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## Theme VII a.

### Application of steel in bridge and structural engineering.

1) The reports and contributions to the discussion at the Congress reflect very notable developments during the last few years in the application of steel to bridges and other structural work. It is also apparent that much greater importance than hitherto is now being attached to the aesthetic aspects of structural work, and in many ways this has given a new impulse to the development of steel construction. A series of handsome steel bridges built during the last few years demonstrate the possibility of reconciling structural necessities with aesthetic requirements.

The attractive designs which have been made for halls, exhibition buildings, etc. represent important developments in steel construction, whether regarded from the point of view of the framework or that of the concordance of steel with glass, or any other combination.

2) There can be no doubt that the new forms developed from the structural and economic exigencies of design have had stimulating repercussions on theory. Thus the problem of the stability of the plate web girder may be looked upon as more or less solved, and very notable progress has also been attained in the theoretical and practical development of framed construction.

3) During recent years a great impulse to the development of steel construction has been given by the growth in the use of welding which offers great advantages from the technical, economic as well as aesthetic points of view. In general, steel structures when welded are more readily adapted to aesthetic considerations, and give the impression of a more homogeneous beauty. The development of the art of welding will still further encourage the use of steel once a solution has been reached to many outstanding problems which are now being studied by laboratory and full-scale tests.

4) An interesting new development is to be recorded in the application of steel to self-supporting systems. The theoretical principles of the resistance and stability of these systems are now understood and can be applied with great advantage in the roofing of halls and hangars. Light weight floors for road bridges also take this form, and welding provides a special stimulus to their development. Welding and light weight design are considerably extending the competitive power of steelwork in the field of small bridge construction.

In assessing the economy of new forms of design it must not be overlooked that changes in the technique of construction, due to the adoption of this new method, may be of quite decisive importance.

5) The results of fatigue experiments, so far as they concern the dimensioning of structural members, exposed to alternating or pulsating loads, have shown that the permissible stresses in high tensile steel might be increased when the

permanent limits of stress are high, within the bounds justified by consideration of stability.

The criteria for expressing the results of fatigue tests in practical rules of design still await clarification in the light of further experimental measurements.

6) In structural steel construction, extensive full-sized fire tests on loaded columns provided with different forms of covering have gone far to solve the problem of finding suitable materials for this purpose, and it should now be possible to arrange these in a sequence according to their suitability for fire protection.

7) Finally there must be placed on record an ever increasing development in the combined use of steel and concrete for bridges and building frames. Measurements which have been carried out on structures in service have proved the accuracy of the methods of calculation in use, and have shown that it is possible to realise considerable economy in the construction of bridges by taking account of the co-operation of the steel girders with the reinforced concrete decking slab.

Likewise the combined action of the usual compound form of steel column with a concrete core has been fully confirmed in buckling tests under concentric and eccentric loading, so as to justify an increase in the permissible stress in the steel where special methods of calculation are applied. Another series of tests to examine the effective co-operation of different kinds of covering over steel frameworks are being undertaken.