to the stanchion below, without any R.S.J. coming between. Figure 2 shows such a column splice, and it will be noticed that the joint is made above the level of the floor.

In the old style of transferring the loads from an upper to a lower stanchion, there was obviously grave risk of buckling the R.S.J. This danger exists in a lesser degree in grillage foundations, as ordinarily constructed to-day, although the risk is diminished, as there are a number of R.S.J.'s in the grillage, as against one, or possibly two, at a floor junction.

An important question in steel buildings is that of rivetting, as compared with bolting, as a means of joining the separate members. Under old building acts, there is no stipulation to the effect that steel work shall be rivetted, and, therefore, it is customary in Sydney for the jointing of stanchions and girders to be made with bolts, as these are more easily handled than rivets. Under acts expressly designed to regulate steel frame construction, it is invariably stipulated that no work shall be bolted where rivets can possibly be used. With solid walls it may be good enough to bolt up the various members, but with skeleton frame construction, it is obviously undesirable that any but the most rigid of connections between various members should be made, on account of the resistance necessary to be made to wind pressure and for other reasons.

That the wind pressure has to be resisted is certain, but the question of the actual amount of such pressure is very debatable. This will be seen from the fact that under the New York Code, it is enacted that all structures exposed to the wind shall be designed to resist a horizontal wind pressure of 30 pounds for every square foot of surface thus exposed, from the ground to the top of same, including the roof. The London Building

Act requires that all buildings shall be designed to safely resist a horizontal wind pressure of 30 pounds per square foot of the upper two-thirds of the surface of such buildings exposed to wind pressure. The San Francisco Building Laws require a pressure of 20 pounds per square foot over the whole exposed area, to be allowed for. The wide variation in these stipulations makes the difficulty of gauging the force of the wind apparent.

Design of Columns.

In designing the general layout of a building in steel or reinforced concrete, it can be said generally that a depth of beams of about 1/12 to 1/15 the span is economical, and a spacing of columns from 15 to 20 feet centres is suitable.

From these general premises one proceeds to the design of the individual members. Stanchions are designed under modern building laws to carry a certain load in tons per square inch of their section, which is dependent upon the ratio of the length of the column to its least radius of gyration, and in a building of several stories height, the stanchions are usually looked upon as having both ends fixed, which is, of course, the condition under which they can carry a maximum of load. It is, however, doubtful whether this assumption that the ends actually are fixed, is theoretically justifiable with steel construction, although it may be so with reinforced concrete frames.

Further, quoting from the paper on steel construction before-mentioned as being recently read in London, the author therein states that, in his opinion, "the actual stress on the pillar is more dependent on the accuracy of milling of the ends of the pillar, the condition of the finished joints after erection, and rigidity of connections to bracing beams, than the height between the beams on the different floors,'' so that the variety of factors which affect the strength of columns is apparent. When a fished joint is made in a stanchion, as illustrated in Figure 2 of this paper, it will be seen that it is very important that the ends of the stanchions should be milled to fit accurately, and to bear evenly the one upon the other. The author has, however, seen steelwork erected where

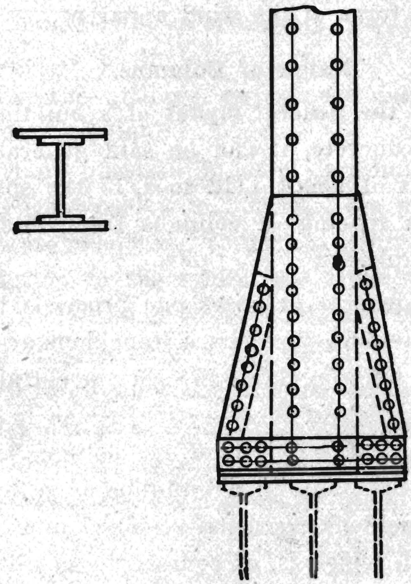

FIGURE 3

jointed stanchions were in contact over part of their surface, and yet far enough apart for a knife blade to be inserted at another part. Such work as this is, of course, subject to unforeseen secondary stresses of a serious nature.

Even assuming that the workmanship in all cases is perfect, the design of columns is really very uncertain. More so is this the case with the design of built up latticed compression members than others, and the author knows of no accurate method of computation for such built up sections.

It is important also to consider the base of a stanchion. The London Building Act requires rivets to be provided in the gusset plates of a stanchion, sufficient in number to transmit the stresses from the stanchion proper to the gusset plates. More usually than not it is impossible to provide this number of rivets in a stanchion of any size. The most rational method of design appears to lie along the following lines. We will assume that there are three R.S.J.'s in the top layer of the grillage under the stanchion base. It is reasonable to assume that these R.S.J.'s receive each an equal amount of the total load. We will also assume that the pressure per inch of length of the stanchion base is uniform. That portion of the total pressure on the base which is beyond the stanchion section itself, must be carried by the gusset plates. Therefore, as the load is uniform along the stanchion base, the amount to be taken up by the rivets through gusset and stanchion shaft will be equal to the load on the portions of the gusset projecting beyond the line of the edge of the stanchion shaft proper. In this case, as there are three R.S.J.'s, the rivets in the gussets should be at least strong enough to take 2/3 of the total pillar load, minus any portion transmitted direct by the shaft on to the two outer beams.

Under obsolete building acts steel framing is permitted for the interior of the structure, but there are no regulations as to its design. Small stanchions are, therefore, frequently constructed under these conditions, where the rivetting is much lighter in the bases than would be given by the design shewn above.

Floor Loadings.

Under old building acts, including the one now in force in Sydney, there is no stipulation as to what loads the floors and stanchions in any building shall be designed to support. The obvious result of this is that although the authorities to whom the plans have to be submitted before the building can be erected, can insist on a certain thickness of exterior walls, they have practically no jurisdiction whatever over the strength of the design of the interior of the building, which may be far too weak to carry the loads intended to be placed upon it.

Under all modern acts, including that now in force in Melbourne, it is enacted that buildings of different classes shall be designed to support certain definite minimum loads per square foot of floor surface, and it is further enacted that all designs deposited for approval with the City authorities shall be accompanied with calculations showing how the designs have been prepared.

The London Building Act, which may be taken as typical, requires that buildings of the following different classes shall be designed to support the loads shown, in addition to the dead weight of the structure itself:

Dwelling Houses	70 lbs.	sq.	ft.	minimum.
Offices	100 „	„	„	„
Workshops and Retail Shops	112 „	„	„	„
Warehouses	224 „	„	„	„
Roofs with slope of 20° or less	56 „	„	„	„

As it is, however, unreasonable to assume that every floor for the full height of a building will be fully loaded at the same time, in buildings other than warehouses, it is permitted that the stanchion loadings may be reduced 5 per cent. per floor below the topmost floor, as regards the live load, until the total reduction in respect of any storey reaches 50 per cent. of the full load on such storey.

This reduction is made clear by the following illustrating table:

Roof	56	56
12th floor	100	100
11th floor	100	95
10th floor	100	90
9th floor	100	85
8th floor	100	80
7th floor	100	75
6th floor	100	70
5th floor	100	65
4th floor	100	60
3rd floor	100	55
2nd floor	100	50
1st floor	100	50
Ground floor	100	50

In warehouse buildings, as before stated, provision must be made for carrying the full superimposed loads in each storey, and no reduction is allowed.

In designing long span floor beams, in either steel or reinforced concrete construction, it is usually enacted that stiffeners shall be added to the beams when the shear stresses are heavy under concentrated loads, and at the supports of the girder. The design of these stiffeners is another instance where approximation has to be made to the truth in default of definite knowledge. The stiffeners are usually inserted at distances apart, but not greater than the depth of the beam, but they cannot be exactly calculated.

The author feels that this paper is very incomplete, and would have wished to have gone more fully into many points which have been merely touched upon. The magnitude of the subject has prevented him from making more than bare mention of much of interest, whilst much more, including the subjects of choice of different building materials, fire prevention, fire escapes, lift enclosures, reinforced concrete columns, eccentric loadings on columns, and the like, has been ignored altogether.

It is hoped, however, that enough has been said to produce an interesting discussion. Mr. Minister Griffith has, within the last month, informed a deputation from professional institutes and commercial bodies, that he believes the revised Sydney Building Act will be passed before Christmas next, and the author trusts that this paper will show some of the benefits which the community may expect to reap in building practice from that long-promised legislation.

Discussion.

THE PRESIDENT: Gentlemen, before the paper Mr. Hart has just read is discussed, I will, if you will allow me, read a note received from Mr. Ross in this connection, which is in the following terms:—

Sydney, 6th July, 1915.

"The Secretary,

"Engineering Association of N.S.W.,

Royal Society's Chambers, Sydney.

"Dear Sir,—I have to thank the Council for their kind invitation to be present at a reading of Mr. Arthur Hart's paper on 'Building Construction under Modern Acts,' but I regret that I cannot attend.

"I have read, however, a draft of the paper, and while the subject matter is one which has always been before us, it is a strong commentary on existing conditions. Particularly important is a clause referring to the more general use of rivets instead of bolts. The existing custom in Sydney to use bolts liberally where rivets should be used should be terminated as soon as possible in the interests of durability and strength.