stresses in a case like this will therefore naturally not give the required factor of safety, and in some cases not even be a possible condition; that is, the assumed stresses in the steel and concrete may never occur together. From the above it would seem to be far more consistent and conservative, until further knowledge on the subject has been gained, to base formulæ on the ultimate strength of the concrete and the elastic limit of the steel, applying the factor of safety to the loads.

Formulæ can further be divided into two groups, those basing the ultimate strength of a beam on the ultimate strength of the steel, and those basing the ultimate strength on the elastic limit of the steel. When calculations for the strength of beams were first made, it was naturally assumed that the working stress allowable in the steel was some factor of its ultimate strength. Closer inspection and study of tests made this very doubtful. It is readily seen that, when steel is strained beyond the elastic limit, the bond between concrete and steel is destroyed, due to the reduction of the cross-section of the steel. If the bond is one of adhesion only, it is unquestionably destroyed; if the bond is a mechanical one, there remains, of course, much resistance to slipping, but the beam is seriously weakened. The best description of the condition of a test beam at this point has been given by Prof. A. H. Talbot, of the University of Illinois, in his bulletin of September, 1904, discussing results of tests carried on under his supervision at the engineering station of the University. Prof. Talbot says in discussing beams reinforced with sufficient steel to take all tensile stresses: "The maximum load averaged about 6% more than the load at the yield point of the metal. It would seem then that for beams not having an excess of metal, the maximum load is nearly reached when the steel is stressed up to its yield point, and that the load at the yield point of the metal may be properly taken as the ultimate strength of the beam. It seems also true that the load which will stress the steel to its elastic limit, may be calculated by using the elastic limit of the naked steel for the tensile stress in the beam, and neglecting tension in the concrete."

What probably does occur in a beam when the elastic limit of the steel is reached is that, owing to the rapid extension of the steel, the neutral axis rises and the beam fails by compression of the extreme fibres of the concrete. For the above reasons, a formula in this discussion has been adopted which represents the ultimate strength of a beam at the point where the steel reaches its elastic limit.

A great deal of work has been designed, using steel which has an ultimate strength of say 64,000 lbs. per square inch, and using a working stress of 16,000 lbs., the designer thinking he has a