DESIGN OF STEEL AND REINFORCED CONCRETE PILLARS.

IN a paper read recently before The Concrete Institute of Great Britain, Mr. Oscar Faber, B.Sc., dealt with the above subject, making special reference to secondary and accidental stresses. He divided his paper into two sections, first taking up jointed construction such as structural steel and afterwards monolithic construction, such as reinforced concrete. He examined the case of a girder resting on the end of a steel stanchion and stated that in several drawing offices he knew as a fact that the construction in such a case would be treated as centrally loaded. He proceeded to argue that such was not the case because, when a load was applied to the beam it would deflect and the end originally horizontal would assume a certain slope and therefore one of two things would happen, namely, (*a*) the end of the girder would lift, in which case the whole load would be carried on one flange, so causing eccentric loading; or, (*b*) the column must be constrained to adapt itself to the slope of the girder, in which case a bending moment would be introduced into the stanchion by such constraint. In this way he showed that increases in strains of 140 and 480 per cent. respectively were obtainable.

Mr. Faber took secondly for consideration the case of a girder resting on an angle bracket. He argued that if an ordinary bracket were used the action would not be very far from the face of the leg of the angle since the horizontal leg of the angle would not be strong enough to resist the bending moment which would be produced in it. It followed, therefore, that although the horizontal leg of the angle served a useful purpose in connecting the girder to the stanchion it must not be thought capable of supporting it. In effect the construction became dangerous if the clearing between the face of the stanchion and the edge of the girder exceeded the thickness of the angle. The author of the paper supposed there were few engineers who would assert that this limiting clearance was never exceeded in practice and an engineer had to carefully consider whether it was desirable to employ this type of bracket except for quite small reactions.

He next considered a stiffened bracket. Confining attention to cases where the workmanship was good, he assumed that the stiffening angles had been machined or forged to fit the angle bracket perfectly, and that the bracket was initially horizontal. It followed that, when the girder deflected there was a tendency for it to rest on the outer edge of the bracket, and for very small loads there was no doubt that this actually happened. As the load increased the outer edge of the stiffeners yielded appreciably, and a greater area supported the load, the reaction gradually approaching the face of the column. The author's practice was to make the web of the stiffeners sufficient in area to carry the reaction under a uniform stress of 7½ tons per sq. in.

In calculating the resistence, he ignored a large area of steel in the flange of the stiffeners, and in the vertical leg of the angle bracket because: (*a*) The clearance between the face of the stanchion and the end of the girder might be sufficient to prevent bearing on this steel; (*b*) even if it was not, this material could not be stressed appreciably until the stiffener webs are greatly overstressed.

In any case, the difference in cost between good and bad brackets was an extremely small percentage of the cost of the steelwork, and a smaller one of the cost of the building, and he declined to endanger the "ship" for what, in this case, might be fairly described as a "ha'porth of tar."

It has long been recognized in good practice that the machining of the ends of stanchions was of the first importance. Yet, there were at least two constructional works in London which, with a view to economy, omitted this item of workmanship, and were erecting considerable tonnages of stanchions with the ends left so that the upper tier had contact with the lower tier over the width of one plate only, the remainder of the section having varying clearances often amounting to ⅛ in. The stress was still gaily calculated as uniformly distributed, and it had been explained to the author that "steel is a ductile material which would yield and flow" and perform other convenient antics, "until the stress was uniformly distributed." The effect of loading such a stanchion was to cause the plates to slide past one another, and to partly shear through the rivets. Even where stanchions are machined, a careful engineer must satisfy himself that they were machined truly square. Architects should bear in mind also that apart from the danger involved in these practices, the yielding of stanchions and brackets before they obtain their bearing involved unknown and unintended stresses on the stonework, and to the author's knowledge many a beautiful and costly facade and interior decorative work had been badly cracked by bad steelwork details and workmanship.

From the consideration of case 1, it would appear to follow that it was desirable to make these joints somewhat flexible, and occasionally this was so. If buildings were braced with diagonal braces, he should say without question, that stiffness of connections should be avoided. Unfortunately, such bracing had obvious objections, and the whole stiffness of practical buildings against wind laid in the stiffness between beams and stanchions. There was, therefore, no alternative but to make the joints stiff and to make the necessary allowance for these secondary stresses in the design of stanchions. This might be onerous, both in requiring extra labor and an increase in material, but a conscientious engineer would grudge neither the one nor the other.

Mr. Faber then dealt with the design of cleats. A common method of calculating the safe reaction of a cleat was to take it as the sum of the resistances of the rivets, the effect being to neglect the very appreciable stresses due to bending.

Dealing with the bracing of pillars, Mr. Faber said that it was well known that pillars failed by buckling and that their stress was to be determined with reference to their length. This phenomenon was fairly well understood and there are sufficient experimental data available to make the design of pillars, with reference to what he might call primary buckling, a comparatively simple matter. The phenomenon to which he referred was that of secondary buckling, in which the pillars, instead of buckling as a whole, fails by the individual buckling of its component members. On this subject there appeared to be practically no experimental data and practically no formulæ or rules for the guidance of a designer. The importance of this problem might be gathered from the fact that bad design in the matter of bracing in pillars was certainly responsible for the two greatest failures in recent years—the Quebec bridge of 1907 and the gasholder in Hamburg.

Mr. Faber then proceeded to the second portion of his paper, treating of monolithic construction and the eccentricity of beam reactions on pillars therein. Whereas in steel construction the eccentricity was very definite and