them over the vertical bars when made. Great care must be taken when using spiral reinforcement in vertical columns that it is not made in too long lengths, as all the concrete has to be put in from the top of each length, and it is well known that when concrete is dropped from even a small height the mixture of its constituents becomes very uncertain. Care must also be taken that each length of spiral is "corkscrewed" well into the one below it, or otherwise there is a plane of weakness between each length of spiral. This form of reinforcement must be so designed that the required strength is obtained without the pitch of the spiral being closer together than the size of the largest pieces of aggregate used, as if it is so, the stones become jammed between the coils and a lack of homogeneity is the result.

The second method of column and strut reinforcement above-mentioned, namely, loops or rings slipped over the vertical bars and held at the proper distance apart, as shown in Fig. 3, is also an excellent one, especially when the loops are carefully made mechanically on hard metal formers, so that each one is an exact replica of its neighbour; the result being that each one equally clasps the group of vertical bars, otherwise should one be tight and the other slack the bursting strains will not be taken up by all the loops in equal proportions. As the first desiratum of this design of column and strut reinforcement is the prevention of the vertical rods spreading apart under the load (the loops themselves, being further apart, do not resist the bursting strains on the concrete to the same extent as the spiral windings), it is not good practice to allow the loops to be curved in between the points where they touch the vertical bars. Unless the wire or rodding forming the loop is straight between its resistance points, it does not get a chance to develop its tensional strength, as it must "pull itself straight" first, which it does at a low stress. For this reason the use of comparatively high-carbon steel is often recommended for columns or strut loops, as it is stiffer to resist distortion, and as distortion is one of the main things to avoid, particularly in this phase of reinforcement, the use of harder steel, if the same can be obtained without any marked increase in cost, appears to be certainly indicated; in fact, as the elastic limit of all reinforcement is almost of as great importance as its ultimate strength, the use of bars and rods possessing considerable resistance to stretching is certainly to be recommended, provided that the said ultimate strength is not appreciably decreased. The use of high-carbon steels has been recommended for various other reasons.

It is often said that it is immaterial whether the reinforcing rods are bent or not, as, being bedded in concrete, they are immovable, and doubtless this may be true in a structure where there is no vibration and where the loads are unvarying in amount and disposition; but where it is not so, there is a tendency on the part of the concrete on the concave side of the curved pieces of wire or rodding to become friable, and this tendency should be eliminated in the design by working the reinforcement in straight lines whenever possible. It should also be noted that all the joints of the vertical rods in columns and struts must be in close fitting sleeves—preferably of good quality lap-welded steam barrel.

When designing reinforcement there are, of course, many points for consideration quite irrespective of the particular method of constructing or attaching the various parts or members, one of the principal being that all beams or floors running continuously over the tops of columns or stanchions or walls must be reinforced above their neutral axis where they pass over the said columns, in exactly the same way as they are reinforced below that axis in their clear span, as the parts in tension and compression are reversed in these circumstances. In one well-known system the bars are run along both top and bottom surfaces from end to end, but these rods or bars in the compression area are only provided as a means of keeping the shear-members or loops or stirrups in position, not as reinforcement against reverse flexure, nor as such in compression, this last not being needed unless the area above the neutral axis is such that it cannot stand the allowable crushing stress.

The exact position of this neutral transverse—or, more correctly speaking, diagonal—plane of "reverse flexure" has not so far been very exactly located, and it will, of course, vary with every variation in the distribution of the load. The present practice is therefore to design the reinforcement, over the supports, to overlap the ends of that which runs along the "belly" of the beam. The diagonal auxiliary shear-members connected to each of the main tension bars above and below the neutral axis thus become parallel to each other, as shown diagrammatically in Fig. 4, in the same way as the tension members in a lattice girder. The same arrangement must be carried out where the ends of beams rest on and in walls, and the diagram, Fig. 5, shows the reinforcements against tension due to the same reverse flexure above the neutral axis under these conditions. As will be noted, the ends of the bars are bent downwards into the beam itself when only the beam is reinforced concrete, but, should the whole structure be of this material, the beams and walls consequently being all monolithic, it is better practice to bend the bars upwards, as shown in the dotted lines, this being also handier as the men can readily see, and, if necessary, adjust, any bar which may have been displaced by punning or otherwise.

When designing long and deep beams or girders such as for a railway bridge with flat (not arched) spans, it will also, not infrequently, be found that the available area of concrete in compression above the neutral axis is such that the stress per square inch is more than the concrete will safely stand, that is, more than 550 to 750 lbs. per square inch. according to the class of concrete and the nature of the aggregate used; but this is easily overcome by using reinforcement in the compression area. always remembering that the value of steel in compression is 50 per cent. less than that of the same in tension. Here also the question of rigidity to resist deformation under compression is important, exactly as it is in columns and struts, and care must be taken that all the separate members in compression are properly braced together to avoid the tendency to spread in any direction, but particularly sideways and downwards. Even with ordinary beams supporting floors this question of the available area of concrete in compression demands consideration, but, the floor and beam being all in one solid piece, not only does the part of the floor immediately over the beam contribute to the desired area, but portions of the floor on each side of this are available also, thus enabling us to regard the beams as of T section, as shown in Fig. 6, but except under special conditions of loading, the breadth of floor which we can consider for the purpose of this calculation should not exceed four to six times the breadth of the beam itself, according to the class of concrete and the nature of the aggregate used. But even with this reservations this fact of the beams and floors being solid together enables a wonderfully strong and light structure to be obtained. The same diagram also shows in closer section an additional means of obtaining this larger area of concrete in compression, namely, that of making fillets at the junction of the beam with the floor.