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PRESENT METHODS OF TESTING MATERIALS

WITH SPECIAL REFERENCE TO THE WORK OF THE INTERNATIONAL TESTING ASSOCIATION—A PAPER READ BEFORE THE IRON AND STEEL INSTITUTE, BRUSSELS

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THE increasing importance of the use of metals in every description of construction, both of the stationary type, such as bridges and roofs, and of mobile type, such as the parts of machinery; the ever-increasing intensity of the stresses they are expected to withstand and of the energy they are required to transmit, have during recent years necessitated a more and more intimate knowledge of the properties of the materials employed and of the laws which determine the distribution of the stresses in the elements of the structure themselves.

Before dealing with the actual subject it might, perhaps, be advisable to make the following generalization: The most conclusive test, from the point of view of the strength of a structure, is obviously that which consists in subjecting the structure to the maximum it is required to undergo, or even to still greater stresses, so as to ensure complete security against all possible accidents. That is what is done, for example, in the case of ropes, in bridges, in boilers, and in pipes. Such tests are obviously of extreme interest from the point of view of the confirmation of the accuracy of the formulas employed in the calculations of dimensions, and of the hypotheses that it is often necessary to introduce into these calculations. They may also often be made to yield valuable data for the building of similar structures. An attempt has been made to introduce such tests into current practice. In this connection reference should be made to the methods and apparatus of Mr. Rabut, which have been applied to begin with in France, and to those of Mr. James Howard, which have been adopted by the Bureau of Standards in Washington, and were made the subject of a memoir presented to the Congress of the International Testing Association in New York in September, last year.

The first-named allows of the determination, with very close approximation to the truth, of the deformation l which a given length of piece L, forming part of a structure, undergoes, and of the stress being deducted from the formula $t = E \frac{l}{L}$, t being in this instance the tensile stress; or of plotting a diagram having as abscissæ the time, and as ordinates the deflections a metallic bridge undergoes under the influence of moving loads; or, finally, of measuring the angular deviation required in investigating the separate influences of overload and of wind pressure.

Howard's apparatus consists of telescopic callipers, furnished with points bevelled to an angle of 55 deg., which can fit into cavities tapering at an angle of 65 deg. in the pieces undergoing test. Mr. Howard has used this apparatus to investigate the deformation and stresses in the elements of bridges, flood-gates, "sky-scrapers," steam boilers, etc.

In the same connection may be mentioned the tests which have to be applied to the plates intended for the armouring of warships, or for the outsides of gun turrets in forts. These plates have to resist the violent impacts of projectiles. This property is one which can only be made manifest by tests carried out on plates placed in conditions identical with those they have to undergo in practice. In a paper, likewise presented to the New York Congress, Mr. Leonardo Fea shows, from numerous experiments carried out on chromium-nickel and on chromium-nickel-vanadium plates, that none of the tests to which metals are ordinarily submitted, such as tensile tests, compression tests, hardness tests, or fatigue tests, can afford an adequate conception of their behavior under fire. Fortunately such considerations do not obtain in every case, and it often happens that the determination of one or more of the elastic properties of a substance affords an engineer sufficient insight into its behavior in some other respect. For instance, tensile tests are carried out on cement intended for masonry buildings, where it will have to undergo compressive stresses. Experiment, as a matter of fact, has established a certain relationship between the two modes of resistance in cement, provided that the tests are carried out under special conditions, that is to say, on test-pieces always prepared in the same way and always stressed in the same manner. It is in this way, likewise, that a tendency has arisen to substitute hardness tests for tensile tests in iron and steel.

Great modern industries no longer confine themselves to the supply of their own national markets. The works of all civilized countries compete amongst themselves for the markets of the whole world. It has therefore become necessary that the conditions specified as to materials and the estimates of the cost of construction should be, as far as possible, uniform, and that indeed a single nomenclature should be everywhere adopted with the object of controlling the manufacture, of facilitating industrial relations, and of avoiding useless and often ruinous disputes. This standardization has been one of the leading objects which the founders of the International Association have had in view.