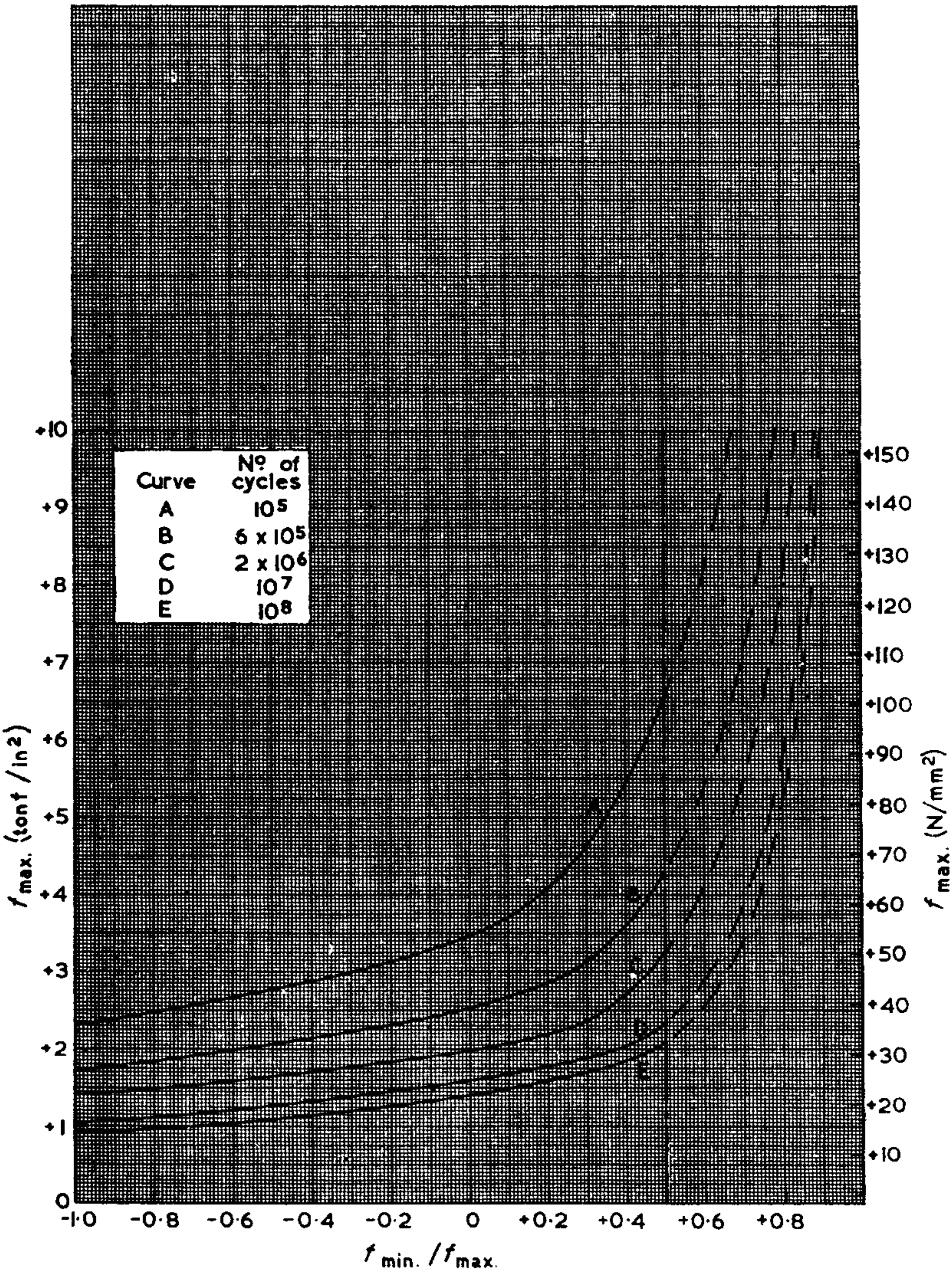
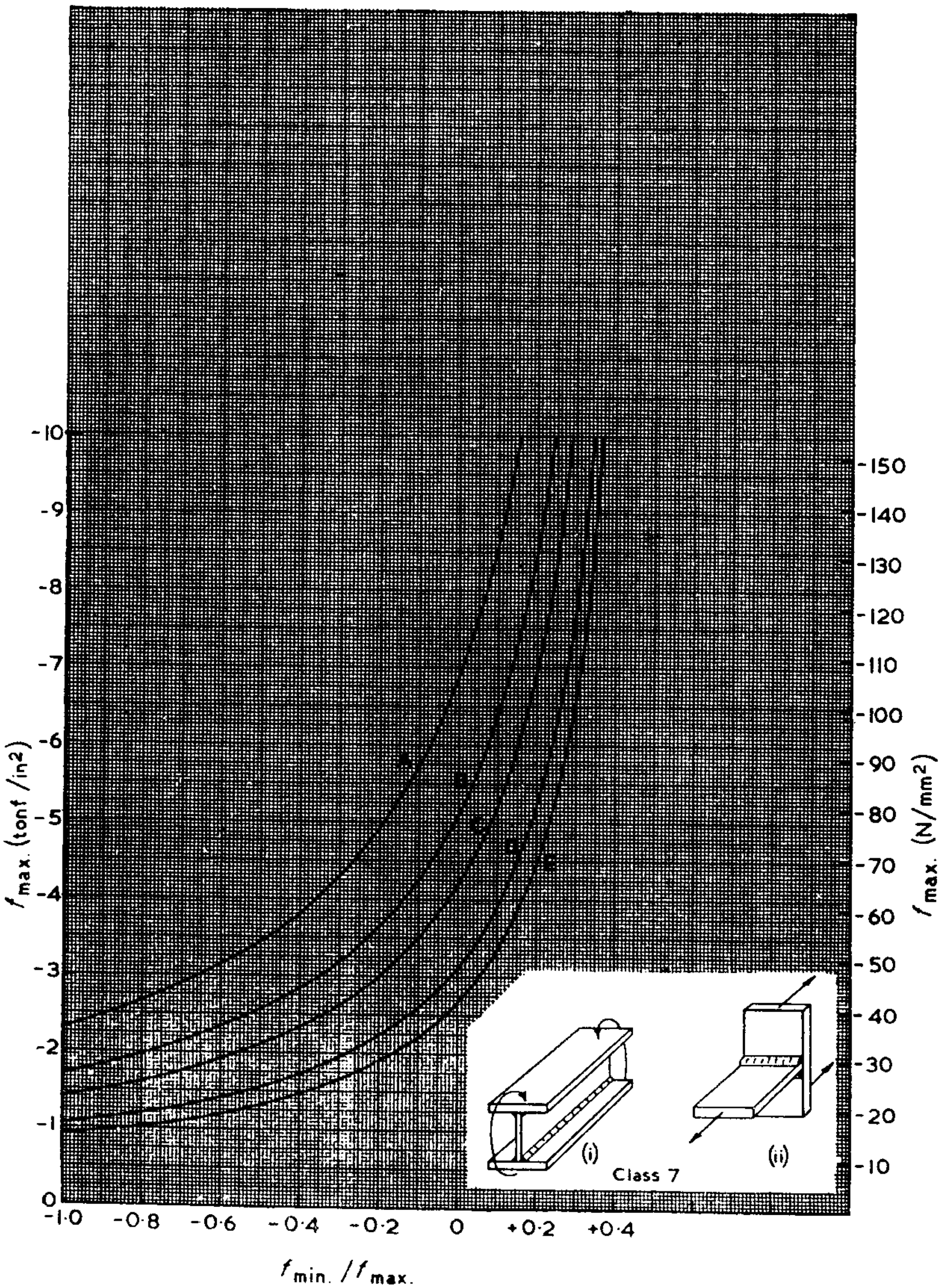


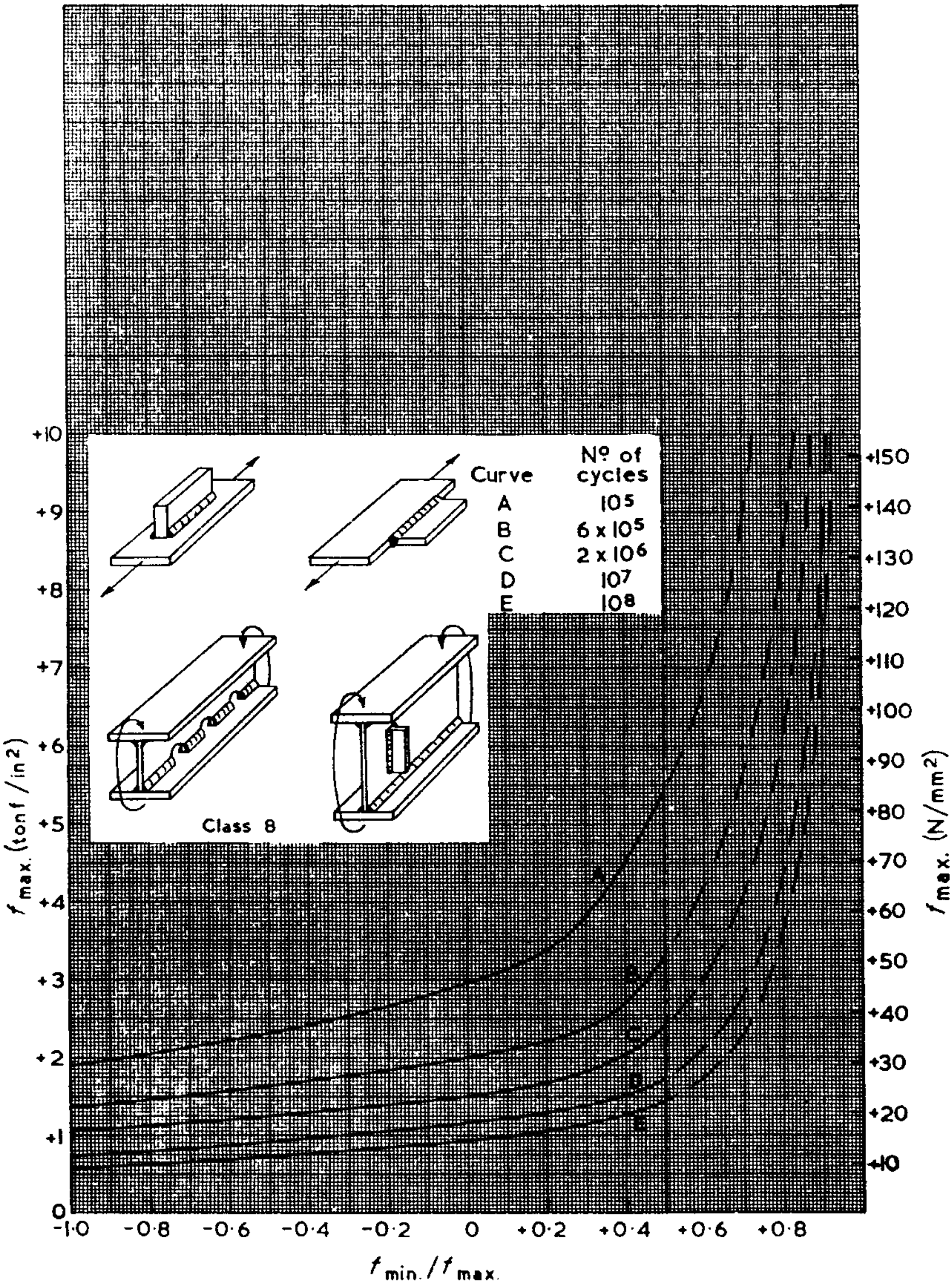
a. Maximum stress tensile

Figure 21 — Curves relating maximum stress, stress ratio and number of cycles for Class 7 members



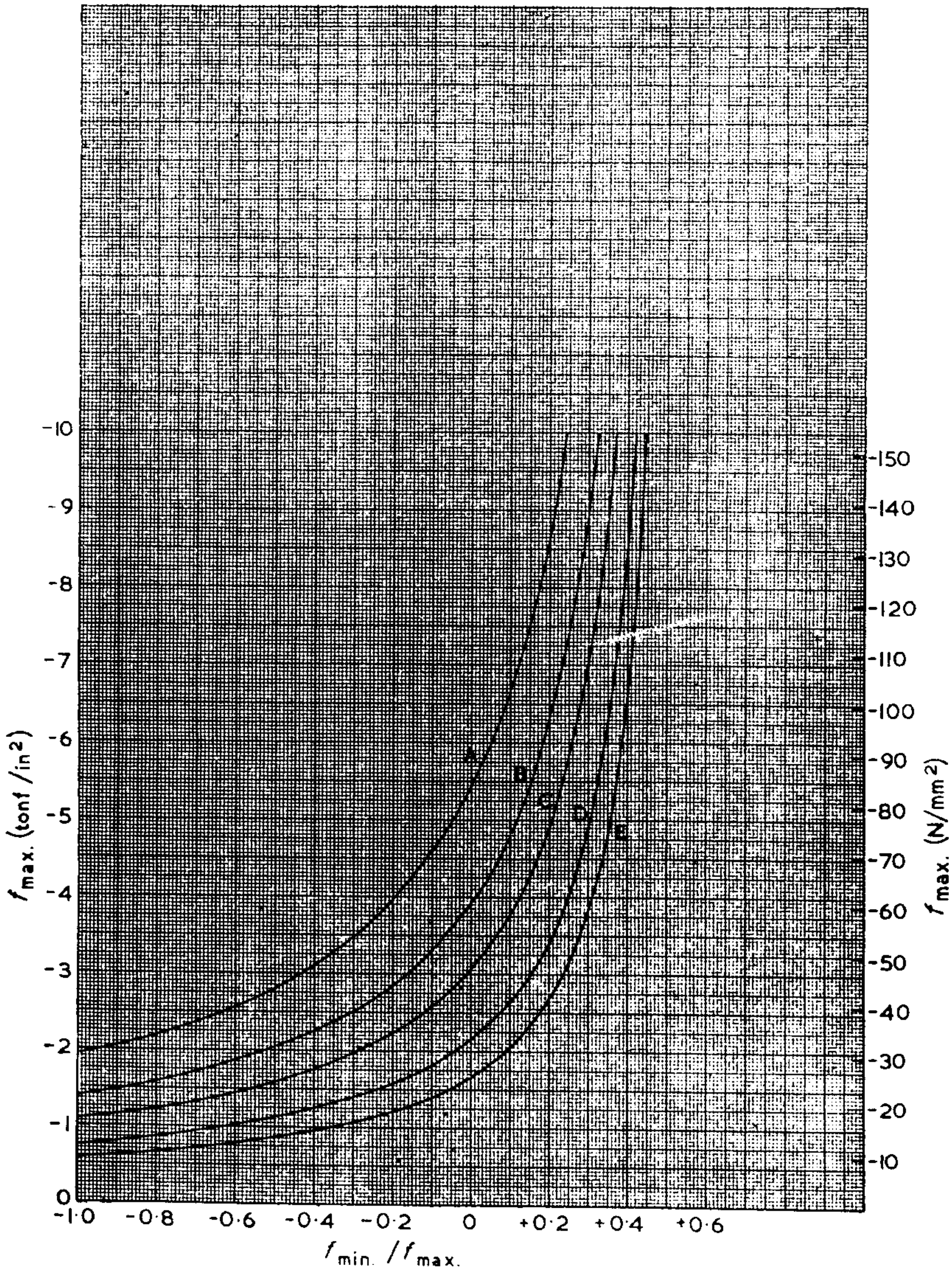
b. Maximum stress compressive

Figure 21 — Curves relating maximum stress, stress ratio and number of cycles for Class 7 members



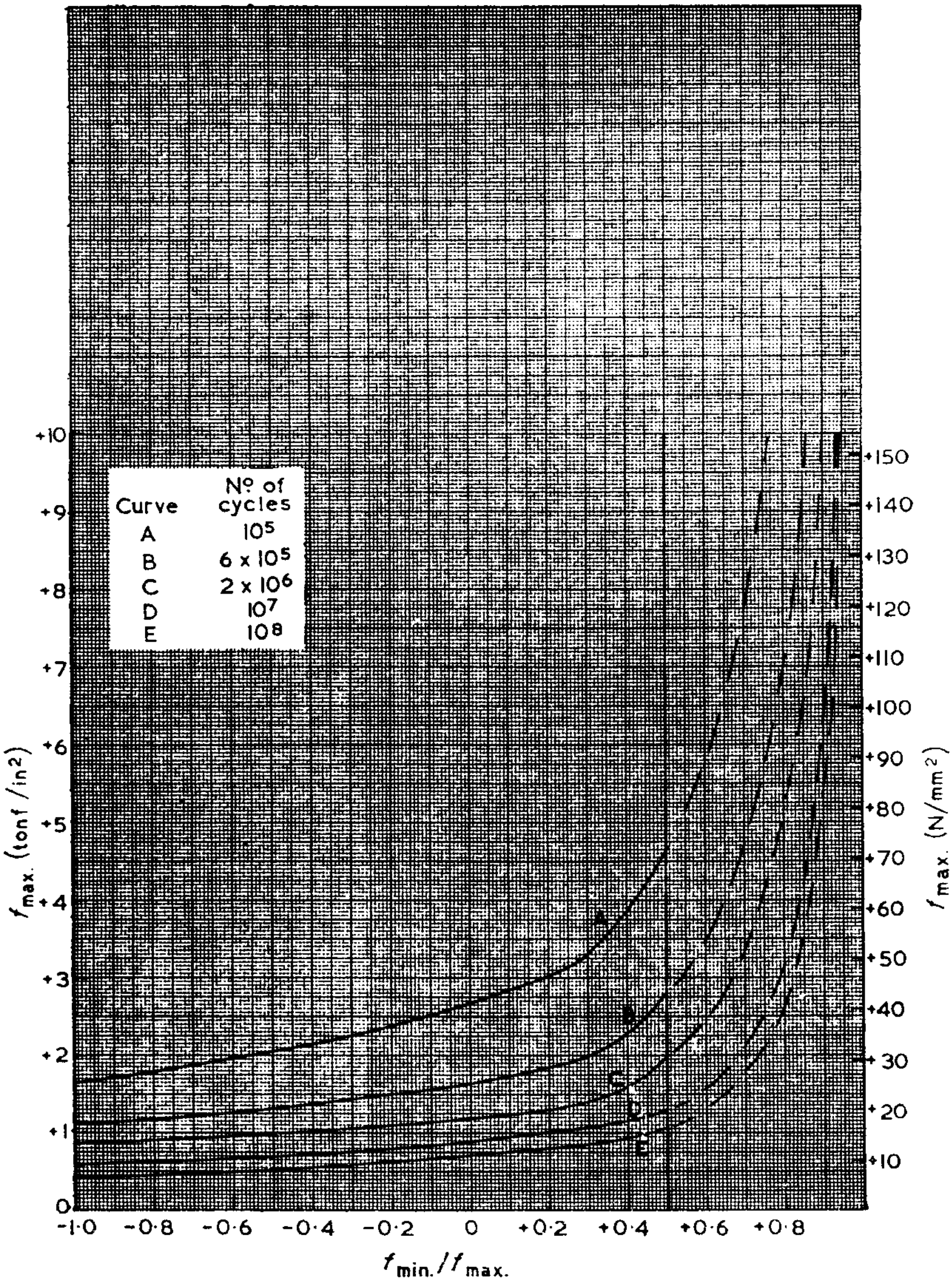
a. Maximum stress tensile

Figure 22 — Curves relating maximum stress, stress ratio and number of cycles for Class 8 members



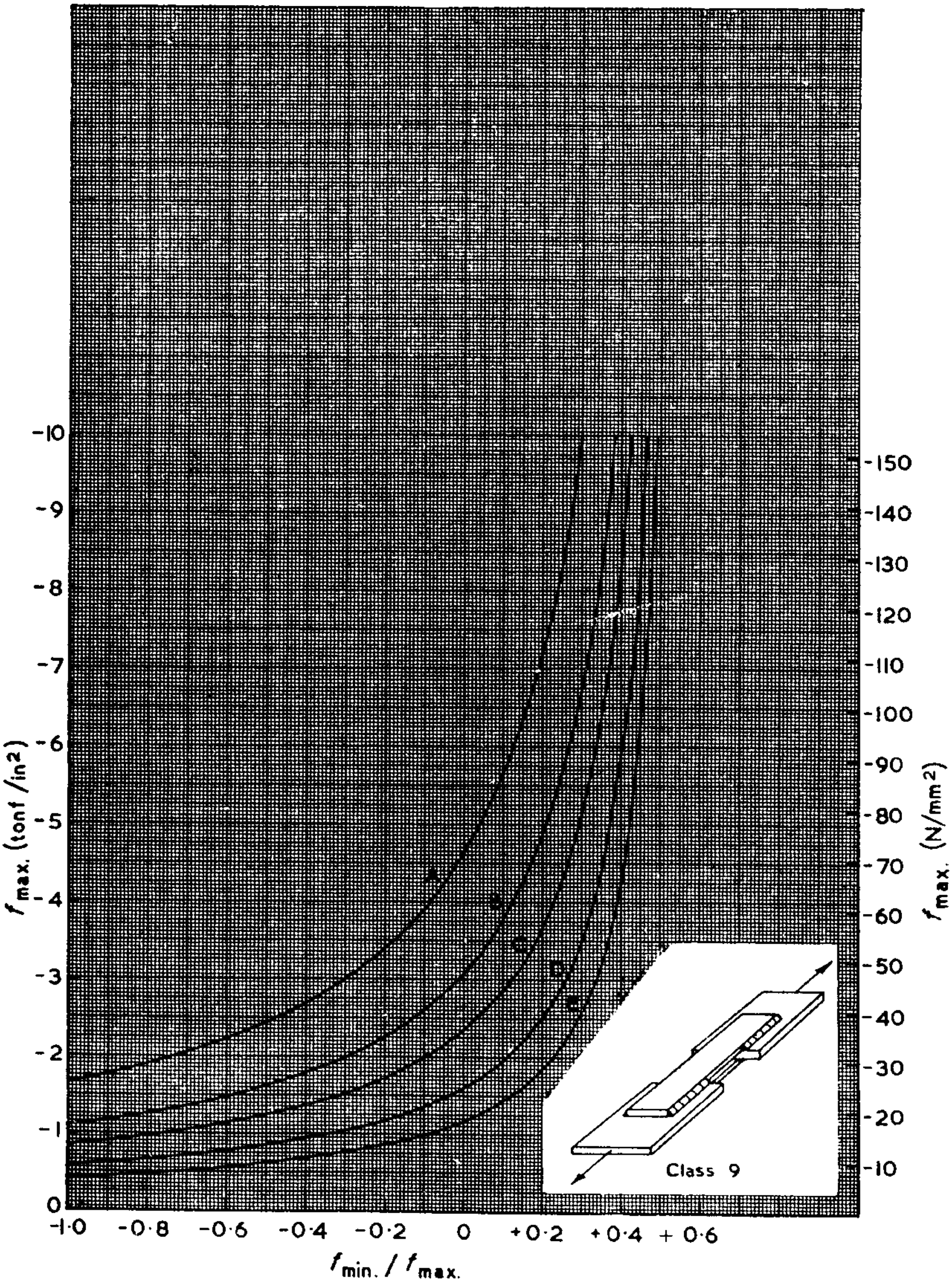
b. Maximum stress compressive

Figure 22 — Curves relating maximum stress, stress ratio and number of cycles for Class 8 members



a. Maximum stress tensile

Figure 23 — Curves relating maximum stress, stress ratio and number of cycles for Class 9 members



b. Maximum stress compressive

Figure 23 — Curves relating maximum stress, stress ratio and number of cycles for Class 9 members

Class 5 (i) Members with transverse butt welds made from one side, with an underbead.

(ii) Members with transverse butt welds made on permanent backing strips attached with full-length fillet welds parallel to the butt welds. To qualify for Class 5, this type of member must comply with **4.7.4.4**.

(iii) Members with transverse non-load-carrying fillet welds.

Class 6 (i) Members with transverse butt welds made on permanent backing strips not attached by full-length fillet welds. To qualify for Class 6, this type of member must comply with **4.7.4.4**.

(ii) Members with transverse load-carrying fillet welds or cruciform welds, either weld being with or without full penetration. To qualify for Class 6, this type of member must comply with **4.7.4.6**.

Class 7 (i) Members with continuous longitudinal fillet welds with interruptions which have not been repaired in accordance with **4.7.4.5**.

(ii) Members with T-joints, the welds being with or without full penetration if made from both sides, but with full penetration if made from one side. To qualify for Class 7, this type of member must comply with **4.7.4.6**.

Class 8 Members with discontinuous longitudinal non-load-carrying fillet or butt welds; this class includes beams with intermittent web-to-flange welds.

Class 9 Members with discontinuous longitudinal load-carrying-fillet or butt welds. To qualify for Class 9, this type of member must comply with **4.7.4.6**.

4.7.4.2 *Dressed butt welds.* Butt welds for members described in Class 2 must be dressed flush by machining finished in the direction of the applied stress; the members must have edges as-extruded or carefully machined or filed in the direction of the stress.

4.7.4.3 *Bolts and rivets.* Bolts or rivets for members described in (i) of Class 3 must be proportioned to develop the full static strength of the member; bolts must be secured against working loose [see **4.6.2.2** 6)].

4.7.4.4 *Butts welds between members of dissimilar thickness or width.* In butt welds for members described in (ii) of Class 3, (ii) of Class 4, (ii) of Class 5, or (i) of Class 6, if the materials on the two sides of the joint differ in thickness by more than ⅛ in (3.2 mm) or one fifth of the thickness of the thinner material, whichever is smaller, the thicker material must be tapered down to the thickness of the thinner with a slope of about 1 in 5 (see Appendix L). Differences in width must be treated similarly. The effect of misalignment on permissible stresses is dealt with in **4.7.2**.

4.7.4.5 *Weld repairs.* In welds of members described in (ii) of Class 3, or (i) of Class 4, if an interruption occurs in welding either the root pass or the final pass, the weld crater must be chipped or machined back in the form of a taper over a length of at least eight times its width, and the weld must then be restarted at the top of the tapered slope; this procedure is intended to prevent lack of fusion and entrapment of oxide. On completion, the surface of the new weld must be machined or filed smooth.

Repairs to members of other classes do not require the above precautions.

4.7.4.6 *Load-carrying fillet welds.* Welds for members described in (ii) of Class 6, (ii) of Class 7, or Class 9, must be designed so that the stress on the total effective throat area does not exceed the appropriate value given for a Class 8 member. Load-carrying fillet-welded joints must be designed so that secondary bending stresses are not introduced (e.g. single-lap joints should not be used except in special circumstances: see Table 29).

5 Testing

5.1 General

A structure designed in accordance with Section 4 is acceptable without testing. A structure or part of a structure not so designed must comply with either the static acceptance test described in **5.2** or the fatigue acceptance test described in **5.3**, except that those tests need not apply where an alternative test is required by an appropriate specification. The choice of test must be agreed with the engineer. An acceptance test is appropriate where:

1) the structure is not amenable to calculation or calculation is deemed impracticable;

2) design methods other than those specifically referred to in Section 4 are used; or

3) there is doubt or disagreement as to whether the structure has been designed in accordance with Section 4, or whether the quality of material or workmanship is of the required standard.

5.2 Static acceptance test[21)]

5.2.1 Application. The static acceptance test applies to structures or parts of structures that are not subject to fluctuating loads likely to cause fatigue failure (see **4.7**). The test is intended to show whether the structure is capable of carrying the design loads without undue distortion and without developing serious defects.

The test may be done on the actual structure under consideration or on one that in all essential respects is its equivalent.

During a static test note must be taken of any readily excited natural vibration and, if the damping characteristics are poor, arrangements must be made to prevent or minimize such vibration in the actual structure.

5.2.2 Loading. If the structure to be tested is complete, its self-weight constitutes the dead load. If the structure is incomplete, the self-weight of each missing part must be carefully estimated and then multipled by 1.1 (or by 0.9 if it acts in opposition to the live load) and applied as a dead load additional to that of the incomplete structure. Any such additional dead load must be positioned so as to represent the missing part as realistically as possible.

All other loads on the structure are considered as live loads; any moving load must be augmented by the appropriate impact effect (see **3.3**).

Prior to the actual test or tests, a preliminary settling-down of the structure must be accomplished by applying to it such a combination of live loads as, together with any additional dead load which may be required as above, produces substantially the severest effect. The live loads must be removed again before the testing begins, but any additional dead load must remain in place except in so far as it may have to be modified according to whether it acts with or in opposition to the live load during the test.

The live loads for the actual test consist of the wind load multiplied by 1.25 and all other live loads multiplied by 1.5. Those combinations of any of them which, together with any additional dead load, produce the severest effects, must in turn be applied to the structure in at least five approximately equal increments. They must in each case be positioned so as to reproduce the actual live loads as realistically as possible.

5.2.3 Duration of loading. The preliminary settling-down live loads must remain in place for at least 15 minutes.

In the actual test, each increment of test live load must remain in place long enough to enable measurements of deflection to be taken at such critical points of the structure as may be determined by the engineer, and to permit examination for damage. The final increment of each combination of loads must remain in place for at least 15 minutes before the measurements and inspection required for acceptance are made.

5.2.4 Acceptance. The criterion for acceptance is that the structure must sustain the test loads without excessive deformation and without the development of deleterious defect. Beam deflections must not exceed the values given in **4.4.1** modified appropriately to allow for the difference between the working load and the test load.

Load-deflection curves must be plotted throughout the incremental loading or loadings, and must be examined for signs of instability. If doubt arises from the examination, the engineer may require that the test be repeated. The engineer must satisfy himself that no undue risk will arise from any local plastic deformation which may be repetitive during the life of the structure.

The recovery of deformation 15 minutes after removal of the test loads must be at least 95 %. Failing this, the structure will be acceptable if, on repetition of the test, recovery is at least 95 % of the deformation occurring during the repetition.

[21)] Attention is drawn to "Report of a committee on the testing of structures" published by the Institution of Structural Engineers in September, 1964.

5.3 Fatigue acceptance test

5.3.1 Application. The fatigue acceptance test applies to structures or parts of structures that are subject to fluctuating loads of such magnitudes and frequencies as to render fatigue failure a reasonable possibility (see **4.7**). The test is intended to show whether the structure is capable of carrying the design loads during its service life.

The test must be done on a specimen which exactly reproduces the structure or part under consideration.

5.3.2 Loading. The structure must be subjected to substantially the same loads or combinations of loads as are expected in service.

Where the service loads vary in a random manner between limits, they must be represented in the test by an estimated equivalent sequence of loads which must be agreed with the engineer. The test programme must be arranged to include at least 30 repetitions of the agreed sequence before failure.

Alternatively, the test load must be the maximum service load, and the number of repetitions must be agreed with the engineer as representing the total number of applications of all service loads that give rise to stresses greater than those permitted for Class 9 assemblies (Figure 23) for the appropriate values of the stress ratio and the number of cycles.

5.3.3 Acceptance. The criterion for acceptance will depend on whether the structure is classified as a safe-life structure (see **5.3.4**) or a fail-safe structure (see **5.3.5**).

5.3.4 Safe-life structures. A safe-life design is one in which the structure is designed to have a fatigue life greater than its estimated service life.

Tests to establish safe-life performance must be done under repeated loadings as defined in **5.3.2** until failure results. The geometric mean life obtained from the effective number of specimens in these tests must be at least equal to the specified service life multiplied by the factor given below.

Effective number of specimens tested	Factor
1	5.0
2	4.2
3	3.9
4	3.75
10	3.5

The effective number of specimens for the purposes of determining the appropriate factor will depend on the design and loading and must be agreed with the engineer. For example, symmetry will normally enable test results to be counted as for two specimens, and a detail which repeats within a length of constant stress may further multiply the effective number.

5.3.5 Fail-safe structures. A fail-safe design is one in which the techniques and frequency of inspection are such that any fatigue crack which would endanger the structure is certain to be discovered before catastrophic failure results.

Acceptance is based on the rate of crack growth, and the test is designed to ensure that the rate is not dangerous in relation to the frequency of inspection.

Tests to establish fail-safe performance must be done under repeated loadings as defined in **5.3.2** and must continue until a fatigue crack is detected by the same technique as will be employed in service. The crack must then be allowed to grow for a testing time equivalent to three times the inspection period, and at the end of that time the static design strength of the structure must not be affected by its presence.

A fail-safe design may, in addition, be required to have a specified minimum life which must be established by tests as for safe life. The tests must show that the geometric mean life obtained from the effective number of specimens is at least half the specified life multiplied by the appropriate factor before significant cracks appear, and is at least equal to the specified life multiplied by the same factor before a prohibitive amount of repair is required.

6 Fabrication and erection

6.1 General

6.1.1 Factors affecting fabrication and erection. Fabrication and erection operations are, in general, the same as for steelwork, but they are considerably affected by the lighter weight of structures and assemblies, by the greater flexibility of members, by the larger dimensional changes due to temperature and by the readier machinability of aluminium. Aluminium lends itself to high standards of workmanship.

During erection the structure must be securely bolted or otherwise fastened, and if necessary temporarily braced, so as to ensure stability under all erection stresses and conditions, including those due to erection equipment and its operation.

6.1.2 Storage and transport. If aluminium is stored in damp conditions, or in conditions where condensation can take place, superficial corrosion may cause unsightly staining or marking; this is particularly the case with sheet and plate.

Where appearance is important, therefore, aluminium must be stored in dry places, clear of the ground; contact with other metals and with materials such as cement and damp timber must be avoided. Care must be taken of material for architectural use, particularly if it is anodized; surfaces should be protected with strippable tapes, waxes or lacquers while danger of damage exists.

For transport, aluminium must be packed so as to avoid mechanical damage, abrasion and, where appearance is important, surface corrosion and staining. For export shipment, aluminium must be packed in moisture-proof parcels, adequately crated to prevent damage to the waterproofing, which may be of heavy bitumen paper. Sheets or other items inside the parcels may be separated by interleaving with paper or cardboard spacers.

6.1.3 Marking out. Marking-out techniques are similar to those for steelwork except that, where subsequent welding is involved, paint, chalk, graphite and other contaminants must not be used. Fine scribing-lines are permissible except on critically stressed areas of thin material.

Due attention must be given to the effects of the relatively high coefficient of expansion of aluminium in measuring, marking out and assembly, particularly when temperature variations are large.

6.1.4 Cutting. Cutting must be by machining, shearing or arc-cutting. Band-saws and circular saws should be of the skip-tooth type. Cut edges must be smooth and free from burrs, distortions and other irregularities. Care must be taken to avoid the use of tools contaminated by other metals, particularly copper or brass.

Shearing should normally be limited to material ¼ in (6.4 turn) thick or less. Arc-cutting must be by a process shown by test, to the satisfaction of the engineer, to have no deleterious effect on the material. Flame-cutting must not be used.

Sheared or arc-cut edges should normally be subsequently machined or filed smooth if used as edge preparations for welds in strength members.

6.1.5 Drilling, punching and reaming. Holes must be made by drilling or reaming or, in sheet, by punching. Undersize punching is permitted provided that all burrs, edge defects and local distortion are removed by subsequent reaming. Holes for bolts and rivets must, unless otherwise specified by the engineer, be of the sizes given in Table 13. Holes for close-fitting bolts must be reamed to exact size after assembly. Holes for bolts and rivets in certain members may need to be drilled with parts assembled and tightly clamped together; if the engineer requires, the parts must be subsequently separated to remove burrs.

6.1.6 Bending and forming. Aluminium alloys are available in a wide range of tempers and formability. Where forming or bending is necessary, the engineer must consult with the manufacturer regarding the alloy and temper appropriate to the operation, and regarding any subsequent heat treatment that may be required. Heat treatment and hot forming or hot bending must be done only under competent metallurgical direction and supervision.

Any piece that cracks or fractures because of forming or bending must be rejected.