>6.3</td>
<td>5.0</td>
</tr>
<tr>
<td>50</td>
<td>14</td>
<td>6.0</td>
<td>4.8</td>
</tr>
<tr>
<td>60</td>
<td>17</td>
<td>5.7</td>
<td>4.5</td>
</tr>
<tr>
<td>70</td>
<td>20</td>
<td>5.3</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Note: The maximum permissible compressive stress for intermediate values of \(l/k\) or \(l/b\) shall be obtained by interpolation between the 2 nearest stresses for the class of timber used.

90. For the purpose of regulation 89 the effective length of a post or strut shall be that specified in Table XIX for the type of post or strut specified in that Table.

### TABLE XIX

Effective length of posts and struts

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of post or strut</td>
<td>Effective length ((L = \text{length of post or strut between centres or restraining members}))</td>
</tr>
<tr>
<td>Properly restrained at both ends in position and direction</td>
<td>0.7 (L)</td>
</tr>
<tr>
<td>Properly restrained at both ends in position and at 1 end in direction</td>
<td>0.85 (L)</td>
</tr>
<tr>
<td>Properly restrained at both ends in position but not in direction</td>
<td>(L)</td>
</tr>
<tr>
<td>Properly restrained at 1 end in position and direction and at the other end partially restrained in direction but not in position</td>
<td>1.5 (L)</td>
</tr>
<tr>
<td>Properly restrained at 1 end in position and direction but not restrained at the other end</td>
<td>2.0 (L)</td>
</tr>
</tbody>
</table>

Note: The effective length of a post or strut of a type not specified in this Table shall be determined to the satisfaction of the Building Authority.
91. The calculated deflexion of any joist or binder shall not exceed \( \frac{3}{3} \) of its length.

92. (1) The maximum permissible stresses specified in this Part may be increased by 25 per cent for members forming part of the roof construction of a pitched roof when the calculations are based on all loads including imposed load.

(2) No increase in the maximum permissible stresses specified in this Part shall be allowed when the calculations are based on all loads other than imposed load.

93. Members subject to combined bending and axial compression shall be so proportioned that the quantities
\[
\frac{f}{F} + \frac{f_h}{F_h}
\]
shall not exceed—

(a) unity, for members with a ratio of effective length to least radius of gyration not exceeding 20; and

(b) 0.9, for members where that ratio exceeds 20.

where—\( f \) = axial compressive stress,
\( F \) = maximum permissible compressive stress in posts and struts,
\( f_h \) = maximum compressive stress due to bending; and
\( F_h \) = maximum permissible compressive flexural stress in extreme fibres of beams.

94. (1) All framing, tenoning, spiking or nailing, bolting, strapping and other jointing shall be so designed as safely to transmit the load and stresses to which it will be subjected and the execution of all such jointing shall be to the satisfaction of the Building Authority.

(2) Where bolts are used, adequate plates or washers shall be used to preserve the grain of the timber from crushing.

PART XI
STRUCTURAL USE OF STEEL

95. (1) Structural steel shall be cleaned of loose scale and rust and, except where it is to be solidly encased with concrete, brickwork or other similar non-combustible material, shall be either—

(a) thoroughly coated with at least 2 coats of paint or boiled oil, 1 coat of which may be applied before erection; or

(b) provided with such other protection against corrosion as the Building Authority may approve.

(2) The coatings of paint or boiled oil, or other protection against corrosion, shall, in the case of all surfaces inaccessible after erection (except surfaces held in direct contact by riveting or intermittent welding) be applied before erection.
96. (1) Subject to the provisions of Part XVI (Fire Resisting Construction), where a column or beam is situated wholly or partly in an external wall or wholly or partly within a recess in a party wall, that column or beam shall be solidly encased with brickwork, concrete or other similar material not less than—

(i) 100 mm thick where the encasement of a column is exposed to the weather; and

(ii) 50 mm thick where not so exposed.

(2) Where structural steel may be adversely affected by moisture from the adjoining earth, it shall be solidly encased with concrete not less than 100 mm thick.

(3) For the purpose of this regulation any concrete used in the encasement of steelwork shall be not inferior to that designated Grade III in regulation 19.

97. (1) Subject to the provisions of regulations 97(3), (4) and (5), 99, 101 and 106, the stresses on structural steel (other than columns and struts), shall not exceed the maximum permissible stresses specified in Table XX.

(2) In compound or built-up sections formed with different thicknesses of high yield stress structural steel, the maximum permissible stress for the whole of the section shall be taken as that for the greatest thickness of material used, except that for shear on webs, the maximum permissible stress shall be that specified for the thickness of the web itself.

### TABLE XX

<table>
<thead>
<tr>
<th>Part of structure and kind of stress</th>
<th>High yield stress structural steel complying with the appropriate provisions of BS 4360: 1972</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For material not exceeding 25 mm in thickness or diameter</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Values**

| (a) on the net section for axial stress | 140 | 190 | 170 |
| (b) flexural stress in extreme fibres of slab bases | 185 | 185 | 185 |
| (c) flexural stress in extreme fibres on the net section of— | 150 | 210 | 190 |
| (i) beams and girders (other than plate girders) | 145 | 200 | 185 |
| (ii) plate girders | 80 | 110 | 100 |
| (d) on shop rivets for axial stress | 60 | 85 | 80 |
| (e) on field rivets for axial stress | 80 | 110 | 100 |
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#### Subsidiary

<table>
<thead>
<tr>
<th>Part of structure and kind of stress</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Content from image]</td>
<td>185</td>
<td>185</td>
<td>185</td>
<td>185</td>
</tr>
<tr>
<td>(a) flexural stress in extreme fibres of slab bases</td>
<td>150</td>
<td>210</td>
<td>190</td>
<td>190</td>
</tr>
<tr>
<td>or</td>
<td>14 200</td>
<td>14 200</td>
<td>14 200</td>
<td>14 200</td>
</tr>
<tr>
<td>/k_x</td>
<td>/k_y</td>
<td>/k_z</td>
<td>/k_z</td>
<td>/k_z</td>
</tr>
<tr>
<td>whichever is the lesser</td>
<td>whichever is the lesser</td>
<td>whichever is the lesser</td>
<td>whichever is the lesser</td>
<td></td>
</tr>
<tr>
<td>(ii) plate girders</td>
<td>145</td>
<td>200</td>
<td>185</td>
<td>185</td>
</tr>
<tr>
<td>or</td>
<td>14 200</td>
<td>14 200</td>
<td>14 200</td>
<td>14 200</td>
</tr>
<tr>
<td>/k_x</td>
<td>/k_y</td>
<td>/k_z</td>
<td>/k_z</td>
<td>/k_z</td>
</tr>
<tr>
<td>whichever is the lesser</td>
<td>whichever is the lesser</td>
<td>whichever is the lesser</td>
<td>whichever is the lesser</td>
<td></td>
</tr>
</tbody>
</table>

3. For parts in shear—

| (a) on webs | 100 | 140 | 120 | 120 |
| or | \(\frac{700}{d^2} \times t^2\) | \(\frac{700}{d^2} \times t^2\) | \(\frac{700}{d^2} \times t^2\) | \(\frac{700}{d^2} \times t^2\) |
| whichever is the lesser | whichever is the lesser | whichever is the lesser | whichever is the lesser |

Webs of beams shall possess or be provided with adequate stiffness to prevent buckling.

| (b) on shop rivets and turned bolts | 90 | 130 | 115 | 115 |
| (c) on field rivets | 80 | 110 | 110 | 110 |
| (d) on black bolts | 60 | | | |

The strength of rivets and bolts in double shear may be taken as 2 times that for single shear.

<p>| (e) other than on webs, rivets and bolts | 100 | 140 | 120 | 120 |</p>
<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>High yield stress structural steel complying with the appropriate provisions of BS 4360: 1972</td>
<td>Mid steel complying with the appropriate provisions of BS 4360: 1972</td>
</tr>
<tr>
<td>Part of structure and kind of stress</td>
<td>For material not exceeding 25 mm in thickness or diameter</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

4. For parts in bearing—

(a) bearing stress steel to steel on net area of contact

(b) on shop rivets and turned bolts

(c) on field rivets

(d) on black bolts

<table>
<thead>
<tr>
<th></th>
<th>185</th>
<th>260</th>
<th>230</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>185</td>
<td>260</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td>150</td>
<td>210</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td>120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. For welded connexions—

(a) tensile stress in butt welds

(b) compressive stress in butt welds

(c) shear stress in butt welds

(d) stress in fillet welds

<table>
<thead>
<tr>
<th></th>
<th>1 × ( f_t )</th>
<th>1 × ( f_t )</th>
<th>1 × ( f_t )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 × ( f_t )</td>
<td>1 × ( f_t )</td>
</tr>
</tbody>
</table>

Note: \( l \) is the length between effective lateral supports.

\( k_{yy} \) is the least radius of gyration of the beam or girder section.

\( d \) is the clear distances between flange angles (or flange plates where there are no flange angles) or web stiffeners, whichever is the lesser.

\( t \) is the thickness of the web.

\( f_t \), \( f_u \), \( f_s \) are the maximum permissible tensile, compressive and shear stresses, respectively, in the parent metal or in the weld metal, whichever is the lesser.

(3) Subject to paragraph (4), where a beam or girder is of symmetrical section, the maximum permissible stresses specified in item 2(b) of Table XX may be increased by the percentage specified in Table XXI for the ratio \( k_{xx}/k_{yy} \) of the greatest to the least radius of gyration of the section of that beam or girder.

**Table XXI**

Percentage increase for shape factor

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( k_{xx}/k_{yy} )</td>
<td>Percentage increase</td>
</tr>
<tr>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>4.5</td>
<td>15.0</td>
</tr>
<tr>
<td>4.0</td>
<td>30.0</td>
</tr>
<tr>
<td>3.5 or less</td>
<td>50.0</td>
</tr>
</tbody>
</table>

Note: (1) \( k_{xx} \) is the greatest radius of gyration of the beam or girder section.

(2) The percentage increase for intermediate values of the ratio \( k_{xx}/k_{yy} \) shall be obtained by linear interpolation between the 2 nearest values.
(4) (a) In no case shall the flexural stresses of a beam or girder of symmetrical section exceed the appropriate stress specified in column 2 of Table XXII.

(b) The percentage increase permitted by paragraph (3) shall not be taken into account in regulation 100.

**TABLE XXII**

<table>
<thead>
<tr>
<th>1</th>
<th>2 MPa</th>
</tr>
</thead>
</table>
| **1.** Steel complying with the appropriate provisions of BS 4360: 1972—  
(a) beams or girders, other than plate girders .......... | 150 |
| (b) plate girders ........................................ | 145 |
| **2.** High yield stress structural steel complying with the appropriate provisions of BS 4360: 1972—  
(a) beams and girders, other than plate girders—  
(i) material not more than 25 mm thick .... | 210 |
| (ii) material more than 25 mm thick ............... | 190 |
| (b) plate girders—  
(i) material not more than 25 mm thick .... | 200 |
| (ii) material more than 25 mm thick ............... | 185 |

(5) Beams and girders with equal flanges may be designed as cased beams provided the following conditions are fulfilled:

(a) the section is of single web and I-form or of double open channel form with the webs not less than 40 mm apart;

(b) the beam is unpainted and is solidly encased in dense concrete not inferior to that designated grade IIIA in regulation 19;

(c) the minimum width of solid concrete encasing is at least equal to \((b + 100)\) mm, where \(b\) is the width of the steel flange in mm;

(d) the surface and edges of the flanges of the beam have a concrete cover of not less than 50 mm;

(e) the casing is effectively reinforced with wire to BS 4482: 1969. The wire shall be at least 5 mm diameter, and the reinforcement shall be in the form of stirrups or binding at not more than 150 mm pitch, and so arranged as to pass through the centre of the covering to the edges and soffit of the lower flange;

(f) the beam or girder has a depth not exceeding 750 mm (over plating where used) and a width not exceeding 450 mm;

(g) the beam or girder is not of a box section. The least radius of gyration \((k_{yy})\) may be deemed to be equal to 0.2 \((b + 100)\) mm and the radius of gyration \((k_{xx})\) shall be deemed to be equal to that of the uncased section:
Provided that in no case shall the maximum flexural stress in extreme fibres of the cased section exceed either—

(i) 1\frac{1}{2} times the maximum permissible stress on the uncased section of that beam or girder; or

(ii) that specified in Table XXIII,

whichever is the lesser stress.

<table>
<thead>
<tr>
<th>TABLE XXIII</th>
</tr>
</thead>
</table>

*Maximum flexural stresses in extreme fibres of the cased section of a beam or girder*

<table>
<thead>
<tr>
<th></th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MPa</strong></td>
<td></td>
</tr>
<tr>
<td>1. Steel complying with the appropriate provisions of BS 4360: 1972—</td>
<td></td>
</tr>
<tr>
<td>(a) beams or girders other than plate girders</td>
<td>150</td>
</tr>
<tr>
<td>(b) plate girders</td>
<td>145</td>
</tr>
<tr>
<td>2. High yield stress structural steel complying with the appropriate provisions of BS 4360: 1972—</td>
<td></td>
</tr>
<tr>
<td>(a) beams and girders, other than plate girders—</td>
<td></td>
</tr>
<tr>
<td>(i) material not more than 25 mm thick</td>
<td>210</td>
</tr>
<tr>
<td>(ii) material more than 25 mm thick</td>
<td>190</td>
</tr>
<tr>
<td>(b) plate girders—</td>
<td></td>
</tr>
<tr>
<td>(i) material not more than 25 mm thick</td>
<td>200</td>
</tr>
<tr>
<td>(ii) material more than 25 mm thick</td>
<td>185</td>
</tr>
</tbody>
</table>

98. (1) The permissible ratio of effective column or strut length (l) to least radius of gyration (k) shall not exceed the following values:

- (a) for any member carrying loads resulting from dead and imposed loads ........................................... 180

- (b) for any member carrying loads resulting from wind forces only, provided the deformation of such member does not adversely affect the stress in any part of the structure carrying loads resulting from dead and imposed loads .......................................................... 250

- (c) for any member normally acting as a tie in a roof truss but subject to possible reversal of stress due to the action of wind suction ......................................................... 350

(2) Subject to the provisions of paragraph (3) and of regulations 99 and 100 the axial stress on column and struts of steel shall not exceed the maximum permissible axial stress specified in Table XXIV for the ratio l/k specified in that Table.
### TABLE XXIV

**Maximum permissible axial stress on columns and struts in MPa**

<table>
<thead>
<tr>
<th>Ratio (\frac{l}{k})</th>
<th>Steel complying with the appropriate provisions of—</th>
<th>2</th>
<th>BS 4360: 1972</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS 4360: 1972 Grade 43</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Not exceeding 25 mm in thickness</td>
<td>Exceeding 25 mm in thickness</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>140</td>
<td>190</td>
<td>170</td>
</tr>
<tr>
<td>10</td>
<td>130</td>
<td>180</td>
<td>160</td>
</tr>
<tr>
<td>20</td>
<td>120</td>
<td>170</td>
<td>150</td>
</tr>
<tr>
<td>30</td>
<td>115</td>
<td>160</td>
<td>140</td>
</tr>
<tr>
<td>40</td>
<td>110</td>
<td>145</td>
<td>130</td>
</tr>
<tr>
<td>50</td>
<td>100</td>
<td>135</td>
<td>120</td>
</tr>
<tr>
<td>60</td>
<td>95</td>
<td>120</td>
<td>110</td>
</tr>
<tr>
<td>70</td>
<td>85</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td>80</td>
<td>80</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td>90</td>
<td>70</td>
<td>85</td>
<td>80</td>
</tr>
<tr>
<td>100</td>
<td>65</td>
<td>75</td>
<td>70</td>
</tr>
<tr>
<td>110</td>
<td>60</td>
<td>65</td>
<td>60</td>
</tr>
<tr>
<td>120</td>
<td>50</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>130</td>
<td>45</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>140</td>
<td>40</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>150</td>
<td>35</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>160</td>
<td>31</td>
<td>35</td>
<td>32</td>
</tr>
<tr>
<td>170</td>
<td>29</td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td>180</td>
<td>26</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>190</td>
<td>23</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>200</td>
<td>21</td>
<td>28</td>
<td>22</td>
</tr>
<tr>
<td>210</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>220</td>
<td>19</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>230</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>240</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>250</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>300</td>
<td>9</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>350</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

Note: The maximum permissible axial stress for intermediate values of \(\frac{l}{k}\) shall be obtained by interpolation between the 2 nearest stresses for the kind of steel used.

(3) For the purpose of calculating the maximum permissible axial stress on a column or strut where that column or strut—

(a) is of I-section;

(b) has a single web;

(c) does not exceed 750 mm in depth over plating where used;

(d) is solidly encased in concrete not inferior to that designated Grade IIIA in regulation 19;

(e) the minimum width of solid concrete encasing is at least equal to \(b + 100\) mm, where \(b\) is the width of the steel flange in mm;
(f) the surface and edges of the flange of the steel section shall have a concrete cover of not less than 50 mm; and

(g) the casing is effectively reinforced with wire to BS 4482: 1969 of at least 5 mm diameter, and the reinforcement shall be in the form of stirrups or binding at not more than 150 mm pitch, and so arranged as to pass through the centre of the concrete cover.

the least radius of gyration $k_{yy}$ may be deemed to be equal to 0.2 $(b+100)$ mm and the radius of gyration $k_{x}$ shall be deemed to be equal to that of the uncased section:

Provided that in no case shall—

(i) the said stress exceed $1\frac{1}{2}$ times the maximum permissible stress on the uncased section of that column or strut; and

(ii) the ratio $(l/k)$ of that uncased section exceed 250.

(4) In compound or built-up sections formed with different thicknesses of high yield stress structural steel, the maximum permissible stress for the whole of the section shall be taken as that for the greatest thickness of material used.

99. The maximum permissible stresses and the increases permitted thereon specified in regulations 97, 98 and 100 for beams, girders, columns and struts and all their connexions may be increased by 25 per cent when the calculations are based on all loads including wind load:

Provided that—

(a) the said stresses and increases are not exceeded when the calculations are based on all loads other than wind load; and

(b) the increase permitted by this regulation shall not apply to the stresses specified in regulations 97 (in respect of slab bases and parts in bearing only), 101 and 106.

100. (1) Members subject to both axial compression and bending stresses shall be so proportioned that the quantity

$$\frac{f_a}{F_a} + \frac{f_{bc}}{F_{bc}}$$

does not exceed unity at any point,

where $f_a =$ the calculated average axial compressive stress;

$F_a =$ total permissible axial stress on columns and struts;

$f_{bc} =$ the maximum resultant compressive stress due to bending about both principal axes; and

$F_{bc} =$ total permissible compressive flexural stress in extreme fibres of beams and girders.

(2) Members subject to both axial tension and bending stresses shall be so proportioned that the quantity
does not exceed unity at any point.

where \( f_t \) = the calculated axial tensile stress;
\( F_t \) = total permissible axial stress in tension;
\( f_{bt} \) = the maximum resultant tensile stress due to bending about both principal axes; and
\( F_{bt} \) = total permissible tensile flexural stress in extreme fibres of beams and girders.

(3) In paragraphs (1) and (2) "total permissible" means, in relation to any stress, the maximum permissible stress specified in regulation 97 or 98 (as the case may be) plus, where applicable, the increase on the maximum permissible stress permitted in respect of wind load under regulation 99.

101. The maximum permissible stresses in grillage beams (other than hollow compound girders) may exceed the stresses specified in Table XX by 33 1/3 per cent where—

(a) the beams are entirely embedded in concrete not inferior to that designated Grade IIIA in regulation 19; and

(b) the beams are spaced apart so that the distance between the edges of adjacent flanges is not less than 75 mm; and

(c) the thickness of the concrete cover on the top of the upper flanges and at the outer edges of the sides of the outermost beams and at the ends is not less than 100 mm; and

(d) the concrete is properly compacted solid around all beams.

102. For the purpose of regulation 98, the effective length of a column or strut shall be that specified in Table XXV for the type of column or strut specified in that Table.

**TABLE XXV**

<table>
<thead>
<tr>
<th>Type of column or strut</th>
<th>Effective length ((L = \text{length of column or strut between centres of restraining members}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properly restrained at both ends in position and direction</td>
<td>0.7 (L)</td>
</tr>
<tr>
<td>Properly restrained at both ends in position and at 1 end in direction</td>
<td>0.85 (L)</td>
</tr>
<tr>
<td>Properly restrained at both ends in position but not in direction</td>
<td>(L)</td>
</tr>
<tr>
<td>Properly restrained at 1 end in position and direction and at the other end partially restrained in direction but not in position</td>
<td>1.5 (L)</td>
</tr>
<tr>
<td>Properly restrained at 1 end in position and direction but not restrained at the other end</td>
<td>2.0 (L)</td>
</tr>
</tbody>
</table>

Note: The effective length of a column or strut of a type not specified in this Table shall be determined to the satisfaction of the Building Authority.
103. (1) Both ends of each length of a column, other than a column of solid round section with shouldered ends, shall be properly prepared and dead square over the whole area of the ends.

(2) Column joints shall be close butted and the caps, baseplates and joint seating plates shall be in effective contact over the whole of the column end.

(3) This regulation shall not apply where sufficient gussets and rivets are provided to transmit the entire load.

104. (1) The foot of every column, other than a column of solid round section, shall have affixed thereto either a base-plate or a slab or bloom base.

(2) Slab or bloom bases shall be properly machined over the bearing surfaces and shall be in effective contact over the whole area of the machined end of the column.

(3) Columns of solid round section shall be provided with caps and bases, the bearing surfaces of which shall be properly machined. Those caps and bases shall be not less than 1.5 $(d+75)$ mm in length or diameter, where $d$ is the diameter of the column, or, where the column has a reduced end. If those columns have shouldered ends, the shoulders shall also be properly machined and the caps and bases shall be properly machined after being shrunk or screwed on.

(4) A bearing surface which is to be grouted directly to a foundation need not be machined if that bearing surface is true and parallel to the machined upper face.

(5) Caps, bases, base-plates and slab or bloom bases shall be of sufficient thickness to transmit and distribute load without exceeding the maximum stresses specified in regulation 97.

(6) (a) When the slab alone will distribute the load uniformly, the minimum thickness of a retangular slab shall be:

$$ t = \sqrt{\left[ \frac{3w}{p} \left( \frac{A^{2}}{4} - B^{2} \right) \right]} $$

where—
$t$ is the slab thickness in mm;
$w$ is the pressure or loading on the underside of the base in MPa;
$p$ is the permissible flexural stress in extreme fibres of slab bases in MPa;
$A$ is the greater projection of the plate beyond the column in mm; and
$B$ is the lesser projection of the plate beyond the column in mm.
(b) For solid round steel columns in cases where the loading on the cap or under the base is uniformly distributed over the whole area including the column shaft, the minimum thickness, in mm, of a square cap or base shall be:

$$t = \sqrt{\frac{9W}{16p} \times \frac{D}{D-d}}$$

where
- $t$ is the thickness of the plate in mm;
- $W$ is the total axial load in kN;
- $p$ is the permissible flexural stress in extreme fibres of slab bases in MPa;
- $D$ is the length of the side of cap or base in mm; and
- $d$ is the diameter, in mm, of the column or, where the column has a reduced end, of the reduced end.

(c) For other cases calculations shall be made, based on the allowable stress of 185 MPa.

105. (1) All column joints shall be designed and constructed to transmit safely all the forces to which they are subjected.

(2) (a) Column joints in which the resultant unit stress is wholly compressive and which depend on contact for the transmission of load shall be sufficiently spliced to retain the members in place.

(b) Each splice plate shall extend above the joint to a distance at least equal to the maximum breadth of the column flange or 150 mm, whichever is the greater dimension, and shall extend below the joint to a similar distance.

(c) Where the whole of the end of a superimposed column is not in effective contact with the column beneath, a seating plate of adequate thickness, which shall extend the full depth and width of the lower column, shall be interposed between the ends of the columns.

106. (1) The strength of filler floor beams solidly encased in a concrete floor slab shall be calculated by either of the following methods—

(a) on the basis of the combined moment of inertia of the steel and the surrounding concrete (calculated as in reinforced concrete neglecting the strength of concrete in tension), in which case the flexural stress in extreme fibres shall not exceed 150 MPa.

(b) on the basis of the section modulus of the fillers alone, in which case the flexural stress on extreme fibres may be taken as $(160 + 0.6t)$ MPa, where $t$ is the number of mm,
not exceeding 75, of structural concrete cover to the compression flanges of the filler joists:

Provided that where the underside of the slab is flush with the bottom flanges of the filler joists, no allowance is to be made for \( t \) in respect of support moments, but, nevertheless, if the top flanges are covered, the allowance for \( t \) may be made in respect of the midspan moments.

(2) The spacing of filler joists centre to centre shall not exceed the minimum thickness of the structural concrete slab multiplied by the value \( n \) specified in Table XXVI for the imposed load specified in that Table, unless suitable transverse reinforcement is provided to the satisfaction of the Building Authority.

| TABLE XXVI |
|---|---|
| **Value of \( n \) for the spacing of filler joists** |
| 1 | 2 |
| **Imposed load in kPa of floor area** | **Value \( n \)** |
| Not exceeding 2.5 | 10 |
| Exceeding 2.5 but not exceeding 5.0 | 8 |
| Exceeding 5.0 but not exceeding 7.5 | 7 |
| Exceeding 7.5 but not exceeding 10.0 | 6 |
| Exceeding 10.0 | 5 |

107. (1) The calculated deflexion of any beam (other than a filler floor beam) shall not exceed \( \frac{1}{325} \) of the span.

(2) The span of any filler floor beam solidly encased in concrete shall not exceed 35 times the depth measured from the bottom flange of the filler beam to the top surface of the structural concrete or 12 times that depth in the case of cantilevering fillers.

(3) The span of any beam composed of steel (other than a filler floor beam) carrying a uniformly distributed load only and complying with the appropriate provisions of—

(a) BS 4360:1972, Grade 43, shall not exceed 20 times its depth

(b) BS 4360:1972, Grade 50, shall not exceed 13 times its depth

unless the calculated deflexion does not exceed \( \frac{1}{325} \) of the span.

108. A flange plate or web plate of a column shall be not less than 10 mm thick. In all other cases, structural steel shall be not less than 6 mm thick, except—

(a) for standard rolled steel joists, standard rolled steel channels and packings;
(b) where rust-resisting steels are used; and

(c) where galvanizing or other special provision is made against corrosion.

Bolts.

109. (1) Bolts shall be provided with washers under the nuts so that no part of the threaded portion of any bolt is within the thickness of the parts bolted together.

(2) Shanks of bolts shall project at least 1 full thread beyond the nuts which shall be so secured as to avoid the risk of their becoming loose.

(3) The heads of nuts and bolts shall have a true bearing and taper washers shall be provided where necessary to give that bearing.

(4) The provisions of regulation 110 relating to rivets shall apply to bolts.

110. (1) The distance from the edge of a rivet hole to the edge of the plate, bar or member shall be not less than—

(a) the diameter of the rivet, for rolled edges; and

(b) the diameter of the rivet plus 6 mm, for sheared edges.

(2) Rivets shall be so spaced that their centres shall not be closer together than 3 times the diameter of the rivets.

(3) Subject to the provisions of paragraph (7), straight line pitch in riveted beams, columns or other members shall not exceed 16 times the thickness of the thinnest outside plate, with a maximum of 150 mm for parts in compression and 200 mm for parts in tension.

(4) Where 2 rows of staggered rivets occur in 1 flange of a single angle, the straight line pitch in the direction of stress shall not exceed 1 ½ times the distance specified in paragraph (3) in each line.

(5) Where 2 or more flange plates are used, the edge distance, from the centre line of the nearest rivets connecting the plates to the web construction, shall not exceed 12 times the thickness of the thinnest outside plate, and where that edge distance exceeds 9 times that thickness, tacking rivets shall be introduced connecting those flange plates together.

(6) Where a single flange plate is used, the edge distance referred to in paragraph (5) shall not exceed 9 times the thickness of that plate.

(7) Where tacking rivets are used, the straight line pitch shall not exceed 24 times the thickness of the thinnest outside plate or 300 mm, whichever is the lesser dimension.

(8) Where a tension member is composed of 2 angles back to back, the pitch of tacking rivets shall not exceed 1 000 mm. and
where a compression member is similarly composed the pitch shall not exceed 750 mm, or 40 times the least radius of gyration of either angle, whichever be the lesser dimension:

Provided that tacking rivets on the connected legs of angles may be staggered.

(9) In paragraphs (7) and (8) “tacking rivets” means rivets connecting flange plates together, but not being subject to calculated stress.

111. (1) Notwithstanding the provisions of regulations 103(3) and 112(2), welded construction may be used and shall be carried out in conformity with the appropriate provisions of BS 5135:1974.

(2) Due account shall be taken in the design of the effects of any rigidity attributable to welding.

(3) The Building Authority may require the employment of properly qualified welding supervisors and welders with approved qualifications for the type of work required as specified in Chapter 6 BS 449:Part 2:1969 for the execution of welded construction.

(4) During construction, the Building Authority may require from time to time non-destructive tests to be carried out on the welded structure.

112. (1) As much of the work of fabrication of all steelwork as is reasonably practicable shall be completed in the works where the steelwork is fabricated.

(2) Except as provided in paragraphs (3) and (4), rivets or turned bolts of driving fit shall be used for all work of fabrication and for field connexions.

(3) Black bolts may be used in cases where no adverse effects on the structure would result from slipping of the bolts, and where suitable dead bearings formed by seating plates, packings, brackets or the like are provided to resist the whole of the shear forces involved.

(4) The requirements of paragraph (3) as regards dead bearings shall not apply to—

(a) roof trusses;

(b) the end connexions of secondary floor beams; or

(c) where, having regard to the particular circumstances of the case, the Building Authority is satisfied that dead bearings may be omitted.

(5) Bedding of column bases and bearings of beams and girders shall be carried out with Portland cement grout or mortar, or fine concrete in accordance with the requirements of clause 76 a BS 449: Part 2:1969.
(6) During erection the work shall be securely bolted or otherwise fastened, and if necessary temporarily braced, so as to make adequate provision for all erection stresses and conditions, including those due to erection equipment and its operation. Neither riveting, permanent bolting or welding shall be done until proper alignment has been obtained.

(7) All structural steel at the site shall be stored and handled so that members are not subjected to excessive stresses and damage.

113. (1) Notwithstanding the provisions of regulations 97, 98 and 100, steel framed structures may be designed and constructed in accordance with the relevant provisions of BS 449:Part 2:1969:

Provided that the structural details and calculations required by regulation 8(1)(i) of the Building (Administration) Regulations shall be prepared and signed by a registered structural engineer.

(2) The registered structural engineer appointed for such design or his successor under section 4(2) of the Ordinance shall be responsible for the supervision of the structural work.

PART XII

STRUCTURAL USE OF REINFORCED CONCRETE

114. (1) Reinforcement shall be free from loose mill scale, loose rust, oil and other matter which might affect adversely its proper function with concrete.

(2) The effective diameter of a bar whose cross-section is constant along its length shall be the diameter of a circle having the same area as the cross-section of the bar.

(3) The effective diameter of a bar whose cross-section varies along its length shall be the diameter of a circle having an area equal to the least area of the bar. An allowance not exceeding 3 per cent may be added to the least area of the cross-section for any non-continuous ribs.

(4) Only one grade of deformed bars may be used on a site.

(5) (a) Mild steel and high-tensile or medium high-tensile steel for main reinforcement shall not be used together in the same member.

(b) For the purpose of this paragraph, “member” means any column, simple beam, continuous beam or slab.

115. (1) Subject to the provisions of Part XVI (Fire Resisting Construction) the minimum thickness of concrete cover to reinforcement (exclusive of plaster rendering or other applied covering or decorative finish) shall be—

(a) for each end of a reinforcement, not less than 25 mm or 2 times the diameter of that reinforcement, whichever is the greater:
for a longitudinal reinforcement in a column, not less than 40 mm or the diameter of that reinforcement, whichever is greater:

Provided that in a column whose least lateral dimension is 200 mm or less and whose reinforcement does not exceed 15 mm in diameter the minimum cover shall be not less than 25 mm;

(c) for a longitudinal reinforcement in a beam not less than 25 mm or the diameter of that reinforcement, whichever is the greater;

(d) for any other reinforcement not less than 15 mm or the diameter of that reinforcement, whichever is the greater.

(2) Where reinforced concrete is exposed to the weather the minimum cover specified in paragraph (1) shall be increased by not less than 15 mm.

(3) Where reinforced concrete is cast in contact with earth the minimum thickness of cover shall be 75 mm.

(4) Where reinforced concrete (other than reinforced concrete piling) is cast against formwork and subsequently may be in contact with earth the minimum thickness of cover shall be 50 mm.

(5) The minimum cover to all reinforcement, including lateral reinforcement, in concrete piling shall be 40 mm.

(6) The Building Authority may require the cover to be increased in marine works or where the concrete is exposed to particularly corrosive conditions.

116. (1) Subject to the provisions of regulations 118 and 120 the compressive, shear and bond stresses in reinforced concrete shall not exceed the maximum permissible stresses specified in Table XXVII for the grade of concrete used.

### TABLE XXVII

**Maximum permissible stresses in ordinary and quality A concretes in reinforced concrete in MPa**

<table>
<thead>
<tr>
<th>Designation</th>
<th>Compression due to bending</th>
<th>Compression direct</th>
<th>Shear</th>
<th>Average bond</th>
<th>Local bond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>6.7</td>
<td>5.1</td>
<td>0.7</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Grade II</td>
<td>5.9</td>
<td>4.4</td>
<td>0.6</td>
<td>0.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Grade III</td>
<td>5.2</td>
<td>3.9</td>
<td>0.5</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Grade IIA</td>
<td>10.0</td>
<td>7.6</td>
<td>0.9</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Grade IIIA</td>
<td>8.5</td>
<td>6.5</td>
<td>0.8</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Grade IIIIA</td>
<td>7.0</td>
<td>5.3</td>
<td>0.7</td>
<td>0.8</td>
<td>1.2</td>
</tr>
</tbody>
</table>
(2) Where the length \( L \) of a beam between adequate lateral restraints exceeds 20 times the breadth \( B \) of its compression flange, the compressive stress in the concrete shall not exceed the maximum permissible stress specified in Table XXVII multiplied by the coefficient specified in Table XXVIII for the appropriate \( L/B \) ratio.

**TABLE XXVIII**

**Stress reduction coefficients for beams**

<table>
<thead>
<tr>
<th>( L/B )</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slenderness ratio ( L/B )</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Coefficient</td>
<td>1.00</td>
<td>0.75</td>
<td>0.50</td>
<td>0.25</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

*Note:* Intermediate values shall be found by linear interpolation.

117. (1) Subject to the provisions of regulations 118 and 120, the tensile and compressive stresses in reinforcement shall not exceed the maximum permissible stresses specified in Table XXIX for each kind of stress.

**TABLE XXIX**

**Maximum permissible stresses in reinforcement in reinforced concrete**

<table>
<thead>
<tr>
<th>Kind of stress</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild steel complying with BS 449:1969</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Exceeding 40 mm</td>
<td>125</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Exceeding 40 mm</td>
<td>125</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Steel with minimum yield point ( f_y ) MPa</td>
<td>0.5 ( f_y ) or 185 whichever is the lesser</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tension other than tension in shear reinforcement</td>
<td>125</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Tension in shear reinforcement</td>
<td>125</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Compression in longitudinal reinforcement of axially loaded columns and in main reinforcement in beams and slabs where the compressive resistance of the concrete is not taken into account</td>
<td>125</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Compression in longitudinal reinforcement in columns other than axially loaded columns and in main reinforcement in beams and slabs where the compressive resistance of the concrete is taken into account</td>
<td>125</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>The calculated compressive stress in the surrounding concrete multiplied by the modular ratio but not exceeding</td>
<td>0.5 ( f_y ) or 140 whichever is the lesser</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(2) In a slender beam to which regulation 116(2) applies, the stress in any compression steel shall not exceed the permissible stress specified in Table XXIX for compression in main reinforcement multiplied by the appropriate coefficient specified in Table XXVIII.

(3) For the purpose of this regulation the modular ratio shall be taken as 15.

118. (1) Where a reinforced concrete column has a ratio of effective column length to least lateral dimension not exceeding 15, the stresses in that column shall not exceed the maximum permissible stresses specified in regulations 116 and 117.

(2) Where a reinforced concrete column has a ratio of effective length to least lateral dimension exceeding 15 and not exceeding 36, the stresses in that column shall not exceed the maximum permissible stress specified in regulations 116 and 117 multiplied by the coefficient specified in Table XXX for the appropriate ratio.

(3) The stress in a column due to a combination of direct load and bending action shall not exceed the maximum permissible stress for bending specified in regulations 116 and 117 multiplied by the coefficient specified in Table XXX for the appropriate ratio of length to least lateral dimension:

Provided that the direct stress shall not exceed the stress specified in paragraph (2).

**TABLE XXX**

<table>
<thead>
<tr>
<th>Ratio of effective column length to least lateral dimension</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1.0</td>
</tr>
<tr>
<td>18</td>
<td>0.9</td>
</tr>
<tr>
<td>21</td>
<td>0.8</td>
</tr>
<tr>
<td>24</td>
<td>0.7</td>
</tr>
<tr>
<td>27</td>
<td>0.6</td>
</tr>
<tr>
<td>30</td>
<td>0.5</td>
</tr>
<tr>
<td>33</td>
<td>0.4</td>
</tr>
<tr>
<td>36</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*Note: The coefficient for intermediate ratios of effective column length to least lateral dimension shall be determined by interpolation.*

(4) The ratio of effective column length to least lateral dimension for any reinforced concrete column or strut shall not exceed 36.
119. For the purpose of regulation 118 the effective length of a column shall be—

(a) in the case of a column specified in Table XXXI, that specified in column 2 of that Table; and

(b) in the case of a column not so specified, that determined to the satisfaction of the Building Authority.

<table>
<thead>
<tr>
<th>Type of column</th>
<th>Effective column length</th>
<th>Effective column length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Properly restrained at both ends in position and direction</td>
<td></td>
<td>.7 (L)</td>
</tr>
<tr>
<td>Properly restrained at both ends in position and at 1 end in direction</td>
<td></td>
<td>.85 (L)</td>
</tr>
<tr>
<td>Properly restrained at both ends in position but not in direction</td>
<td></td>
<td>(L)</td>
</tr>
<tr>
<td>Properly restrained at 1 end in position and direction and at the other end partially restrained in direction but not in position</td>
<td></td>
<td>1.5 (L)</td>
</tr>
<tr>
<td>Properly restrained at 1 end in position and direction but not restrained at the other end</td>
<td></td>
<td>2.0 (L)</td>
</tr>
</tbody>
</table>

Stresses due to wind.

120. The stresses in reinforced concrete may exceed the permissible stresses specified in regulations 116, 117 and 118 by not more than 25 per cent:

Provided that—

(a) such excess is solely due to stresses induced by wind loading; and

(b) except as provided in regulation 158(2) the maximum stress in reinforcement shall in no case exceed 185 MPa.

121. (1) The aggregate cross-sectional area of the longitudinal reinforcements in a reinforced concrete column shall be not less than 0.8 per cent nor more than 4 per cent of the gross cross-sectional area of that column required to transmit all the load.

(2) Where the longitudinal reinforcement in any column is continuous without laps and where the least lateral dimension of the column is not less than 375 mm, the maximum percentage of the longitudinal reinforcement may be increased to 8 per cent.

(3) A reinforced concrete column having helical reinforcement shall have not less than 6 longitudinal reinforcements placed equidistantly around the inner circumference of, and in contact with, the helical reinforcement.
(4) At each lap in each longitudinal reinforcement, the spliced reinforcements shall over-lap longitudinally through a distance of not less than—

(a) (i) 24 times the diameter of the smaller reinforcement for compressive reinforcement; and
(ii) 30 times the diameter of the smaller reinforcement for tensile reinforcement; or

(b) a sufficient distance to develop the force in the reinforcement by bond, as calculated in accordance with regulation 141,

whichever is the greater dimension.

122. (1) (a) A reinforced concrete column shall have transverse or helical reinforcement so disposed as to provide all necessary restraint against the buckling of each of the longitudinal reinforcements. Every bar in a column near the face should be properly linked.

(b) The transverse or helical reinforcement shall be secured to the longitudinal reinforcements and the ends of such transverse or helical reinforcement shall be properly anchored.

(2) The diameter of transverse reinforcement shall be not less than 6 mm or \( \frac{1}{4} \) of the diameter of the longitudinal reinforcement, whichever is the greater dimension.

(3) The pitch of the transverse reinforcement shall not exceed—

(a) the least lateral dimension of the column;

(b) 12 times the diameter of the smallest longitudinal reinforcement in that column; or

(c) 300 mm,

whichever is the least dimension.

(4) (a) Helical reinforcement shall be of regular formation with the turns of the helix spaced evenly.

(b) Where an increased load on the column on account of the helical reinforcement is allowed for under regulation 143(1)(b), the pitch of the helical turns shall be—

(i) not more than 75 mm or \( \frac{1}{12} \) of the core-diameter of the column, whichever is the lesser dimension; and

(ii) not less than 25 mm or 3 times the diameter of the helical reinforcement, whichever is the greater dimension.

(c) Where an increased load on the column on account of the helical reinforcement is not allowed, the requirements of paragraphs (2) and (3) shall be complied with.
123. (1) The diameter of a longitudinal reinforcement in a reinforced concrete column shall be not less than 12 mm.

(2) The diameter of the main reinforcement in a reinforced concrete slab shall be not less than 10 mm and that in a reinforced concrete beam not less than 12 mm.

(3) The diameter of a reinforcement in reinforced concrete (other than a longitudinal reinforcement in a column or a main reinforcement in a beam or slab) and the diameter of a link, helix, stirrup or the like, shall be not less than 6 mm.

(4) The diameter of reinforcement forming a fabric reinforcement for the purpose of resisting tension in reinforced concrete shall be not less than 5 mm.

124. (1) The distance between 2 reinforcements in reinforced concrete shall be not less than—

(a) the diameter of either bar if their diameters are equal;

(b) the diameter of the larger bar if their diameters are unequal; or

(c) 5 mm more than the greatest size of coarse aggregate comprised in the concrete.

whichever is the greatest dimension.

(2) (a) When immersion vibrators are used, sufficient space shall be provided to enable the vibrator to be inserted.

(b) The vertical distance between 2 horizontal main reinforcements and the corresponding distance at right angles to 2 inclined main reinforcements shall be not less than 15 mm or the maximum size of the coarse aggregate, whichever is the greater.

(3) The provisions of paragraph (1) shall not apply at a splice, except for the distance between pairs of lapped bars, nor to bars transverse to one another.

(4) The pitch of main reinforcements in a reinforced concrete solid slab shall not be more than 3 times the effective depth of that slab.

(5) The pitch of distributing reinforcements in a reinforced concrete solid slab shall be not more than 4 times the effective depth of that slab.

125. (1) Where at any cross-section the shear stress, as calculated from the equation given in regulation 140(1), exceeds the maximum permissible shear stress specified in regulation 116 the whole shearing force shall be provided for by the tensile resistance of shear reinforcement acting in proper combination with the compressive resistance in the concrete:
Provided that—

(a) the magnitude of the shear stress so calculated shall not exceed 4 times the maximum permissible shear stress for the concrete alone; and

(b) the local bond stress in the main reinforcement calculated in accordance with regulation 141(2)(a) does not exceed the maximum permissible local bond stress specified in regulation 116.

(2) Tensile reinforcement which is inclined and carried through a depth of beam equal to the arm of the resistance moment may also act as shear reinforcement provided it is anchored sufficiently.

126. (1) A stirrup in reinforced concrete shall pass round, or otherwise be adequately secured to, the appropriate tensile reinforcement and each end of that stirrup shall be properly anchored. Stirrups.

(2) Where at any cross-section the shear stress, as calculated from the equation given in regulation 140(1) does not exceed the permissible shear stress for the concrete, nominal stirrups shall be provided at a spacing not exceeding the arm of the resistance moment, or 450 mm., whichever is the smaller. Such nominal stirrups shall be not less than 6 mm in diameter for beams not more than 450 mm in depth and not less than 10 mm in diameter for beams more than 450 mm in depth:

Provided that in any event the cross-sectional area of such stirrups shall be not less than 0.15 per cent of the horizontal cross-sectional area of the beam.

127. In a reinforced concrete solid slab spanning in one direction—

(a) distributing reinforcement shall be provided at right-angles to the main tensile reinforcement of that slab; and

(b) the area of reinforcement in each direction shall be not less than 0.15 per cent of the gross cross-sectional area of the concrete at right-angles to the direction of the reinforcement.

128. (1) Where compression reinforcement is required in a beam, it shall be effectively anchored against buckling by stirrups at points not further apart, measured from centre to centre, than 12 times the diameter of that compression reinforcement or 300 mm., whichever is the smaller.

(2) Where the area of the compression reinforcement in a beam exceeds 4 per cent of the cross-sectional area of the beam, any steel in excess of that percentage shall be ignored in calculating the resistance moment of the beam.
(3) For the purposes of paragraph (2) the cross-sectional area of a rectangular beam shall be taken as the total depth multiplied by the width and for a T or L beam shall be taken as the total depth multiplied by the width of the rib.

129. (1) Where reinforced concrete walls are intended to carry vertical loads, they shall, subject to the provisions of this regulation, be in accordance with the appropriate provisions of regulations 114 to 123 for reinforced concrete columns—

(a) in the application of regulations 114 to 123 to reinforced concrete walls, "effective height", "thickness" and "vertical" shall respectively be substituted for "effective column length", "least lateral dimension" and "longitudinal" wherever they occur in those regulations; and

(b) the provisions of regulation 122 relating to helical reinforcement shall not apply.

(2) In a reinforced concrete wall intended to carry vertical loads—

(a) the aggregate cross-sectional area of the vertical reinforcement shall be not less than 0.4 per cent of the gross cross-sectional area of the wall;

(b) the aggregate cross-sectional area of the lateral reinforcement shall be not less than 0.2 per cent of the gross cross-sectional area of the wall;

(c) the diameter of a vertical reinforcement shall be not less than 10 mm; and

(d) the distance between 2 vertical reinforcements shall not exceed 300 mm.

(3) Where in a reinforced concrete wall, the stresses do not exceed 75 per cent of the maximum permissible stresses specified in regulation 116—

(a) the provisions of regulation 122 relating to transverse reinforcement shall not apply;

(b) the aggregate cross-sectional areas of the vertical and lateral reinforcements shall each be not less than 0.2 per cent of the gross cross-sectional area of the wall.

(4) The thickness of any load-bearing reinforced concrete wall shall be not less than 125 mm.

(5) When tension occurs in a reinforced concrete wall, adequate reinforcement shall be provided to resist such tension and throughout the wall the reinforcement shall not in any section thereof be less than 0.4 per cent of the gross cross-sectional area of that section.
(6) Whenever the vertical reinforcement is taken to assist in resisting compression, transverse reinforcements in the form of cross-ties shall be provided to prevent the vertical reinforcement from buckling.

(7) The pitch of the transverse reinforcement shall not exceed—

(a) 2 times the thickness of the reinforced concrete wall; or

(b) 16 times the diameter of the smallest vertical reinforcement in the wall; or

(c) 300 mm,

whichever is the least dimension.

(8) The effective width of a reinforced concrete wall subject to concentrated loads, shall not exceed—

(a) the distance measured from centre to centre between concentrated loads; or

(b) width of bearing plus 4 times the wall thickness on each side of the concentrated load.

whichever is the smaller dimension.

(9) A wall shall be effectively supported laterally by—

(a) horizontal reinforced concrete slabs of adequate thickness to prevent buckling; or

(b) beams spaced with a clear spacing of not more than a distance of 8 times the thickness of the wall; or

(c) reinforced concrete cross walls, where the wall is stiffened by closely spaced cross walls such that the length of wall between adjacent cross walls is less than the effective height, the slenderness ratio shall be assumed to be the ratio of this length to the wall thickness.

(10) In paragraphs (2) and (3) “lateral reinforcement” means reinforcements parallel to the length of the wall.

130. (1) Reinforcements shall not be connected by welding without the approval of the Building Authority.

(2) When reinforcements are connected by welding, they shall conform to the appropriate provisions of BS 693:1960 or BS 5135:1974.

131. (1) Computation of stresses shall accord with the laws of mechanics and the recognized general principles relating to the design of reinforced concrete.

(2) In the computation of stresses it shall be assumed that—
(a) both steel and concrete are elastic within the range of the permissible stresses and the modular ratio is equal to 15;

(b) at any cross-section plane sections remain plane; and

(c) 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 regulation 116.

132. (1) Reinforced concrete members shall possess adequate stiffness to prevent such deflexion or deformation as might impair the strength or efficiency of the structure or produce cracks in finishes or in partitions.

(2) For all normal cases it shall be assumed that the stiffness will be satisfactory if

(a) in the case of members with steel stresses not more than 125 MPa, the ratio of span to overall depth does not exceed the values given in Table XXXII; and

(b) in the case of members with steel stresses greater than 125 MPa, the ratio of span to overall depth does not exceed 90 per cent of the values given in Table XXXII.

| TABLE XXXII |
|-------------|------------------|
| Permissible values of ratio of span to depth of beams and slabs |
| (1) | (2) |
| BEAMS— | Ratio of span to overall depth |
| Simply supported | 20 |
| Continuous | 25 |
| Cantilever | 10 |
| SLABS— | |
| Spanning in 1 direction | |
| (i) simply supported | 30 |
| (ii) continuous | 35 |
| Spanning in 2 directions | |
| (i) simply supported | 35 |
| (ii) continuous | 40 |
| Cantilever | 12 |

(3) (a) For the purposes of calculating bending moments in continuous structures, the moment of inertia shall be estimated by considering—
(i) the entire concrete section, ignoring the reinforcement;
(ii) the entire concrete section, including the reinforcement, on the basis of the modular ratio; or
(iii) the compression area of the concrete section, combined with the reinforcement on the basis of the modular ratio.

(b) The same method shall be adopted for the beams and the columns.

133. (1) The effective span of a beam or slab shall be taken as—

(a) the distance between the centres of bearings; or
(b) the clear distance between supports plus the effective depth of the beam or slab,

whichever is the lesser.

(2) In paragraph (1)(b) "effective depth" of a beam or slab is the distance between the centre of tension and the edge of the compression section.

134. (1) In T-beams the breadth of the flange assumed as taking compression shall not exceed

(a) \( \frac{1}{4} \) of the effective span of the T-beams;
(b) the distance between the centres of the ribs of the T-beams; or
(c) the breadth of the rib plus 12 times the thickness of the slab,

whichever is the least.

(2) In L-beams the breadth of the flange assumed as taking compression shall not exceed—

(a) \( \frac{1}{4} \) of the effective span of the L-beams;
(b) the breadth of the rib plus \( \frac{1}{2} \) of the clear distance between ribs; or
(c) the breadth of the rib plus 4 times the thickness of the slab,

whichever is the least.

(3) When a part of a slab is considered as the flange of a T-beam or L-beam—

(a) \( \backslash (i) \) the reinforcement in the slab transverse to the beam shall cross the full breadth of the flange; and
(ii) where the slab is assumed to be spanning independently in the same direction as the beam, such transverse reinforcement shall be near the top surface of the slab; and

(b) the quantity of such reinforcement shall—

(i) be related to the shear stress in the slab produced by its acting as the compression member of the T-beam or L-beam; and

(ii) in no case be less than 0.3 per cent of the gross cross-sectional area of the slab.

135. (1) Bending moments in beams and slabs shall be calculated for the effective span and all loading thereon.

(2) The bending moments to be provided for at a cross-section of a continuous beam or slab shall be the maximum positive and negative moments at such cross-section, allowing in both cases, if so desired, for the reduced moments due to the width of the supports, for the following arrangements of super-imposed loadings—

(a) alternate spans loaded and all other spans unloaded;

(b) any 2 adjacent spans loaded and all other spans unloaded.

(3) Except where the approximate values for bending moments assumed in regulation 136(1)(c) are used, the negative moments at the supports for any assumed arrangements of loading may each be increased or decreased by not more than 15 per cent, in which case the calculated simultaneous positive moments in the 2 adjacent spans shall be decreased or increased, respectively, by the same numerical value and the positive moments elsewhere in the span adjusted accordingly.

136. (1) The bending moments in beams and slabs spanning in 1 direction shall be calculated on 1 of the following assumptions—

(a) beams shall be designed as members of a continuous framework, with monolithic connexion between the beams and columns, and the bending moments calculated taking into account the resistance of the columns to bending;

(b) beams and slabs shall be designed as continuous over supports and capable of free rotation about them. Nevertheless, where the supports to beams or slabs are monolithic with them and stiff in relation to them, the beams or slabs shall be designed with due regard to such stiffness; or

(c) unless more exact estimates are made, the bending moments in uniformly loaded beams and slabs continuous over 3 or more approximately equal spans shall be assumed to have the values given in Table XXXIII.
TABLE XXXIII

Approximate values of bending moments in uniformly loaded beams and slabs continuous over 3 or more approximately equal spans

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Near middle of end span</td>
<td>At support next to end support</td>
<td>At middle of interior spans</td>
<td>At other interior supports</td>
</tr>
<tr>
<td>Moment due to dead load</td>
<td>( \frac{W_d}{12} )</td>
<td>( \frac{W_d}{10} )</td>
<td>( \frac{W_d}{24} )</td>
<td>( \frac{W_d}{12} )</td>
</tr>
<tr>
<td>Moment due to superimposed load</td>
<td>( \frac{W_c}{10} )</td>
<td>( \frac{W_c}{9} )</td>
<td>( \frac{W_c}{12} )</td>
<td>( \frac{W_c}{9} )</td>
</tr>
</tbody>
</table>

Note: \( W_d \) is the total dead load per span.
\( W_c \) is the total superimposed load per span.
Spans may be considered as approximately equal when the shortest span is not less than 85 per cent of the longest span.

(2) Notwithstanding the provisions of paragraph (1), where beams are framed into external columns they shall be designed to resist bending moments in combination with the columns in conformity with regulation 143.

137. (1) The design of solid slabs spanning in 2 directions at right angles shall be based on either of the methods given in paragraphs (2) and (3).

(2) In order to estimate the bending moments in a slab spanning in 2 directions at right angles, the slab shall be assumed to act as a perfectly elastic thin plate, Poisson’s ratio being assumed equal to zero.

(3) Where, in the case of a simply supported slab, adequate provision is not made to resist torsion at the corners of the slab and to prevent the corners from lifting, the bending moments at mid-span shall be assumed to have the values given by the following equations:

\[
M_x = z_x w l_x^2 \\
M_y = z_y w l_y^2
\]

where \( M_x \) and \( M_y \) are the bending moments at mid-span on strips of unit width and spans \( l_x \) and \( l_y \) respectively;
\( w \) is the total load per unit area;
\( l_x \) is the length of the longer side;
\( l_y \) is the length of the shorter side; and
\( z_x \) and \( z_y \) are coefficients shown in Table XXXIV.
TABLE XXXIV
Bending moment coefficients for slabs spanning in 2 directions
at right angles simply supported on 4 sides

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>l_y/l_x</td>
<td>1.0</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
<td>1.75</td>
<td>2.0</td>
<td>2.5</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>χ_y</td>
<td>0.062</td>
<td>0.074</td>
<td>0.084</td>
<td>0.093</td>
<td>0.099</td>
<td>0.104</td>
<td>0.113</td>
<td>0.118</td>
<td>0.122</td>
<td>0.124</td>
<td></td>
</tr>
<tr>
<td>χ_x</td>
<td>0.062</td>
<td>0.061</td>
<td>0.059</td>
<td>0.055</td>
<td>0.051</td>
<td>0.046</td>
<td>0.037</td>
<td>0.029</td>
<td>0.020</td>
<td>0.014</td>
<td></td>
</tr>
</tbody>
</table>

(4) In the case of slabs restrained on 4 sides—

(a) where the corners of a slab are prevented from lifting and adequate provision for torsion in accordance with subparagraph (e) is made, the bending moments shall be assumed to have the values given in sub-paragraph (c);

(b) slabs are considered as being divided in each direction into middle strips and edge strips as shown in Diagram 1, the middle strip having a width of \( \frac{3}{4} \) of the width of the slab and each edge strip having a width of \( \frac{1}{4} \) of the width of the slab, except that, for slabs for which the ratio of the sides \( l_y/l_x \) exceeds 4.0, the middle strip in the short direction shall be taken to have a width of \( l_y - l_x \) and each edge strip a width of \( l_x/2 \).

(c) the maximum bending moments per unit width in the middle strip of a slab shall be calculated by the following equations:

\[
M_x = \beta_x w l_x^2
\]
\[
M_y = \beta_y w l_y^2
\]

where—\( M_x \) and \( M_y \) are the maximum bending moment on strips of unit width in the direction of spans \( l_y \) and \( l_x \) respectively;

\( w \) is the total load per unit area;

\( l_y \) is the length of the longer side;

\( l_x \) is the length of the shorter side;

\( \beta_x \) and \( \beta_y \) are coefficients given in Table XXXV.
### TABLE XXXV

Bending moment coefficients for rectangular panels supported on 4 sides with provision for torsion at corners

<table>
<thead>
<tr>
<th>Type of panel and moments considered</th>
<th>Short span coefficients $\beta_s$</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values of $\frac{l_s}{l_c}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 3 4 5 6 7 8 9 2.0 or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0 1.1 1.2 1.3 1.4 1.5 1.75 2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Interior panels—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>negative moment at continuous edge</td>
<td>0.033 0.040 0.045 0.050 0.054</td>
<td></td>
</tr>
<tr>
<td>positive moment at mid-span</td>
<td>0.025 0.030 0.034 0.038 0.041</td>
<td></td>
</tr>
<tr>
<td>2. 1 short or long edge is discontinuous—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>negative moment at continuous edge</td>
<td>0.041 0.047 0.053 0.057 0.061</td>
<td></td>
</tr>
<tr>
<td>positive moment at mid-span</td>
<td>0.031 0.035 0.040 0.043 0.046</td>
<td></td>
</tr>
<tr>
<td>3. 2 adjacent edges discontinuous—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>negative moment at continuous edge</td>
<td>0.049 0.056 0.062 0.066 0.070</td>
<td></td>
</tr>
<tr>
<td>positive moment at mid-span</td>
<td>0.037 0.042 0.047 0.050 0.053</td>
<td></td>
</tr>
<tr>
<td>Type of panel and moments considered</td>
<td>Short span coefficients $\beta_x$</td>
<td>10</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------------------------</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>Values of $\frac{l_x}{l_c}$</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 short edges discontinuous—</td>
<td></td>
<td></td>
</tr>
<tr>
<td>negative moment at continuous edge</td>
<td>0.056</td>
<td></td>
</tr>
<tr>
<td>positive moment at mid-span</td>
<td>0.044</td>
<td></td>
</tr>
<tr>
<td>5 long edges discontinuous—</td>
<td>0.044</td>
<td></td>
</tr>
<tr>
<td>negative moment at continuous edge</td>
<td>0.053</td>
<td></td>
</tr>
<tr>
<td>positive moment at mid-span</td>
<td>0.060</td>
<td></td>
</tr>
<tr>
<td>6 edges discontinuous (1 short or</td>
<td>0.058</td>
<td></td>
</tr>
<tr>
<td>long edge continuous)—</td>
<td>0.044</td>
<td></td>
</tr>
<tr>
<td>negative moment at continuous edge</td>
<td>0.065</td>
<td></td>
</tr>
<tr>
<td>positive moment at mid-span</td>
<td>0.067</td>
<td></td>
</tr>
<tr>
<td>7 edges discontinuous—</td>
<td>0.050</td>
<td></td>
</tr>
<tr>
<td>positive moment at mid-span</td>
<td>0.057</td>
<td></td>
</tr>
</tbody>
</table>

Long span coefficients $\beta_c$ for all values of $\frac{l_x}{l_c}$ of 2 or more:

<table>
<thead>
<tr>
<th>Values of $\frac{l_x}{l_c}$</th>
<th>2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.056</td>
<td>0.044</td>
</tr>
</tbody>
</table>
(d) No reinforcement parallel to the adjacent edges of the slab need be inserted in the edge strips above that required to comply with sub-paragraph (e) and regulations 124 and 127(b).

(e) (i) Torsion reinforcement shall be provided at the corners of a slab except at corners contained by edges over both of which the slab is continuous.

(ii) At corners contained by edges over neither of which the slab is continuous, top and bottom reinforcement shall be provided for torsion at the corners of the slabs. Both top and bottom reinforcement shall consist of 2 layers of bars placed parallel to the sides of the slab and extending in these directions for a distance of 1/2 of the shorter span. The area of the bars in each of the 4 layers, per unit width of the slab, shall be 1/4 of the area required for the maximum positive moment in the slab.

(iii) At corners contained by edges over only 1 of which the slab is continuous, the torsional reinforcement may be reduced to 1/4 of that required by sub-sub-paragraph (ii).

(iv) Any reinforcement provided for the purpose of complying with other regulations may be included as part of the reinforcement required to comply with this paragraph.

(f) Where a slab ends and there is monolithic connexion between the slab and the supporting beam or wall, provision shall be made for the negative moments that may occur in the slab at such support. The negative moment to be assumed in these cases depends on the degree of fixity afforded to the edge of the slab, but for general purposes it may be taken as 1/4 of the moment given in Table XXXV for the mid-span of the slab.

(5) The loads on the supporting beams for a 2-way rectangular slab shall be assumed to be in accordance with Diagram 2.

**Diagram 2**

Diagram showing the load carried by supporting beams
138. (1) Allowance shall be made for the bending moments due to concentrated loads, using methods based on the elastic theory.

(2) (a) If a solid slab is simply supported on 2 opposite edges and carries 1 or more concentrated loads in a line in the direction of the span, it shall be designed to resist the maximum bending moment caused by the loading system. Such bending moment shall be assumed to be resisted by an effective width of slab (measured parallel to the supports) equal to the sum of the load width and \(2.4 \times (1 - \frac{x}{l})\) where \(x\) is the distance from the nearer support to the section under consideration and \(l\) is the span.

(b) Where the concentrated load is near an unsupported edge of a solid slab the effective width shall not exceed the value in sub-paragraph (a), nor \(\frac{1}{2}\) that value plus the distance of the centre of the load from the unsupported edge as shown in Diagram 3.

![Diagram 3](image)

(3) Notwithstanding the provisions of regulation 127, distribution reinforcement of not less than 0.3 per cent of the gross cross-sectional area of the slab shall be provided over the full effective width resisting the bending moment due to the concentrated load.

139. When openings in floors or roofs are required such openings shall be trimmed where necessary by special beams or reinforcement so that the designed strength of the surrounding floor is not impaired by the opening, due regard being paid to the possibility of diagonal cracks developing at the corners of openings.

140. (1) The shear stress \(q\) at any cross-section in a reinforced concrete beam or slab shall be calculated from the following equation:
\[ q = \frac{Q}{bl_a} \]

where—
- \( Q \) is the total shearing force across the section;
- \( b \) is the breadth of a rectangular beam or the breadth of the rib of a T-beam or L-beam; and
- \( l_a \) is the arm of the resistance moment.

(2) (a) Where 2 or more types of shear reinforcement are used in conjunction, the total shearing resistance of the beam may be assumed to be the sum of the shearing resistances computed for each type separately.

(b) The spacing of stirrups when required to resist shear—
(i) shall be not less than 8 times the diameter of the stirrups or 75 mm, whichever is the greater; and
(ii) shall not exceed a distance equal to the arm of the resistance moment.

The resistance to shear \( Q \) shall then be calculated from the following equation:

\[ Q = \frac{P_u A_w l_a}{s} \]

where—
- \( P_u \) is the permissible tensile stress in the shear reinforcement;
- \( A_w \) is the cross-sectional area of the stirrup;
- \( l_a \) is the arm of the resistance moment; and
- \( s \) is the spacing of stirrups.

(c) (i) The resistance to shear at any section of a beam, reinforced with inclined bars, may be calculated on the assumption that the inclined bars from the tension members of 1 or more single systems of lattice girders in which the concrete forms the compression members.

(ii) The shear resistance at any vertical section shall then be taken as the sum of the vertical components of the tension and compression forces cut by the section.

(iii) Care must be taken that such assumptions do not involve greater stresses in the horizontal bars than the permissible stresses.

141. (1) (a) A bar in tension shall extend from any section for a distance to the end of the bar such that the average bond stress does not exceed the permissible average bond stress given in regulation 116.

(b) The length measured from such section shall be not less than—

\[ \frac{\text{the bar diameter} \times \text{the tensile stress in the bar}}{4 \times \text{the permissible average bond stress}} \]
(c) The bar shall extend at least 12 bar diameters beyond the point at which it is no longer required to resist stress.

(d) For the purposes of this paragraph, the length of the bar so determined may have deducted from it a length equivalent to the value of the hook as given in paragraph (5) but no deduction shall then be made for the length of the bar contained in the hook.

(2) (a) The local bond stress calculated from the formula—

\[
\frac{Q}{l_o \rho}
\]

where—

- \(Q\) is the total shear force across the section;
- \(l_o\) is the arm of the resistance moment; and
- \(\rho\) is the sum of the perimeters of the bars in the tensile reinforcement,

shall not at any point exceed the permissible local bond stress given in regulation 116.

(b) In members of variable depth the effect of the change in depth shall be taken into account in calculating the bond stress.

(3) Hooks and other anchorages of reinforcement shall be of such form, dimensions and arrangement as will ensure their adequacy without over-stressing the concrete or other anchorage material.

(4) (a) A hook at the end of a mild steel bar shall be of the form indicated in Diagram 4 with an internal radius of the bend not less than 2 times the diameter of the bar, and a length of straight bar beyond the end of the curve of at least 4 times the diameter of the bar, except that where the hook fits over a main reinforcing or other adequate anchor bar, the radius of the bend may be reduced to that of the main reinforcing or anchor bar.

![Diagram 4](image-url)

**Diagram 4**

Standard hook for mild steel bars

- Diameter of bar
- Radius 2D, unless round main bar
- Not less than 6D
(h) Where hooks are formed in high-yield bars—
   (i) the internal radius of the bend shall be at least 3 times the diameter of the bar; and
   (ii) the length of straight bar beyond the end of the curve shall be at least 4 times the diameter of the bar.

(5) A bend in a reinforcement bar shall be assumed to have an anchorage value equivalent to a length of bar equal to 4 times the diameter of the bar for each 45 degrees through which the bar is bent:

Provided that—

(a) the radius of the bend shall be not less than 2 times the diameter of mild steel bars, or 3 times the diameter of high-yield bars;

(b) the length of the straight part of the bar beyond the end of the curve shall be at least 4 times the diameter of the bar; and

(c) whatever be the angle through which the bar is bent, the assumed anchorage value shall not be taken as more than equivalent to a length of bar equal to 16 times the diameter of the bar.

(6) In bends in reinforcing bars, the local stress on the concrete shall not exceed 3 times the value permitted in regulation 116 for the concrete in direct compression.

(7) Notwithstanding any of the provisions of paragraphs (1) to (6), in the case of stirrups and transverse ties, complete bond length and anchorage shall be deemed to have been provided when the bar is—

(a) (i) bent through an angle of at least 90 degrees round a bar of at least its own diameter; and
   (ii) the stirrup or tie is continued beyond the end of the curve for a length of at least 8 bar diameters; or

(b) (i) bent through an angle of 180 degrees; and
   (ii) the stirrup or tie is continued beyond the end of the curve for a length of at least 4 bar diameters.

(8) (a) A bar in compression shall extend from any section for a distance such that the average bond stress does not exceed the permissible average bond stress given in regulation 116 by more than 25 per cent.

(b) The length measured from such section shall be not less than—

\[
\frac{\text{the bar diameter} \times \text{the compressive stress in the bar}}{5 \times \text{the permissible average bond stress.}}
\]
(c) The bar shall extend at least 12 bar diameters beyond the point at which it is no longer required to resist stress.

(9) (a) Laps in bars in any member shall be staggered wherever practicable.

(b) The length of lap in bars in tension shall be not less than—

\[
\text{the bar diameter } \times \frac{\text{the tensile stress in the bar}}{4 \times \text{the permissible average bond stress}} = 30 \text{ bar diameters.}
\]

whichever is the greater.

(c) The length of lap in bars in compression shall be not less than—

\[
\text{the bar diameter } \times \frac{\text{the compressive stress in the bar}}{5 \times \text{the permissible average bond stress}} = 24 \text{ bar diameters.}
\]

whichever is the greater.

(10) (a) In the case of deformed bars, the bond stresses shall not exceed those permitted in regulation 116 by more than 25 per cent.

(b) For the purpose of this paragraph, a bar is deformed if its bond strength exceeds that of a plain round bar by 25 per cent or more.

(11) All bent up bars acting as shear reinforcements shall be fully anchored in both flanges of the beam, the anchorage length being measured from the end of the sloping portion of the bar.

142. (1) In this regulation, a floor or roof of ribbed and hollow block construction means a floor or roof which consists of a series of reinforced concrete ribs cast-in-situ—

(a) between blocks which remain part of the completed floor or roof; or

(b) on forms which may be removed after the concrete has set.

(2) Blocks and forms shall be of suitable material which will retain its shape and dimensions and is strong enough to support the concrete when placed.

(3) The tops of the ribs shall be connected by a topping of concrete, of the same quality as the concrete used for the ribs and, cast-in-situ, over the blocks or forms.

(4) The blocks shall be neglected in determining the bending and shearing resistance of hollow block construction.
(5) Subject to the provisions of Part XVI (Fire Resisting Construction), the thickness of topping, after allowance has been made for the effect of wear if necessary, shall be not less than 50 mm or \( \frac{1}{10} \) the clear distance between the ribs, whichever is the greater.

(6) (a) The width of the rib shall be not less than 75 mm.

(b) The depth, excluding any topping, shall be not more than 3 times the width.

(c) The spacing shall be not more than 750 mm measured from centre to centre.

(7) At least 50 per cent of the total positive reinforcement in ribs shall be carried through at the bottom on to the bearing and effectively anchored.

(8) For the purpose of determining the positive reinforcement in the span, floors continuous over supports may be treated as simply supported. in which case, negative reinforcement shall—

(a) be provided over the support to prevent cracking;

(b) have a cross-sectional area of not less than \( \frac{1}{2} \) of the positive reinforcement in the middle of the adjoining bays; and

(c) extend at least \( \frac{1}{2} \) of the clear spans into the adjoining bays.

(9) Notwithstanding regulation 115 (minimum cover to reinforcement) and subject to the provisions of Part XVII (Fire Resisting Construction), cover to reinforcement shall be not less than 20 mm or the diameter of the bar, whichever is the greater, exclusive of any finishing materials.

(10) Notwithstanding regulations 123, 124 and 125, the topping slab shall be reinforced with—

(a) main reinforcement at right angles to the ribs, required for flexure, but not less than 0.3 per cent of the gross cross-sectional area of the concrete and spaced at a distance not more than 4 times the total thickness of the topping; and

(b) distribution reinforcement at right angles to the main reinforcement of an amount not less than 0.15 per cent of the gross cross-sectional area of the concrete and spaced at a distance not more than 5 times the total thickness of the topping:

Provided that the diameter of the main reinforcement shall be not less than 6 mm where bars are used or 5 mm where fabric is used.

(11) Where blocks are used in between cast-in-situ ribs as part of the completed floor or roof, they shall not be placed within 75 mm from the walls or beams at right angles or parallel to the ribs.
(12) In floor or roof systems where the ribs run in one direction only, stiffeners of minimum 75 mm width between ribs for the full depth of the rib shall be provided for clear length of rib greater than 4 m and at intervals not exceeding 4 m.

Permissible loads on columns.

143. (1) (a) The permissible axial load $P_o$ on a column reinforced with longitudinal bars and lateral ties shall not exceed that given by the following equation:

$$P_o = p_{ce} A_c + p_{sc} A_{sc}$$

where—$p_{ce}$ is the permissible stress for the concrete in direct compression;

$A_c$ is the cross-sectional area of concrete excluding reinforcing steel;

$p_{sc}$ is the permissible compressive stress for column bars; and

$A_{sc}$ is the cross-sectional area of the longitudinal steel.

(b) Where helical reinforcement is used, the permissible axial load $P_o$ on a column shall not exceed that given by the equation in sub-paragraph (a), or the following equation, whichever is the greater:

$$P_o = P_{cv} A_k + P A_w + 185 A_h$$

where—$A_k$ is the cross-sectional area of concrete in the core excluding the area of longitudinal reinforcement; and

$A_h$ is the equivalent area of helical reinforcement (volume of helix per unit length of the column), and

$P_{cv} A_k + 185 A_h$ shall not exceed $0.5 u_w A_h$, where $u_w$ is the works resistance to crushing of the concrete at 28 days.

(c) The permissible combination of direct load and bending moment to which a column may be subjected shall be determined on the basis of the elastic theory, with a modular ratio of 15 and the permissible stresses in bending given in regulations 116 and 117.

(d) The load on a column subject to both direct load and bending moment shall not exceed that permissible for an axially load column.

(e) The permissible load on a reinforced concrete column, having a ratio of effective length to least lateral dimension between 15 and 36, shall not exceed the appropriate permissible load in sub-paragraph (a), (b), (c) or (d) multiplied by the coefficient appropriate for each ratio of
effective column length to least lateral dimension shown in Table XXX. When, in a column having helical reinforce-
ment, the permissible load is based on the core area, the least lateral dimension shall be taken as the diameter of the core.

(2) (a) Bending moments in internal columns supporting an approximately symmetrical arrangement of beams and loading shall not be required to be calculated except in the case of flat slab construction.

(b) Bending moments in external columns and in internal columns supporting an arrangement of beams and loading not approximately symmetrical shall be calculated and provided for. The expression given in Table XXXVI shall be used for estimating moments—

TABLE XXXVI

Moments in columns

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Moments for frames of 1 bay</td>
<td>Moments for frames of 2 or more bays</td>
</tr>
<tr>
<td>External and similarly loaded column</td>
<td>Moment at foot of upper column</td>
<td>$M_c = \frac{K_u}{K_f + K_e + 0.5 K_h}$</td>
<td>$M_c = \frac{K_u}{K_f + K_e + K_h}$</td>
</tr>
<tr>
<td></td>
<td>Moment at head of lower column</td>
<td>$M_c = \frac{K_f}{K_f + K_e + 0.5 K_h}$</td>
<td>$M_c = \frac{K_f}{K_f + K_e + K_h}$</td>
</tr>
<tr>
<td>Internal column</td>
<td>Moment at foot of upper column</td>
<td>$M_c = \frac{K_u}{K_f + K_e + K_h + K_{h1}}$</td>
<td>$M_c = \frac{K_u}{K_f + K_e + K_h + K_{h2}}$</td>
</tr>
<tr>
<td></td>
<td>Moment at head of lower column</td>
<td>$M_c = \frac{K_f}{K_f + K_e + K_h + K_{h1}}$</td>
<td>$M_c = \frac{K_f}{K_f + K_e + K_h + K_{h2}}$</td>
</tr>
</tbody>
</table>

Note:—

(1) $M_c$ is the bending moment at the end of the beam framing into the column, assuming fixity at both ends of the beam;

$M_{e1}$ is the maximum difference between the moments at the ends of the 2 beams framing into opposite sides of the column, each calculated on the assumption that the ends of the beams are fixed and assuming one of the beams unloaded;

$K_h$ is the stiffness of the beam;

$K_{h1}$ is the stiffness of the beam on 1 side of the column;

$K_{h2}$ is the stiffness of the beam on the other side of the column;

$K_f$ is the stiffness of the lower column;

$K_u$ is the stiffness of the upper column.

(2) The stiffness of a member shall be obtained by dividing the moment of inertia of a cross-section by the length of the member, provided that the member is of constant cross-section throughout its length.
144. (1) The bending moments at any section of a footing for a reinforced concrete column or wall shall be taken to be the moment of the forces over the entire area on 1 side of the section. The critical section for bending in the footing shall be taken at the face of the column or the wall.

(2) (a) Subject to sub-paragraph (b) the reinforcement provided to resist the bending moments specified in paragraph (1) shall be distributed uniformly across the full width of the section.

(b) In rectangular footings for columns, the reinforcement parallel to the short edge should be more closely spaced near the column.

(3) The critical sections for shear shall be taken to be at a distance from the column face equal to the effective depth of the footing.

(4) The critical section for local bond stress shall be taken to be the same section as the critical section for bending moment at the face of the column or wall.

145. Flat slabs may be designed—

(a) as continuous frames analysed by the elastic theory in the manner described in regulation 155; or

(b) by the empirical method described in regulation 156,

and shall comply with regulations 146 to 154.

146. (1) In regulations 147 to 156—

“flat slab” means a reinforced concrete slab with or without drops, supported, generally without beams, by columns with or without flared column heads;

“panel” means the rectangular part of a flat slab enclosed by the centre lines joining 4 adjacent columns;

“drop” means the part of a flat slab which is thickened throughout an area surrounding the column or column head; and

“column head” means an enlargement at the top of a column which is designed and built to act monolithically with the column and flat slab.

(2) In regulations 147 to 156—

$L_1$ is the length of the panel in the direction of the span;

$L_2$ is the width of the panel at right angles to the span;

$L$ is the average of $L_1$ and $L_2$;

$D$ is the diameter of the column head or column, where no column head is provided;

$t_s$ is the thickness of the slab;

$t_d$ is the thickness of the drop; and

$w$ is the total load per unit area on the panel.
147. Flat slab panels shall be assumed to be divided into:

(a) a middle strip which shall run the full length of the panel symmetrical about the centre line of the panel and \( \frac{1}{2} \) the width of the panel;

(b) a column strip which shall run the full length of the panel and consist of 2 adjacent quarter panel widths, 1 on each side of the column centre line.

as shown in Diagram 5.

148. The minimum thickness \( t_s \) of a flat slab shall be not less than—

(a) 125 mm;

(b) \( \frac{L}{32} \) for end panels without drops;

(c) \( \frac{L}{36} \) for fully continuous interior panels without drops and for end panels with drops;

(d) \( \frac{L}{40} \) for fully continuous interior panels with drops.

whichever is the greatest.

149. (1) The critical sections for shear shall be assumed to be—

(a) at a distance from the column head or, when no column head is provided, from the column of \( \frac{1}{2} \) the thickness of the drop, or, where no drop is provided, \( \frac{1}{2} \) the thickness of the slab; and
(b) at a distance from the drop of \( \frac{1}{2} \) the thickness of the slab, as shown in Diagrams 6, 7 and 8.

(2) The shearing stresses at the critical sections shall not exceed the permissible values specified in regulation 116.

150. (1) Columns supporting flat slabs shall not be less than 300 mm in diameter.

(2) When column heads are provided, the interior column heads and such parts of the exterior column heads as will lie within the building shall satisfy the following requirement—

(a) the angle of slope of the column head shall not exceed 45° from the vertical;

(b) the diameter \( (D) \) of the column head shall be measured at a distance 40 mm below the slab or drop; and

(c) the diameter \( (D) \) shall not exceed \( \frac{L}{4} \).

as shown in Diagrams 7 and 8.

(3) For the purposes of paragraph (2), where column and column head are not circular in cross-section the term diameter \( (D) \) shall be deemed to mean the diameter of the largest circle which can be drawn within the actual section at a distance of 40 mm below the slab or drop.

(4) No part of any column head which lies outside the envelope described in paragraph (2) shall be considered for structural purposes.

**DIAGRAM 6**

Critical section for shearing stress in flat slabs without drop and column without column head
151. (1) An opening shall not encroach on a column head or a drop.

(2) Except where the aggregate length or width of openings does not exceed any of the following—

(a) in the area common to 2 middle strips, 0.4L measured parallel to the centre line;

(b) in the area common to a middle strip and a column strip, \(\frac{1}{2}\) the width of the strip;
(c) in the area common to 2 column strips, \( \frac{1}{10} \) of the width of the strip.

openings shall be completely framed on all sides with beams capable of carrying the loads to the columns.

(3) When framing capable of carrying the loads to the columns is not provided for openings within the limitations of paragraph (2), the remaining portions of the slab or strip shall be designed to resist the total negative or positive moments and shear so that the strength of the slab as a whole is not impaired by the openings.

Drops in flat slab construction.

152. (1) Drops shall be rectangular in plan.

(2) The thickness of a drop shall be not less than \( 1\frac{1}{4} \), nor more than \( 1\frac{1}{2} \), times the thickness of the slab.

(3) The overall width of a drop shall be not less than \( \frac{1}{2} \) the panel width nor more than \( \frac{1}{4} \) the panel width in that direction.

(4) For exterior panels the width of the drop at right angles to the discontinuous edge and measured from the column centre line shall be \( \frac{1}{2} \) the width of drop for interior panels.

Reinforcement of flat slabs generally.

153. (1) The spacing of reinforcement at critical sections shall not exceed 2 times the effective depth except in those portions of the slab which may be of cellular or ribbed construction.

(2) When the drop, if provided, is less than the full width of the column strip, the reinforcement in the thinner part of the column strip shall be of the same diameter at the same spacing as the reinforcement in the middle strip and the remainder of the reinforcement required to resist the maximum bending moments in the column strip shall be placed within the width of the drop.

(3) When the diameter of the column head is less than 2 times the diameter of the column, \( \frac{1}{3} \) of the reinforcement required to resist the negative moment in the column strip shall be placed in \( \frac{1}{2} \) the width of the column strip and symmetrical about the line joining the column centres.

(4) At all discontinuous edges all reinforcement shall extend to within 75 mm of the edge of the panel and shall be hooked around a bar of its own or greater diameter or shall be properly anchored in the edge beam, if any.

(5) Splices—

(a) shall not be made at sections of maximum stress; and

(b) where required, should be staggered.
154. Where the slab is supported by a marginal beam of depth greater than 1 1/2 times the thickness of the slabs, or by a wall—

(a) the load to be carried by the beam or wall shall be all loads carried directly on the beam or wall plus a uniformly distributed load equal to 1/4 of the total load on the slab;

(b) the bending moment in the 1/2 column strip adjacent and parallel to the beam or wall shall be 1/4 of the moments specified in regulation 155 or 156.

155. Where flat slabs are designed as continuous frames and analysed by the elastic theory—

(a) the structure shall be divided longitudinally and transversely into frames each consisting of a row of columns and a strip of slab bounded by the centre lines of the panels on each side of the row of columns, both longitudinal and transverse frames each being designed for the full load on the floor area;

(b) each frame may be analysed in its entirety, or each strip of floor or roof may be analysed separately assuming the columns to be fixed at the floor above and below;

(c) the spans used in the analysis shall be to the centre lines of supports except for a slab supported on a wall when the span shall be taken to the face of the wall plus 1/2 the depth of the slab;

(d) the moment of inertia of the slab or column shall be assumed to be that of the gross cross-section of the concrete, variation of moment of inertia along the axes of columns or slabs being taken into account;

(e) the joints between column and slab shall be considered rigid and this rigidity (infinite moment of inertia) shall extend in the slab from the column centre line to the edge of the column or column head and in the column from the top of the slab to the bottom of the column head if provided;

(f) the maximum moments shall be calculated for the following arrangement of the imposed loads—

(i) where alternate spans are loaded and all other spans unloaded; and

(ii) where any 2 adjacent spans are loaded and all other spans unloaded;

(g) the slab shall be designed for the bending moments as determined in sub-paragraph (f), which shall be distributed between the column strip and middle strip in accordance with Table XXXVII;
TABLE XXXVII

Distribution expressed as percentage of

total negative or positive moments

<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Column strip</td>
<td>Middle strip</td>
</tr>
<tr>
<td>Negative moments</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>Positive moments</td>
<td>55</td>
<td>45</td>
</tr>
</tbody>
</table>

Note: Provision need not be made for greater negative moments than those at the critical sections for shear immediately adjacent to the column as defined in regulation 149 (1)(a).

Provided that the sum of the maximum positive bending moment and the average of the maximum negative bending moments for the whole panel width used in the design of any 1 span shall be not less than:

\[
\frac{wL_2}{10} \left( L_1 - \frac{2D}{3} \right)^2
\]

(i) where \( w \) is the total load per unit area on the panel;

(ii) where the diameters of the columns or column heads supporting the panel are not equal, \( D \) shall be taken as the average of the 2 diameters;

(h) columns shall be designed to resist the combination of bending moment and direct load consistent therewith which produces the greatest stresses in the column.

156. (1) Flat slabs designed by the empirical method shall comply with the provisions of this regulation.

(2) The slabs shall comprise rectangular panels and there shall be at least 3 continuous panels in both directions.

(3) The ratio of the length of a slab to its width shall not exceed 4:3.

(4) The length or width of any 2 adjacent panels shall not differ by more than 10 per cent of the greater length or width. End spans may be shorter but not longer than adjacent interior panels.

(5) Where adjacent spans differ the length of the longer span shall be used in calculating the negative bending moments between the 2 panels.

(6) For fully continuous interior panels the critical sections for bending moment are—

(a) for positive moment, along the centre lines of the panels;
(b) for negative moments, along lines joining the centres of the columns and around the perimeter of the column heads.

(7) The total bending moment in each direction for a panel shall be:

\[ M_o = \frac{wL^2}{10} \left[ L_1 - \frac{2D}{3} \right]^2 \]

and shall be distributed between the column strips and middle strip by the percentage specified in Table XXXVIII.

| Distribution of bending moments in panels of flat slabs designed by the empirical method |
|-----------------------------------------------|---------------|
| Distribution of moments expressed as a percentage of \( M_o \) | 1 | 2 | 3 |
| Column strip | Middle strip |
| Interior panels— | | |
| (i) with drops— | | |
| negative moments | 50 | 15 |
| positive moments | 20 | 15 |
| (ii) without drops— | | |
| negative moments | 46 | 16 |
| positive moments | 22 | 16 |
| Exterior panels— | | |
| (i) with drops— | | |
| exterior negative moments | 45 | 10 |
| positive moments | 25 | 20 |
| interior negative moments | 50 | 15 |
| (ii) without drops— | | |
| exterior negative moments | 41 | 10 |
| positive moments | 28 | 20 |
| interior negative moments | 46 | 16 |

(8) (a) Slabs shall be reinforced in 2 directions and the reinforcement shall be so disposed that each strip is reinforced over its full width.

(b) In each strip not less than 50 per cent of the positive reinforcement shall extend in the lower part of the slab to not less than 0.125L from the line joining the centres of the columns.
(c) Not more than 50 per cent of the positive reinforcement may be bent up at a distance of not less than 0.25L from the centre line of the panel.

(d) Not less than 50 per cent of the negative reinforcement shall extend not less than 0.3L beyond the line joining the centres of the columns.

(e) Negative reinforcement in the top of the slab shall not stop or be bent down at a distance of less than 0.2L from the line joining the centres of the columns as shown in Diagram 9.

(9) (a) Internal columns shall be designed to resist 50 per cent of the maximum negative moment in the column strip.

(b) External columns shall be designed to resist 90 per cent of the maximum negative moment in the column strip.

(c) These moments shall be apportioned between the upper and lower columns in proportion to their stiffnesses.

(d) When external columns carry portions of the floors and walls as a cantilevered load the specified column moments may be reduced by the moment due to dead load only on the cantilever.

**Diagram 9**

**Details of Reinforcement**

**Columns**

- 0.2L Min.
- 0.2L Max.
- 0.3L Min.
- 0.3L Max.

**Bent-Up Bars**

- 0.125L Max.

**Not Less Than 50% of Total Negative Reinforcement**

**Not Less Than 50% of Total Positive Reinforcement**

---

157. (1) Subject to the provisions of regulations 118 and 120 the compressive, shear and bond stresses in reinforced concrete constructed of special or designed mixes shall not exceed the maximum permissible stresses specified in Tables XXXIX and XL for the appropriate mix.
(2) For the purpose of Tables XXXIX and XL, $u_w$ is the works resistance to crushing of the concrete when tested in accordance with the First Schedule within 28 days after mixing.

**TABLE XXXIX**

*Maximum permissible compressive stresses for special mixes and designed mixes in MPa*

<table>
<thead>
<tr>
<th>1</th>
<th>Maximum permissible compressive stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>direct</td>
<td>due to bending</td>
</tr>
<tr>
<td><strong>Special mixes</strong></td>
<td>$\frac{u_w}{4}$ but not more than 8.5</td>
</tr>
<tr>
<td><strong>Designed mixes</strong></td>
<td>$\frac{u_w}{3.65}$ but not more than 11</td>
</tr>
</tbody>
</table>

**TABLE XL**

*Maximum permissible shear and bond stresses for special and designed mixes in MPa*

<table>
<thead>
<tr>
<th>Resistance to crushing $u_w$</th>
<th>2</th>
<th>Maximum permissible bond stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>average</td>
<td>local</td>
</tr>
<tr>
<td><strong>More than 20</strong></td>
<td>$\frac{u_w}{50} + 0.27$ but not more than 0.9</td>
<td>$\frac{u_w}{50} + 0.40$ but not more than 1.0</td>
</tr>
<tr>
<td>20</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Less than 20</strong></td>
<td>$\frac{u_w}{30}$</td>
<td>$\frac{u_w}{25}$</td>
</tr>
</tbody>
</table>
(3) Before adopting the higher stresses permitted for designed mixes the registered structural engineer responsible for the design shall give due consideration to the exactness of the method of design, deflexions, site conditions which may affect adversely the control or proper curing of the concrete, and such other factors as might influence his selection of the appropriate strength of concrete for the work.

(4) The requirements of regulation 116(2) shall apply to special and designed mixes subject to the maximum permissible stresses specified in Table XXXIX.

158. (1) Subject to regulation 118, the upper limit for the maximum permissible stresses specified in Table XXIX may be increased to those specified in Table XLI.

**TABLE XLI**

*Maximum permissible stresses in reinforcement in reinforced concrete*

<table>
<thead>
<tr>
<th>Kind of stress</th>
<th>Maximum permissible stresses in reinforcement in MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mild steel complying with BS 4449:1969</td>
</tr>
<tr>
<td>2</td>
<td>Not exceeding 40 mm diameter</td>
</tr>
<tr>
<td>Tension other than tension in shear reinforcement</td>
<td></td>
</tr>
<tr>
<td>Tension in shear reinforcement</td>
<td></td>
</tr>
<tr>
<td>Compression in longitudinal reinforcement in axially loaded columns and in main reinforcement in beams and slabs where the compressive resistance of the concrete is not taken into account</td>
<td></td>
</tr>
<tr>
<td>Compression in longitudinal reinforcement in columns other than axially loaded columns and in main reinforcement in beams and slabs where the compressive resistance of the concrete is taken into account</td>
<td></td>
</tr>
</tbody>
</table>
(2) The maximum stress specified in regulation 120(b) may be increased from 185 to 230 MPa.

(3) In slender beams to which regulation 116(2) applies the stress in any compression steel shall not exceed the permissible stress specified in Table XLI for compression in main reinforcement multiplied by the appropriate coefficient specified in Table XXVIII.

(4) For the purposes of this regulation the modular ratio shall be taken as 15.

159. The provisions of regulation 118 shall apply to columns of special and designed mixes subject to the maximum permissible stresses specified in Table XXXIX.

160. (1) It shall be assumed for all normal cases that the stiffness of members will be satisfactory:

Provided that—

(a) where either the stress in the reinforcement exceeds 140 MPa or the stress in the concrete exceeds 10 MPa the ratio of span to overall depth does not exceed 90 per cent of the value given in Table XXXII;

(b) where both the stress in the reinforcement exceeds 140 MPa and the stress in the concrete exceeds 10 MPa the ratio of span to overall depth does not exceed 85 per cent of the values given in Table XXXII.

(2) In the case of members designed by the load factor method, the limiting stresses for the purposes of paragraph (1)(a) and (b) shall be the stresses at working loads.

161. (1) Subject to the following provisions of this regulation, reinforced concrete members may be designed to have a load factor of not less than 1.8 against crushing of the concrete and against yielding of the steel.

(2) For the purposes of paragraph (1) the resistance to crushing of the concrete in the member shall, for beams and slabs, be assumed to be—

(a) not more than \( \frac{3}{4} \) of the specified resistance to crushing of the concrete for the works test at 28 days—

(i) for ordinary concretes in accordance with Table IV;

(ii) for Quality A concretes in accordance with Table V; and

(iii) for special concrete mixes in accordance with Table VI; and

(b) not more than \( \frac{2}{3} \) of the specified resistance to crushing of the concrete for the works test at 28 days for designed concrete mixes in accordance with Table VI.
(3) For the purposes of paragraph (1) the resistance to crushing of the concrete in the member shall, for columns, be assumed to be—

(a) not more than 0.68 times the specified resistance to crushing of the concrete for the works test at 28 days—
(i) for ordinary concretes in accordance with Table IV;
(ii) for Quality A concretes in accordance with Table V; and
(iii) for special concrete mixes in accordance with Table VI; and

(h) not more than 0.76 times the specified resistance to crushing of the concrete for the works test at 28 days for designed concrete mixes in accordance with Table VI.

(4) For the purposes of paragraph (1)—

(a) the maximum stress in the concrete at failure shall be taken as not more than \( \frac{1}{3} \) of its resistance to crushing as assumed in paragraph (2) or (3) and considered as constant over the depth of the compression zone, which depth in the case of beams and slabs shall not be taken as greater than \( \frac{1}{4} \) the effective depth of the member;

(b) the yield point of the reinforcement shall be taken as not greater than 1.8 times the appropriate maximum permissible stress specified in Table XXIX and regulation 158.

(5) Paragraph (1) shall apply only where the stresses in the members at working loads are not such as to cause excessive cracking or excessive deflexions.

162. (1) For a beam to which regulation 116(2) applies designed by the load factor method, the maximum permissible load shall be the maximum load calculated as for a normal beam and multiplied by the coefficient specified in Table XXVIII for the appropriate slenderness ratio.

(2) For a column to which regulation 118(2) applies designed by the load factor method, the maximum permissible load, or combination of direct load and bending moment, shall not exceed the maximum load, or combination of direct load and bending moment, calculated as for a short column and multiplied by the coefficient specified in Table XXX for the appropriate ratio of effective column length to least lateral dimension.

163. For beams and solid slabs of rectangular cross-section without compressive reinforcement and for qualities of concrete and steel within the range permitted by these regulations, the requirements of regulation 161 may be deemed to be satisfied if the resistance moment \( M_e \) (corresponding to the working loads) is assumed to be the lesser of the 2 values calculated from the following 2 equations:

Slender beams and long columns designed by the load factor method.

Simplified formulae for rectangular beam and solid slab sections in load factor method.
(1) based on the tensile reinforcement,

\[ M_r = A_{st} P_{st} l_a \]

(2) based on the resistance to crushing of the concrete in compression,

\[ M_r = \frac{P_{cb}}{4} b d_1^2 \]

where—
- \( l_a \) is the lever arm, which may be taken as
- \( d_1 = \frac{3A_{st} P_{st}}{4b P_{cb}} \)
- \( A_{st} \) is the area of tensile reinforcement;
- \( P_{st} \) is the permissible tensile stress in the reinforcement;
- \( P_{cb} \) is the permissible compressive stress in the concrete in bending;
- \( b \) is the breadth of the section; and
- \( d_1 \) is the effective depth to the tensile reinforcement;

(3) where it is necessary for the resistance moment to exceed \( \frac{P_{cb}}{4} b d_1^2 \), compressive reinforcement should be provided so that

\[ M = \frac{P_{cb}}{4} b d_1^2 + A_{sc} p_{sc} (d_1 - d_2) \]

where—
- \( A_{sc} \) is the area of compressive reinforcement;
- \( p_{sc} \) is the permissible compressive stress in the steel, or

\[ 380(1 - \frac{d_2}{d_n}) \text{MPa}, \]

whichever is the lesser;
- \( d_n \) is the depth of the concrete in compression; and
- \( d_2 \) is the depth to the compressive reinforcement.

The area of tensile reinforcement shall be such that the stress in the steel does not exceed the permissible stress.

164. (1) The resistance moment when compressive reinforcement is not provided may be assumed to be the lesser of the 2 values calculated from the following equations:

(a) based on the tensile reinforcement,

\[ M_r = A_{st} P_{st} (d_1 - \frac{d_n}{2}) \]
(b) based on the resistance to crushing of the concrete in compression.

\[ M_r = \gamma p_{ch} b d_1^2 \]

where \( d_1 \) is the depth of slab forming the flange and the factor \( \gamma \) has the values given in Table XLII.

**TABLE XLII**

Values of \( \gamma \) for computing resistance moment based on the resistance to crushing of the concrete in compression

<table>
<thead>
<tr>
<th>( h/h_r )</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 or less</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>x</td>
</tr>
<tr>
<td>1</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>2</td>
<td>0.25</td>
<td>0.22</td>
<td>0.20</td>
<td>0.185</td>
<td>0.175</td>
<td>0.125</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
<td>0.20</td>
<td>0.17</td>
<td>0.15</td>
<td>0.14</td>
<td>0.062</td>
</tr>
<tr>
<td>6</td>
<td>0.25</td>
<td>0.195</td>
<td>0.165</td>
<td>0.14</td>
<td>0.125</td>
<td>0.042</td>
</tr>
<tr>
<td>8</td>
<td>0.25</td>
<td>0.19</td>
<td>0.16</td>
<td>0.135</td>
<td>0.12</td>
<td>0.031</td>
</tr>
</tbody>
</table>
| x         | 0.25 | 0.185 | 0.145 | 0.12 | 0.10 | 0 | 0

*Note: \( h_r \) is the width of the rib.*

(2) Where it is necessary for the resistance moment to exceed \( \gamma p_{ch} b d_1^2 \), compressive reinforcement should be provided so that:

\[ M_r = \gamma p_{ch} b d_1^2 + A_v \sigma_v (d_1 - d_2) \]

and the area of tensile reinforcement should be such that the stress in this steel does not exceed the permissible stress.

(3) For intermediate values of \( h/h_r \) and \( d_1/d_1 \), the value of \( \gamma \) can be calculated from the following formula:

\[ \gamma = \frac{b_r}{4b} + \frac{1}{3} \left[ 1 - \frac{b_r}{b} \right] \left[ \frac{d_1}{d_1} - \left( \frac{d_1}{d_1} \right)^2 \right] \]

---

Formulae for short columns subject to both direct load and bending in load factor method.

**165. (1)** For columns of rectangular section with symmetrical reinforcement, the section should be assumed to be controlled by compression when the load exceeds \( P_h \) given by the following equation:

\[ P_h = \sigma_c b d_1 X - A_v (\sigma_v - \sigma_w) \]

where -

- \( \sigma_c \) is the permissible stress for the concrete in direct compression;
- \( b \) is the breadth of the column;
- \( d_1 \) is the effective depth to the tensile reinforcement;
- \( A_v \) is the area of the compressive reinforcement; which for the conditions of bending to which the above equation applies is equal to \( \frac{1}{4} \) of the total area of reinforcement in the column;
\[ p_{sc} \text{ and } p_{st} \text{ are the permissible stresses in the reinforcement for compression and tension, respectively; and} \]
\[ X = \frac{585}{690 + 1.8P_{st}} \]

where cold worked reinforcement is used, the denominator in the formula for \( X \) should be increased to:
\[ 690 + \frac{375P_{st} \times 10^3}{E_s} \]
in which \( E_s \) is the secant modulus of elasticity of the steel at a stress of 1.8\( P_{sc} \).

At the load \( P_h \) the corresponding eccentricity of load \( e_h \) relative to the centre of the section is given by the following equation:
\[ P_h(e_h + \frac{d_1 - d_2}{2}) = p_{cc}bd_1^2X(1 - \frac{1}{2}X) + A_{sv}p_{sc}(d_1 - d_2) \]

where \( d_2 \) is the depth to the compressive reinforcement.

(2) When the section is controlled by compression, the permissible load (\( P \)) on the column is related to the permissible load (\( P_{sc} \)) for an axially loaded column, as given in regulation 143(1)(a), and the eccentricity (\( e \)) of the load (\( P \)) relative to the centre of the section, according to the following equation:
\[ P = \frac{P_{sc}}{1 + \left[ \frac{P_{sc}}{P_h} - 1 \right] \frac{e}{e_h}} \]

(3) When the applied load is less than \( P_h \), the section is controlled by tension and the permissible load is given by the following equation:
\[ P = p_{cc}bd\left\{ (0.5 - \frac{e}{d} - Y) \right. \]
\[ + \sqrt{(0.5 - \frac{e}{d} - Y)^2 + \left[ \frac{p_{st}}{p_{cc}}(\frac{d_1 - d_2}{d}) + Y(2\frac{d_1}{d} - Y) \right] \}
\]

where \( Y = \frac{r}{2} \left[ \frac{p_{st} - p_{sc}}{p_{cc}} \right] \)
\[ r = \text{total area of reinforcement} \cdot \frac{bd}{bd} \text{; and} \]
\( d \) is the overall depth of the column section.
PART XIII

WHARVES, PIERS AND SEA-WALLS

166. Every sea-wall, breakwater, jetty, mole, quay, wharf or pier shall be designed and constructed to the satisfaction of the Building Authority.

PART XIV

RETAINING WALLS

167. (1) Retaining walls may be constructed of masonry, brickwork, or plain or reinforced concrete.

(2) Retaining walls shall be so designed and constructed as to support safely the ground they retain and any loads and pressures from any surcharge, traffic and footings of nearby structures on top or at the back of the walls and any water pressures that may be imposed on the back face and on the base of the walls, and to provide a safety factor of—

(a) 2.0 against overturning; and

(b) 1.5 against sliding depending on friction on ground only, or 2.0 against sliding if passive ground resistance is added to counteract sliding.

168. (1) A foundation of concrete shall be provided on solid, undisturbed ground or on piles.

(2) Such foundation shall extend for the full thickness at the base of the retaining wall, and shall be so designed that the resultant of all forces acting on the wall shall be within the middle third of the foundation, or if on piled foundation shall cause no tension in any pile.

169. Retaining walls constructed of brickwork shall be properly bonded and built solid throughout in cement mortar.

170. Retaining walls constructed of masonry may be built in cement mortar or dry. In either case the wall shall be properly bonded.

171. (1) Retaining walls constructed of brickwork or masonry exceeding 4 m in height shall be provided with 1 or more bond courses of concrete, in no respect inferior to Grade III and at least 300 mm in depth:

Provided that bond courses of reinforced concrete may be less than 300 mm in depth.

(2) The distance between the foundation and the first of such bond courses and the distance between any 2 adjacent bond courses shall not exceed 2 m measured vertically.
172. (1) A weep hole, with an internal diameter of not less than 75 mm, shall be provided to every 3 m² of the face of every retaining wall:

Provided that weep holes may be omitted in retaining walls—

(a) constructed of masonry built dry; or

(b) designed to withstand maximum potential hydraulic pressure; or

(c) with adequate subsoil drainage behind such retaining wall to carry away subsoil water.

(2) Where on or after the date* on which the Building (Construction) (Amendment) Regulations 1981 come into operation a drainage system is incorporated in a retaining wall to reduce any water pressures that may be imposed on the back face and on the base of the retaining wall, such drainage system shall be designed and constructed so as not to be rendered ineffective during service by the penetration of soil or due to any other cause.

173. (1) Every retaining wall shall be provided with a proper coping of concrete or such other materials as the Building Authority may approve.

(2) (a) Where the ground at the top of any retaining wall or portion of the wall is accessible and is more than 600 mm above the ground level at the foot of the walls or portion of wall, parapet walls or railings not less than 1 100 mm in height from top of coping level, shall be provided.

(b) Such parapet walls or railings shall be so constructed as to inhibit—

(i) climbing; and

(ii) the passage of articles more than 100 mm in their smallest dimension.

(c) The lowermost 150 mm of such parapet walls or railings shall be built solid.

174. Adequate channels laid to suitable gradients, or paving in accordance with the provisions of regulation 41 shall be formed at the top and toe of every retaining wall to carry away stormwater, seepage, or other surface water.

PART XV

WELLS

175. No well shall be sunk or reopened without the permission of the Building Authority.
176. No well shall be sunk in the vicinity of any septic tank, cesspool, sewage sump or in any foul ground and no well shall be excavated near any foundations.

177. (1) Wells may be excavated or bored and shall be of sufficient diameter and depth to provide an adequate water supply.

(2) For the purposes of this regulation, a supply of water shall be adequate if in the opinion of the Building Authority the yield of water from such well, during the period from 1 December to 30 April next succeeding as ascertained and certified in accordance with this regulation, would be sufficient in all respects for all the purposes for which the well is to be used.

(3) For the purposes of this regulation, the yield of water from a well shall be ascertained by the authorized person in a manner and by a method approved by the Building Authority—

(a) during the first such period as is referred to in paragraph (2) after the first consent to the commencement of the building works is given by the Building Authority in respect of the building for which the well is required, or if such first consent is given during such a period then during such period; or

(b) if the Building Authority so directs, during any such period as is referred to in paragraph (2) after the first consent to the commencement of the building works is given by the Building Authority in respect of the building for which the well is required.

(4) The yield of water from the well ascertained in accordance with paragraph (3) shall be certified by the authorized person to the satisfaction of the Building Authority.

178. (1) Every excavated well except in solid rock shall be properly lined for its entire depth with brickwork, or other suitable material and such lining shall be provided with suitably fixed iron rungs or foot rests not more than 600 mm apart for the entire depth.

(2) The lining of every well shall be rendered impervious for a depth of not less than 1 800 mm from the level of the adjoining ground.

(3) A suitable filter of clean broken stone, gravel or sand shall be provided at the bottom of every excavated well.

179. (1) Access for cleaning purposes must be provided for every excavated well.

(2) An efficient close-fitting cover shall be fitted over every well.
180. (1) The top of every well shall be suitably protected to prevent the direct entry of any surface water or sullage water.

(2) The ground surface adjoining the top of every well shall be paved with suitable impervious material for a distance of not less than 1 m in every direction from the side of such well and so constructed as to slope away from the well to a suitable channel.

181. A suitable parapet wall, not less than 750 mm in height, shall be constructed around the top of every well from which water is to be drawn by means of a bucket.

PART XVI

FIRE RESISTING CONSTRUCTION

182. In this Part—

"basement" means any storey of a building or any compartment which is wholly below the level of the street or streets on which such building abuts, or being partially below such level has no access to such streets in the event of fire;

"compartment of a building" means any volume, or floor area in any 1 storey, in any building assessed as a unit for the purposes of Table XLIII;

"elements of construction" means—

(a) any floor, beam, column or hanger;

(b) any load bearing wall or load bearing member; and

(c) any staircase and the landings and supports thereto;

"F.R.P." means the period for which the element of construction is capable of resisting the action of fire when tested in accordance with BS 476:Part 8 or as specified in the Third Schedule;

"staircase" includes landings and lobbies attached thereto without any intervening enclosure.

183. Every building shall be separated from any adjoining building by a wall having an F.R.P. of not less than 4 hours.

184. (1) Each element of construction in a building or compartment of a building shall have an F.R.P. not less than that specified in Table XLIII appropriate to the use and the volume, or floor area in any one storey, as the case may be:

Provided that each element of construction in any building which exceeds 3 storeys shall in no case have an F.R.P. of less than 1 hour.
### TABLE XLIII

<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Use</td>
<td>Fire resistance period</td>
</tr>
<tr>
<td>1</td>
<td>Bulk storage or warehouse purposes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) More than 700 m³ but not more than 1 400 m³ in volume.</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(b) More than 1 400 m³ but not more than 3 500 m³ in volume.</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(c) More than 3 500 m³ but not more than 7 000 m³ in volume.</td>
<td>2 hours.</td>
</tr>
<tr>
<td>2</td>
<td>Trade or manufacture.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) More than 1 400 m³ but not more than 3 500 m³ in volume.</td>
<td>½ hour.</td>
</tr>
<tr>
<td></td>
<td>(b) More than 3 500 m³ but not more than 7 000 m³ in volume.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(i) not more than 700 m² in floor area in any 1 storey;</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(ii) more than 700 m² in floor area in any 1 storey.</td>
<td>2 hours.</td>
</tr>
<tr>
<td>3</td>
<td>Office or domestic purposes; schools; hospitals.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) (i) More than 1 400 m³ but not more than 3 500 m³ in volume;</td>
<td>½ hour.</td>
</tr>
<tr>
<td></td>
<td>(ii) More than 90 m² but not more than 230 m² in floor area in any 1 storey.</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(b) (i) More than 3 500 m³ in volume; or</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(ii) More than 230 m² in floor area in any 1 storey.</td>
<td>1 hour.</td>
</tr>
<tr>
<td>4</td>
<td>Partly for office purposes and partly for trade or manufacture, any part used for trade or manufacture.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) (i) Not more than 1 800 m³ in volume.</td>
<td>½ hour.</td>
</tr>
<tr>
<td></td>
<td>(ii) More than 1 800 m³ but not more than 3 500 m³ in volume.</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(iii) More than 3 500 m³ but not more than 7 000 m³ in volume.</td>
<td>2 hours.</td>
</tr>
<tr>
<td></td>
<td>(b) (i) Not more than 230 m² in floor area in any 1 storey.</td>
<td>½ hour.</td>
</tr>
<tr>
<td></td>
<td>(ii) More than 230 m² but not more than 460 m² in floor area in any 1 storey.</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(iii) More than 460 m² in floor area in any 1 storey.</td>
<td>2 hours.</td>
</tr>
<tr>
<td>5</td>
<td>Partly for domestic purposes and partly for manufacture, any part used for trade or manufacture.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) (i) Not more than 900 m³ in volume.</td>
<td>½ hour.</td>
</tr>
<tr>
<td></td>
<td>(ii) More than 900 m³ but not more than 1 800 m³ in volume.</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(iii) More than 1 800 m³ in volume.</td>
<td>2 hours.</td>
</tr>
<tr>
<td></td>
<td>(b) (i) Not more than 90 m² in floor area in any 1 storey.</td>
<td>½ hour.</td>
</tr>
<tr>
<td></td>
<td>(ii) More than 90 m² but not more than 230 m² in floor area in any 1 storey.</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(iii) More than 230 m² in floor area in any 1 storey.</td>
<td>2 hours.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td></td>
<td>Use</td>
<td>Fire resistance period</td>
</tr>
<tr>
<td>6</td>
<td>Transformer chamber or purpose involving a similar fire risk.</td>
<td>2 hours.</td>
</tr>
<tr>
<td></td>
<td>Volume, or floor area in any 1 storey (as the case may be)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Garage purposes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Not more than 45 m² in floor area.</td>
<td>½ hour.</td>
</tr>
<tr>
<td></td>
<td>(b) More than 45 m² but not more than 90 m² in floor area.</td>
<td>1 hour.</td>
</tr>
<tr>
<td></td>
<td>(c) More than 90 m² in floor area.</td>
<td>2 hours.</td>
</tr>
</tbody>
</table>

(2) Save with the consent of the Building Authority the floor area of any 1 compartment used for bulk storage or warehouse purposes shall not exceed 700 m².

(3) Where a single storey building does not exceed 7 000 m³ in volume or 7.5 m in height, steel work therein other than columns and beams in external or party walls may, subject to the provisions of PART XI (Structural Use of Steel) be unprotected.

(4) The joints of and any elements of construction shall be tight and proof against the passage of smoke or flame.

185. Every compartment of a building shall be separated from any adjoining compartment by a wall or floor having an F.R.P. of not less than 2 hours, and if 1 or both compartments demand a longer period of fire resistance, the separating wall or floor between the compartments shall have an F.R.P. of 4 hours:

Provided that where adjoining compartments are used solely for domestic purposes the separating wall or floor between the compartments shall have an F.R.P. of 1 hour.

186. (1) Each element of construction of a staircase shall have an F.R.P. not less than the period required for each element of construction of the building or compartment in which the staircase is situated:

Provided that this paragraph shall not apply to staircases enclosed in accordance with paragraph (2).

(2) Where a staircase serves more than 1 compartment of a building—

(a) such staircase shall be enclosed by walls, and

(b) such walls shall have an F.R.P. not less than the longer period required for the elements of construction in any compartment so served:

Provided that this paragraph shall not apply to any external staircases open to the weather on at least 2 sides.
187. Where compartments of a building to which the provisions of regulation 185 apply are situated in the topmost storey of a building, the walls required by that regulation shall be carried up to the underside of the roof of the storey:

Provided that where the ceiling is formed beneath a pitched roof, the walls need only be carried up to the underside of the roof so as to form in the roof space vertical firechecks at a distance apart not exceeding 35 m.

188. Walls separating compartments of a building or enclosing staircases, in accordance with regulation 185 or 186 may have openings where—

(a) the door and frame of such opening has an F.R.P.—

(i) in the case of walls separating compartments, \( \frac{1}{2} \) hour, or

(ii) in the case of walls enclosing staircases, \( \frac{1}{2} \) the period required for such walls:

Provided that in no case shall the door have an F.R.P. less than \( \frac{1}{2} \) hour; and

(b) such door is self-closing, except in the case of such a door in a domestic building which does not lead from a staircase to a corridor used in common.

189. (1) Borrowed lights may not be provided in walls separating compartments of buildings in accordance with regulation 185.

(2) Where borrowed lights are provided in any wall enclosing, in accordance with regulation 186, a staircase—

(a) the area of such lights shall be not more than \( \frac{1}{8} \) of the total area of the wall; and

(b) the lights shall be glazed with a 6 mm wired glass or covered with glass bricks or blocks.

190. Each element of construction in a basement shall have an F.R.P. of 4 hours.

PART XVII

MISCELLANEOUS

191. Where any doors for disabled persons are provided in accordance with regulation 72* of the Building (Planning) Regulations—

(a) double-action self-closing doors shall have a check mechanism to prevent the doors swinging beyond the closed position and a transparent panel with a bottom edge not more than one metre and the top edge not less than 1.5 m above floor level;

(b) door handles shall be not less than 900 mm and not more than 1.05 m above floor level, measured from the top surface of the grip; and

(c) door thresholds shall not exceed 25 mm in height.
FIRST SCHEDULE

METHODS FOR DETERMINING THE RESISTANCE TO CRUSHING OF CONCRETE

PART I

GENERAL

1. (1) In this Schedule unless the contrary appears—

"average resistance to crushing" means the arithmetical mean of the resistances to crushing of a stated number of cubes;

"consecutive cubes" means cubes made from consecutive samples of concrete as taken during the work, and tested at the same age;

"designed mean resistance to crushing" means the mean resistance to crushing to be aimed for in designing a mix to comply with a specified resistance to crushing;

"designed standard deviation" is the standard deviation adopted in designing a mix;

"mean resistance to crushing" means the arithmetical mean resistance to crushing of all the concrete of a particular grade produced in a given period of time;

"preliminary test" means a test made in accordance with BS 1881: Parts 3 and 4: 1970 both prior to the commencement of the work and subsequently whenever any important change is to be made in the materials or in the proportions of the materials to be used, to ascertain the suitability of the available materials or to determine suitable mix proportions;

"range" means the difference between the highest and lowest value in a set;

"set" means a stated number of consecutive individual results;

"specified resistance to crushing" means for ordinary concretes and Quality A concretes, the resistance to crushing specified in Tables IV and V for the appropriate grade; for special mixes and designed mixes, the particular resistance to crushing within the limits of Table VI appropriate to the permissible stresses adopted for the structural design;

"standard deviation" means a measure of variability calculated from the resistances to crushing of the individual cubes tested at a given age each representing a different batch of concrete having the same specified resistance to crushing;

"works resistance to crushing" means the resistance to crushing obtained from works tests;

"works test" means a test made in accordance with BS 1881: Parts 3 and 4: 1970 during the course of the work to assess or prove the quality of the concrete used in the work.

(2) The mean resistance to crushing may be estimated from tests on such a number of cubes of concrete as may be approved by the Building Authority generally or for a particular grade of concrete or in a particular case.

(3) The standard deviation, $\sigma$, may be calculated from either of the following equations:

$$
\sigma = \sqrt{\frac{\sum(x^2) - \left(\frac{\sum x}{n}\right)^2}{n - 1}}
$$

$$
\sigma = \sqrt{\frac{\sum(x - \bar{x})^2}{n - 1}}
$$

Interpretation.
where—
\[\Sigma x\]
\[\Sigma (x - \bar{x})^2\]
\[\Sigma (x - \bar{x})^2\]
is the sum of all the individual results;
is the sum of the squares of all the individual results;
is the sum of the squares of the differences between the average, \(\bar{x}\), of all the individual results and each individual result, \(x\), in turn; and
\[n\]
is the number of results, which should be not less than 40 for a reasonably accurate estimate of the standard deviation.

2. The resistance to crushing of concrete shall be determined by testing standard 150 mm cubes of the appropriate age made, cured and tested in accordance with the appropriate provisions of BS 1881: Parts 3 and 4: 1970 and in accordance with this Schedule.

3. (1) Samples of concrete for making test cubes shall be taken in accordance with BS 1881: Part 1: 1970.

(2) For the purpose of determining the resistance to crushing at a particular age after mixing, each works cube shall be made from a different batch of concrete.

(3) For the purpose of checking the ratio of resistances to crushing at different ages 3 cubes shall be made from the same batch of concrete for each age for which the ratio is required.

Records.

4. (1) The following information shall be recorded—

(a) identification mark of each cube;
(b) designation of concrete;
(c) brand and type of cement;
(d) types of aggregates;
(e) mix proportions;
(f) water:cement ratio;
(g) dates of moulding and testing;
(h) location after placing in the work of the concrete from which the sample was taken;
(i) number of cubes and their marks;
(j) mixer from which sample was taken (if more than 1 mixer is used);
(k) weather conditions; and
(l) curing conditions.

(2) Copies of test reports for concretes of Quality A, special mixes and designed mixes shall be submitted to the Building Authority within 21 days after testing.

(3) Test reports for concretes of ordinary quality shall be kept and made available for inspection if necessary, until at least 6 months after the completion of the building works.

PART II

CONCRETE OF ORDINARY QUALITY

5. (1) Preliminary tests are not required for concrete of ordinary quality.

(2) (a) The works resistance to crushing of concrete of ordinary quality shall be determined from sets of 3 consecutive cubes from the same grade of concrete tested at the same age.

(b) At least 1 cube should be made for each grade of concrete on each day that it is used.

6. The specified resistance to crushing for the appropriate grade shall be deemed to have been attained if the average resistance to crushing of each set of 3 consecutive cubes is not less than the specified resistance and no individual result is less than 85 per cent of the specified resistance.
PART III

CONCRETES OF QUALITY A

7. (1) (a) Preliminary tests should be made for concrete of Quality A.
(b) 6 cubes shall be made for each test and 3 of these cubes shall be tested at the age of 7 days and the remaining 3 at 28 days.

(2) (a) The works resistance to crushing of Quality A concrete shall be determined from sets of 3 consecutive cubes from the same grade of concrete tested at the same age.
(b) For each age at which the resistance to crushing is to be determined at least 3 cubes shall be made for each grade of concrete on each day it is used.

8. The specified resistance to crushing for the appropriate grade shall be deemed to have been obtained if—
(a) none of the individual crushing resistances is less than the specified resistance to crushing; or
(b) if the average resistance to crushing of each set of 3 consecutive cubes is not less than the specified resistance and the difference between the greatest and least result of the set is not more than 20 per cent of that average.

PART IV

CONCRETES OF SPECIAL MIXES

9. (1) (a) Preliminary tests shall be made for special mixes.
(b) For each preliminary test 6 cubes shall be made from each of 2 batches of the same mix proportions.
(c) 3 cubes of each set of 6 cubes shall be tested at 7 days and the remaining 3 at 28 days.

(2) (a) The works resistance to crushing of concrete of special mixes shall be determined from a set of 3 cubes tested at the same age.
(b) For each age at which the resistance to crushing is to be determined, at least 1 set of 3 cubes shall be made for each grade of concrete on each day it is used and if more than 75 m³ of any grade is used in a day 1 set shall be made for each 75 m³ or part thereof.

10. The specified resistance to crushing in accordance with Table VI shall be deemed to have been attained if—
(a) none of the individual resistances to crushing is less than the specified resistance to crushing; or
(b) the average resistance to crushing of each set of 3 consecutive cubes is not less than the specified resistance to crushing and the difference between the greatest and least result of the set is not more than 20 per cent of that average, provided that if individual cubes from 2 consecutive sets fall below the required resistance to crushing the mix shall be adjusted to give a higher strength so that not more than 1 set in 3 consecutive sets shall contain individual results lower than the specified resistance to crushing.

PART V

CONCRETES OF DESIGNED MIXES

11. (1) (a) Preliminary tests shall be made for designed mixes.
(b) For each test 6 cubes shall be made from each of 3 batches of the same mix proportions.
(c) 3 cubes of each set of 6 cubes shall be tested at 7 days and the remaining 3 at 28 days.

(2) (a) The works resistance to crushing of designed mixes shall be determined from a statistical analysis of not less than 40 cube tests at the same age.

(b) A sample of concrete shall be taken on 8 separate occasions during each of the first 5 days of using that mix and thereafter at least 3 samples shall be taken on each day that the mix is used and if more than 120 m³ is used in a day a sample shall be taken from each 40 m³ or part thereof.

(c) 1 cube from each sample taken under sub-paragraph (b) shall be tested at 7 days and 1 additional cube from at least every fourth sample taken under sub-paragraph (b) shall be tested at 28 days.

12. The preliminary test under sub-paragraph 11(1) shall be deemed to be acceptable if the average of the resistances to crushing of the 3 sets of 3 cubes tested at the specified age exceeds the specified resistance to crushing by not less than 2 times the designed standard deviation. If the difference between the greatest and least individual results for any set of 3 cubes is more than 20 per cent of the mean resistance to crushing for which the mix has been designed an additional set of 3 cubes shall be made and tested.

13. (1) The specified resistance to crushing of designed mixes shall be deemed to have been attained if the works test results, when examined individually and in consecutive (but not overlapping) sets of 4 cubes, satisfy each of the following conditions—

(a) no individual result is less than 80 per cent of the specified resistance to crushing;

(b) not more than 2 individual results of any 40 consecutive results fall below the specified resistance to crushing;

(c) the range of any set is not more than 4 times the designed standard deviation;

(d) the average of any set is not less than the specified resistance to crushing plus the designed standard deviation;

(e) the average of not more than 1 set in any 10 consecutive sets is less than the specified resistance to crushing plus 1½ times the designed standard deviation; and

(f) the overall average of not less than 40 consecutive individual resistances is not less than the specified resistance to crushing plus 2 times the standard deviation of those resistances.

(2) If sub-paragraph (1) (a) is not satisfied the parts of the structure made from the batch of concrete from which the low test result was obtained shall be subjected to individual inspection and testing.

(3) (i) If sub-paragraph (1) (b), (c), (d) or (e) is not satisfied in the first 10 sets the mix shall be modified to increase the resistance to crushing.

(ii) If sub-paragraph (1) (b), (c), (d) or (e) is not satisfied in subsequent sets, the overall average of the previous 40 consecutive results including the non-complying set, shall be calculated and examined for compliance with sub-paragraph (1) (f).

(iii) If sub-paragraph (1) (f) is not satisfied the mix shall be modified to increase the resistance to crushing until it complies therewith.

SECOND SCHEDULE [reg. 19(7.)]

DESIGN OF CONCRETE MIXES

1. (1) The proportions of concretes of special mixes and of design mixes shall be selected within the limits of Table VI so that the designed mean resistance to crushing of the concrete exceeds the specified resistance to crushing (as defined in the First Schedule) by a suitable margin and so that the workability is adequate for the means of compaction available on the site.

(2) In designing a mix to satisfy these requirements attention should be given to the following factors—
(a) specified strength;
(b) durability;
(c) degree of control;
(d) age at which a particular resistance to crushing is required;
(e) size of members;
(f) type of cement;
(g) spacing of reinforcement;
(h) maximum size of aggregate;
(i) shape and grading of aggregates available;
(j) available means of compaction;
(k) ratio of water to cement ratio; and
(l) ratio of aggregate to cement ratio.

2. (1) The designed mean resistance to crushing of special mixes shall initially exceed the specified resistance to crushing by a margin of not less than 14 MPa.

(2) Where the works tests show to the satisfaction of the Building Authority that the standard of acceptance can be maintained with a smaller margin, the mix may be redesigned with a margin of not less than 10 MPa.

3. (1) The designed mean resistance to crushing of designed mixes shall exceed the specified resistance to crushing by a margin of not less than 2 times the designed standard deviation.

(2) Where there is no previous information on the standard deviation which may be expected under similar conditions, the designed standard deviation used initially shall be not less than 7 MPa for the purpose of ensuring that the margin initially taken shall be not less than 14 MPa.

(3) Where there is previous information on the standard deviation which can be expected under similar conditions or where the standard deviation can be calculated from the results of at least 40 works cube tests, such standard deviation may be used as a basis for designing or redesigning the mix:

Provided that the standard deviation used in designing or redesigning a mix shall be not less than 3.5 MPa.

4. (1) For concrete which is protected from the weather or from corrosive conditions, the cement content and the ratio of water to cement will generally be selected on the basis of the required resistance to crushing and workability.

(2) For exposed concrete the maximum ratio of water to cement may be limited by the requirements of durability rather than strength. The Table hereto sets out the maximum ratio of water to cement for various types of exposure. The cement content should be selected so that the required workability can be obtained without exceeding the maximum ratios of water to cement.

<table>
<thead>
<tr>
<th>TABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum ratios of water to cement (by mass) for durability of different types of structure under various degrees of exposure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conditions of exposure</th>
<th>Type of structure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Thin sections</td>
<td>Medium sections</td>
</tr>
<tr>
<td></td>
<td>Heavy sections</td>
</tr>
<tr>
<td>Protected concrete</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>0.60</td>
</tr>
<tr>
<td></td>
<td>0.65</td>
</tr>
<tr>
<td>Normal outside exposure</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>0.60</td>
</tr>
<tr>
<td>Frequent wetting and drying in fresh water or continuously wet in sea water</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>0.55</td>
</tr>
<tr>
<td>Frequent wetting and drying in sea water or spray</td>
<td>0.40</td>
</tr>
<tr>
<td></td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
</tr>
</tbody>
</table>
### TABLE A

#### WALLS AND PARTITIONS

<table>
<thead>
<tr>
<th>Construction and Materials</th>
<th>Minimum thickness in mm (excluding plaster) for period of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4 hours</td>
</tr>
</tbody>
</table>

| SOLID CONSTRUCTION—       | 225 | 225* | 100 | 100 |
| Bricks of clay, concrete or sand lime | 100 | 75 | 65 |
| Concrete blocks           | 100 | 75 | 50 |
| Class 1 Aggregate         | 100 | 75 | 50 |
| No plaster                 | 100 | 75 | 50 |
| Plastered at least 12.5 mm thick on each side | 75 | 50 | 50 |
| Class 2 Aggregate         | Aggregate in accordance with regulation 18(2), with minimum concrete cover to reinforcement of 25 mm |
| No plaster                 | 175 | 100 | 75 | 75 |
| Plastered at least 12.5 mm thick on each side | 19 |
| Gypsum blocks              | 175 | 100 | 75 | 75 |
| No plaster                 | 175 | 100 | 75 | 75 |
| Plastered at least 12.5 mm thick on each side | 19 |
| Wood wool slabs            | 175 | 100 | 75 | 75 |
| Plastered at least 12.5 mm thick on each side | 19 |
| Reinforced concrete        | 175 | 100 | 75 | 75 |
| Supported at top and bottom edges in steel channels and plastered on each side at least 15 mm thickness with gypsum plaster | 19 |
| Hollow Block Constructions— | 225 | 100 | 75 | 75 |
| Clay blocks                | 225 | 100 | 75 | 75 |
| Plastered at least 12.5 mm thick on each side and shells not less than 20 mm thick— | 19 |
| 1 cell in each block and each block not less than 50 per cent solid | 100 | 75 | 75 | 75 |
| 1 cell in each block and each block not less than 30 per cent solid | 150 |
| 2 cells in each block and each block not less than 50 per cent solid | 225 | 100 | 75 | 75 |
| 2 cells in each block and each block not less than 30 per cent solid | 150 |
## Building (Construction) Regulations

### Minimum thickness in mm (excluding plaster) for period of

<table>
<thead>
<tr>
<th></th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 hours</td>
<td>2 hours</td>
<td>1 hour</td>
<td>1 hour</td>
</tr>
<tr>
<td><strong>Concrete blocks</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastered at least 12.5 mm thick on each side and 1 cell in wall thickness:—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 1 Aggregate</td>
<td>225</td>
<td>115</td>
<td>75</td>
<td>65</td>
</tr>
<tr>
<td>Class 2 Aggregate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gypsum blocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not less than 70 per cent solid:—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No plaster</td>
<td>100</td>
<td>75</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Plastered at least 12.5 mm thick on each side</td>
<td>75</td>
<td>50</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td><strong>CAVITY WALL CONSTRUCTION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walls constructed in accordance with regulation 60:—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) of solid bricks or blocks of clay, concrete or sand lime:—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>thickness of each leaf</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) with outer leaf, not less than 100 mm thick of solid bricks or blocks of clay, concrete or sand lime:—</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(i) Thickness of inner leaf of solid or hollow concrete or blocks of Class 1 Aggregate</td>
<td>100</td>
<td>75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Thickness of inner leaf of hollow clay or solid or hollow concrete blocks of Class 2 Aggregate</td>
<td></td>
<td></td>
<td></td>
<td>75</td>
</tr>
<tr>
<td><strong>STEEL OR TIMBER STUDDING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plaster on metal or timber lathing</td>
<td>Portland cement plaster, Portland cement-lime plaster or gypsum plaster</td>
<td>19</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Plaster board with or without gypsum plaster</td>
<td>9.5 mm thick plaster board on each side</td>
<td>9.5 mm thick perforated plaster board on each side</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two 9.5 mm thick plaster boards on each side</td>
<td>12.5 mm thick plaster board on each side</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19 mm thick plaster board on each side</td>
<td>9.5 mm thick plaster board on each side</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this Table:—

- **Class 1 Aggregate** means foamed slag, pumice, blast furnace slag, crushed brick and burnt clay products, well burned clinker, crushed limestone.
- **Class 2 Aggregate** means flint, gravel, granite and all crushed natural stones other than limestone.
### TABLE B

**Floors and landings**

<table>
<thead>
<tr>
<th>Construction and Materials</th>
<th>Minimum thickness in mm for period of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 hours</td>
</tr>
<tr>
<td><strong>FILLER JOIST CONSTRUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>Thickness of concrete</td>
<td>150</td>
</tr>
<tr>
<td>Concrete cover on bottom of joist</td>
<td>25</td>
</tr>
<tr>
<td><strong>SOLID REINFORCED CONCRETE CONSTRUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>(including flat slab construction and floors constructed of precast inverted “U”, channel or T-sections, without a ceiling or soffit).</td>
<td></td>
</tr>
<tr>
<td>Thickness of concrete</td>
<td>150</td>
</tr>
<tr>
<td>Concrete cover to reinforcement</td>
<td>25</td>
</tr>
<tr>
<td><strong>HOLLOW BLOCK FLOOR CONSTRUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>(including floors constructed of precast concrete units of box-section or I-section).</td>
<td></td>
</tr>
<tr>
<td>Aggregate thickness of incombustible material (excluding ceiling finishes (if any))</td>
<td>125</td>
</tr>
<tr>
<td>Concrete cover to reinforcement</td>
<td>25</td>
</tr>
<tr>
<td><strong>STRUCTURAL TIMBER CONSTRUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>Boards 22 mm thick on timber joists not less than 175 mm deep by 50 mm wide.</td>
<td></td>
</tr>
<tr>
<td>(a) Tongued and grooved boards with ceiling of:—</td>
<td></td>
</tr>
<tr>
<td>(i) timber lath and plaster</td>
<td></td>
</tr>
<tr>
<td>Thickness of plaster</td>
<td></td>
</tr>
<tr>
<td>(ii) metal lath and plaster</td>
<td></td>
</tr>
<tr>
<td>Thickness of plaster</td>
<td></td>
</tr>
<tr>
<td>(iii) 2 layers of plaster-board. each of minimum thickness</td>
<td></td>
</tr>
<tr>
<td>(iv) 1 layer of plaster-board of minimum thickness</td>
<td></td>
</tr>
<tr>
<td>(v) 1 layer of plaster-board of minimum thickness of 9.5 mm covered with gypsum plaster of minimum thickness</td>
<td></td>
</tr>
<tr>
<td>(b) Plain edge boarding with ceiling of:—</td>
<td></td>
</tr>
<tr>
<td>(i) metal lath and plaster</td>
<td></td>
</tr>
<tr>
<td>Thickness of plaster</td>
<td></td>
</tr>
<tr>
<td>(ii) timber lath and plaster with plaster of minimum thickness of 16 mm. covered with sheets of plaster-board of minimum thickness</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE C

#### STEEL COLUMNS AND BEAMS

<table>
<thead>
<tr>
<th>Construction and Materials</th>
<th>Minimum thickness of protection in mm for period of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4 hours</td>
</tr>
</tbody>
</table>

#### SOLID PROTECTION

**Columns**

- Concrete not inferior to that designated Grade III in regulation 19 and reinforced ........................................ 65* 50* 25 25
- *The thickness of protection on any projecting cleat, projecting rivet head and the like need not exceed 25 mm.

- Solid bricks of burnt clay or sand lime .......................... 75 50 50 50
- Solid blocks; reinforced in every horizontal joint
  - (i) Foamed slag or pumice concrete .......................... 65 50 50 50
  - (ii) Gypsum blocks .............................................. 50 50 50 50
- Sprayed Asbestos ................................................... 50 25 15 7

**Beams**

- Concrete not inferior to that designated Grade III in regulation 19 and reinforced ........................................ 65* 50* 25 25
- *The thickness of protection on the upper surface of the upper flange of an internal beam, and on any projecting cleat, projecting rivet head and the like need not exceed 25 mm.

- Sprayed Asbestos ................................................... 50 25 15 7

#### HOLLOW PROTECTION

**Columns**

- Solid bricks of burnt clay or sand lime: reinforced in every horizontal joint ........................................ 115 75 50 50
- Solid bricks of foamed slag or pumice concrete or gypsum: reinforced in every horizontal joint .............. 75 50 50 50
- Moulded asbestos bound in position with nicotine wire not less than 1.6 mm diameter, the wires to be sunk in grooves not less than 3 mm deep in the outer surface of the asbestos and the grooves and all joints in the asbestos to be filled with refractory cement ........................................ 65 40 25 25
- Cement plaster or cement-lime plaster on metal lathing .......................................................... 19
- Cement plaster or cement-lime plaster on metal lathing with reinforcement over rendering coat .......................................................... 25
- Gypsum plaster on metal lathing ........................................... 22 16
- Gypsum plaster on 9.5 mm gypsum plaster board with 1.6 mm diameter wire binding at 100 mm pitch ........................................... 12.5
<table>
<thead>
<tr>
<th>Construction and Materials</th>
<th>Minimum thickness of protection in mm for period of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gypsum plaster on 19 mm gypsum plaster board with 1.6 mm diameter wire binding at 100 mm</td>
<td>12.5</td>
</tr>
<tr>
<td>2 layers of metal lathing plastered with gypsum plaster on each layer, each................</td>
<td>19</td>
</tr>
<tr>
<td>Precase concrete consisting of 4 volumes of vermiculite to 1 volume of Portland cement,</td>
<td>25</td>
</tr>
<tr>
<td>reinforced with expanded metal, wire mesh or with 1.6 mm diameter wire binding at 100 mm</td>
<td></td>
</tr>
<tr>
<td>pitch</td>
<td></td>
</tr>
<tr>
<td><strong>Beams</strong></td>
<td></td>
</tr>
<tr>
<td>Moulded asbestos bound in position with nicrome wire not less than 1.6 mm diameter in</td>
<td>65 40 25 25</td>
</tr>
<tr>
<td>thickness, the wires to be sunk in grooves not less than 3 mm deep in the outer surface of</td>
<td></td>
</tr>
<tr>
<td>the grooves and all joints in the asbestos to be filled with refractory cement.............</td>
<td></td>
</tr>
<tr>
<td>Cement plaster or cement-lime plaster on metal lathing...............................................</td>
<td>19</td>
</tr>
<tr>
<td>Cement plaster or cement-lime plaster on metal lathing with reinforcement over the rendering</td>
<td>25</td>
</tr>
<tr>
<td>coat</td>
<td></td>
</tr>
<tr>
<td>Gypsum plaster on metal lathing.........................</td>
<td>22 16</td>
</tr>
<tr>
<td>Gypsum plaster on 9.5 mm gypsum plaster board with 1.6 mm diameter wire binding at 100 mm</td>
<td>12.5</td>
</tr>
<tr>
<td>pitch</td>
<td></td>
</tr>
<tr>
<td>Gypsum plaster on 9.5 mm gypsum plaster board supported on wood battens........................</td>
<td>5</td>
</tr>
<tr>
<td>(neat single coat)</td>
<td></td>
</tr>
<tr>
<td>Gypsum plaster on 19 mm gypsum plaster board with 1.6 mm diameter wire binding at 100 mm</td>
<td>12.5</td>
</tr>
<tr>
<td>pitch</td>
<td></td>
</tr>
<tr>
<td>Precast concrete consisting of 4 volumes of vermiculite to 1 volume of Portland cement,</td>
<td>25</td>
</tr>
<tr>
<td>reinforced with expanded metal, wire mesh or with 1.6 mm diameter wire binding at 100 mm</td>
<td></td>
</tr>
<tr>
<td>pitch</td>
<td></td>
</tr>
</tbody>
</table>

In this Table:

"Solid Protection" means casing which is bedded close up to the steel without any intervening cavities and with all joints in that casing made full and solid.

"Hollow Protection" means that there is a void between the protective material and the steel. All hollow protection to columns shall be effectively sealed at each floor level.

Reinforcement—where reinforcement is required in this Table, that reinforcement shall consist of steel binding wire not less than 2.5 mm diameter, or a steel mesh weighing not less than 0.5 kg m². In the case of concrete protection, the spacing of that reinforcement shall not exceed 300 mm in any direction.
TABLE D

REINFORCED CONCRETE COLUMNS AND BEAMS

<table>
<thead>
<tr>
<th>1</th>
<th>Minimum overall size of column in mm for period of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Construction and Materials</td>
<td></td>
</tr>
<tr>
<td>Reinforced concrete columns</td>
<td>450</td>
</tr>
<tr>
<td>Reinforced concrete columns with light 50 mm mesh reinforcement in the concrete cover to longitudinal reinforcement</td>
<td>300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum concrete cover to longitudinal reinforcement in columns in mm for period of</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 hours</td>
</tr>
<tr>
<td>65</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minimum concrete cover to main reinforcement in mm for period of</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 hours</td>
</tr>
<tr>
<td>65</td>
</tr>
</tbody>
</table>

Reinforced concrete beams

Where the minimum thickness of concrete cover to main reinforcement specified in this Table exceeds that required by regulation 115 the excess cover may be provided by renderings of cement plaster, cement-lime plaster or gypsum plaster, on a mesh reinforcement fixed to the concrete of the beam.

TABLE E

STAIRS

<table>
<thead>
<tr>
<th>1. Reinforced concrete construction—</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) minimum thickness at waist of slab ..........</td>
</tr>
<tr>
<td>(ii) concrete cover to reinforcement ..........</td>
</tr>
<tr>
<td>2. Structural timber construction (timber with all joints in treads, risers and flooring, tongued and grooved or cross tongued)—</td>
</tr>
<tr>
<td>(i) Soffit unprotected</td>
</tr>
<tr>
<td>Minimum finished solid thickness in any part ...</td>
</tr>
<tr>
<td>(ii) Soffit protected with</td>
</tr>
<tr>
<td>(a) plaster not less than 16 mm in thickness on metal lathing, or</td>
</tr>
<tr>
<td>(b) sheets of incombustible material not less than 5 mm in thickness on backing of close jointed boarding not less than 12 mm in thickness, or</td>
</tr>
<tr>
<td>(c) sheets of incombustible material not less than 5 mm in thickness bedded to plaster and fixed securely to the carriages and joists, minimum finished solid thickness in any part ...</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Construction and Materials</th>
<th>Minimum thickness in mm for period of</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 hours</td>
<td>2 hours</td>
</tr>
<tr>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>25</td>
<td>15</td>
</tr>
</tbody>
</table>

| 45 |

| 30 |
### TABLE F

**GLAZING**

| Construction and Materials                                                                 | Minimum thickness of glazing in mm for period of
<table>
<thead>
<tr>
<th></th>
<th>4 hours</th>
<th>2 hours</th>
<th>1 hour</th>
<th>½ hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass, in direct combination with metal, the melting point of which is not lower than 980°C in squares not exceeding 0.15 m² in area.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of Glass</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Glass reinforced with wire not less than 0.5 mm in diameter laid to a square mesh measuring 12.5 mm from centre to centre of wire, and electrically welded at the inter-sections, or laid to a hexagonal mesh measuring 25 mm across the flat sides.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of Glass</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
</tr>
</tbody>
</table>

In windows, doors, borrowed lights, lanterns and skylights, glass complying with paragraph 1 or 2 of this Table shall be fixed with wood or metal fillets in panels not exceeding 0.4 m² in area secured to frames of metal (fixed shut) having a melting point not lower than 980°C or in timber frames (fixed shut) having a minimum thickness of 45 mm.

3. Glass Bricks or Blocks.
   In panels not exceeding 3.5 m² in area with expansion joints not less than 8 mm per metre of the panel at each side of the panel, and not less than 8 mm per metre of the height of the panel at the top of the panel ................................................. 95

### TABLE G

**DOORS**

| Construction and Materials                                                                 | Finished Minimum overall thickness in mm for period of
<table>
<thead>
<tr>
<th></th>
<th>4 hours</th>
<th>2 hours</th>
<th>1 hour</th>
<th>½ hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid timber with timber door stops continuous round the sides and the head of the frame and having a dimension parallel to the face of the door of not less than 25 mm and at right-angles to the face of the door of not less than 36 mm .................................................</td>
<td></td>
<td></td>
<td></td>
<td>44</td>
</tr>
<tr>
<td>Fire-check flash doors complying with the appropriate provisions of BS 459: Part 3: 1951</td>
<td></td>
<td></td>
<td></td>
<td>54 44</td>
</tr>
</tbody>
</table>