EXPERIMENTAL RESEARCHES ON REINFORCED CONCRETE

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ON

REINFORCED CONCRETE

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WITH AN INTRODUCTION

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INTRODUCTION.

Concrete as a material for structures, or parts of them, for the many and various needs of modern industrial life, had, as is well known, an extensive and growing application before iron or steel rods were embedded in it for reinforcing. The great advantages of concrete, viz., stability of characteristic properties, small effects caused by changes in temperature, protection against rust and heat, fireproof qualities, and, finally, the facility of adaptation to different forms and shapes, combined with a low cost of manufacture, made its still more extensive application desirable. But the resistance of concrete to the stresses and strains caused in it by external forces is low compared to that of the materials generally used by engineers, such as steel and wrought iron. Especially is the resistance of concrete to tensile and shearing stresses so small that structures or parts thereof which are subjected to such stresses to a considerable extent become uneconomical and impractical.

When it, therefore, became known from the applications made by Monier, Wayss, and others that iron embedded in concrete would act together with the latter and thus virtually strengthen it, engineers all over the world were eager to take advantage of this method of reinforcing concrete. Many and multiform applications of this principle were made and numerous letters-patent taken, each claiming superiority over the other. It is due especially to the initiative and boldness of French and German engineers and their untiring energy in overcoming difficulties and objections, both engineering and legal, that reinforced concrete has had such a rapid and successful development. Practically within the last decade reinforced concrete structures began to be universally used in

all civilized countries and to compete, in many instances successfully, with steel structures. The importance of the new material has become such that no civil engineer can well afford to be without a thorough knowledge of its properties.

As is generally the case with new materials, the practical advantages of reinforced concrete were demonstrated a long time before the theoretical analyses of its properties were attempted. Rather to explain than to study the increased resistance of concrete and steel combined, various assumptions were made as to the behavior of the new material. The most rational of these assumptions were based on the analogy of composite structures, assuming that steel embedded and well distributed in concrete will act the same as does a rod laid parallel with a piece of timber. Formulas founded on these various assumptions have been deduced, and, while they have a rational appearance, they are empirical only. As such they answer very well their purpose of giving quick and safe rules for the computation of certain reinforced concrete constructions, such as beams, especially, provided the limits of their range of application are observed. They are useful and convenient to the busy engineer in estimating and preliminary work. But it should be observed that these empirical formulas give satisfactory results only because in beams the practical proportions of depth to length vary within narrow limits and that it is comparatively easy to fit empirical constants into the chosen formulas.

This is not stated to depreciate the value of the empirical formulas, but to point out that all these coefficients of elasticity of concrete, the ratios of the latter to that of steel, the allowed unit stresses, etc., are not what they claim to be in name, but are merely numerical constants to be applied to given empirical formulas. It therefore follows that the numerical values given to the above constants cannot furnish us a true insight into the behavior of reinforced concrete.

To fully understand the action and utilize the properties of a material, its stress and strain story must be thoroughly

known and not merely results of tests of given structures. The great value of Considère's researches consists in the fact that they represent practically the first systematic attempt to study the properties of reinforced concrete in a scientific manner, by one of the world's foremost experimenters. How fruitful in results such researches can be, is proved by Considère's discovery of "hooped" concrete for compression members, and the Italian engineer Maciachini's adaptation of this principle to hooped beams.

It is in the continuation of such researches and their full discussion that the future development of reinforced concrete lies. From such investigations the designing engineer will be able to judge for himself the use he can make of this material in the vast field of modern engineering construction. This is well understood by engineers the world around, and very recently the Swiss Commission on Reinforced Concrete has decided to undertake the investigation of the subject, at a cost of about $8,000, on the lines practically laid down by Considère's researches.

The researches, the results of which are given in this book, were undertaken in the year 1898 and cover the period of time from that date to the end of 1902. The first published report of the results obtained is found in a paper by the experimenter before the French Academy of Sciences at the end of 1898. As the work proceeded M. Considère published a number of papers containing the results of his labors, the list of which is given below.* The book presented

*The following are the publications of the author on the subject:
Académie des Sciences. Influence des armatures métalliques sur les propriétés des mortiers et bétons, 12 décembre 1898 et 2 janvier, 1899.
Académie des Sciences. Variations de volume, 18 sept., 1899.
Académie des Sciences. Résistance à la traction, 18 août, 1902.
Académie des Sciences. Etude théorique du béton fretté. 25 août, 1902.
"Influence des armatures métalliques," Génie Civil, 1899.
"Résistance à la compression du béton armé et du béton fretté," Génie Civil, 1903.
"Méthode d'épreuve des constructions en béton armé," congrès international des méthodes d'essai à Paris, 1900.
"Contribution à l'étude des propriétés du béton armé," congrès international des méthodes d'essai à Budapest, 1901.

here consists of a compilation of these publications arranged and classified so as to make as far as possible one coherent treatise. It has been the intent to adhere to the author's wording and treatment, avoiding at the same time unnecessary repetitions. The chapters of the book follow in general, as will be seen, the titles of the several papers as they were published and also their chronological order. Of all arrangements this appeared to be the best, containing, as each paper does, the further development of the author's views. It is hoped that this book will be found to present adequately before American engineers the famous researches of the author; and if it should, as it is hoped it will, be of any value to the engineering profession, the objects of this translation will be attained.

THE TRANSLATOR.

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