

## HIGHWAY ENGINEERING EDUCATION.\*

By Arthur H. Blanchard, M.Am.Soc.C.E.†

The educational training of the engineer who may enter that branch of civil engineering devoted to the economics, construction and maintenance of highways should be considered from two standpoints: first, the essentials, which, from an educational point of view, are considered as prerequisite to a successful career in highway engineering; and, second, practical methods of securing this training under American conditions.

The American youth who has expressed the desire to enter the profession of engineering has various channels open to him. The usual course followed is to enroll in one of the four-year engineering courses designated as civil engineering, mechanical engineering, electrical engineering, engineering, mechanical engineering, electrical engineering, chemical engineering or mining engineering. There are, however, notable deviations. Several institutions and some engineers advocate a broader training for the engineering profession than is possible in the ordinary four-year course, and in fact believe that the profession of engineering demands the same type of training as is now universally recognized as desirable for men entering the legal or medical profession.

Usually the American boy, in entering on a technical career, has not fully made up his mind as to the particular field in which he is most interested. In the four year courses he has in some cases one, and in others two years in which to make up his mind as to which of the five general branches of engineering referred to above he wishes to enter. It is self-evident that the ideal training is one which will prepare a student upon graduation to enter any one of the numerous fields of engineering. At least it is possible that a comparatively wide field of activities will be open to a man whichever one of the above courses he takes in the technical school.

Having these general facts in mind, attention will now be riveted upon the situation which confronts the young man who may be one of our future highway engineers. Let us suppose, for example, that he has decided to devote four years to securing a technical education and that there is offered to him the four-year course in civil engineering and a four-year course designated as highway engineering. Which course should he take? The evils of over-specialization in the undergraduate engineering course have been fully discussed in the Society for the Promotion of Engineering Education. Suffice it to say in this discussion before the general public interested in highway improvement that the graduate of the civil engineering course on the one hand has before him a large field of activities for all of which he is equally well equipped. For instance, he may enter the field of structural engineering, sanitary engineering, railroad engineering, geodetic engineering, hydraulic engineering, engineering, irrigation engineering and in many cases mechanical, electrical and mining engineering. On the other hand, a graduate from a so-called four years course in highway engineering has, if the course is made up of the subjects which the title implies, only a limited field in which he considers that he is particularly proficient.

The consensus of opinion of eminent highway engineers and educators is to the effect that the highway engineer of the future requires the broad foundation which the four-year course in civil engineering gives. A knowledge of practi-

cally all of the subjects included is found of value in the manifold duties imposed in the various positions which he may occupy in the service of municipalities, states, counties, towns, estates, contractors' organizations, consulting engineers' offices, and manufacturing companies.

In the consideration of the training received and the subjects covered in the four-year course in civil engineering relating especially to highway engineering, it is of interest to note the present status of highway engineering in the civil engineering courses of American universities and technical institutions. An examination of the latest catalogues received from ninety-two institutions in the United States offering courses in civil engineering showed that seventy-eight included a text-book-lecture course in highway engineering in the curriculum. The number of recitation-lecture hours in the various courses may be arranged approximately in the following groups: thirteen, 15 hours or less; twenty-eight, 30 hours; seventeen, 45 hours; six, 60 hours; six, 75 hours; three, 90 hours, three, 120 hours; one, 135 hours; and one, 165 hours. Fifteen give some instruction in laboratory work, while ten include special courses in highway surveying. In the case of institutions devoting over ninety hours to highway engineering, the general civil engineering course covers three years, while a highway option is taken in the fourth year. A comparison of the present status of highway engineering education, as outlined above, with the conditions described by Logan Waller Page in his valuable paper on "Highway Engineering," presented before the Society for the Promotion of Engineering Education in 1909, is certainly encouraging, especially when it is remembered that only three years have elapsed. In 1909, according to Mr. Page, fifty per cent. of the institutions investigated did not include a course on highways in the civil engineering curriculum, while it is noted that of the courses in ninety-two institutions examined by the speaker, eighty-five per cent. now give a course in highway engineering.

The importance of the subject of the economics, construction and maintenance of roads and pavements in the United States at the present time demands that more prominence should be given to the course in highway engineering in civil engineering curricula. Having in mind the various component parts which go to make up the curricula, it appears that a well-balanced civil engineering course under present conditions should contain a three-hour course of one year in length devoted to highway engineering.

In such a course lectures and text book work should cover the following topics: historical review of the construction of roads and pavements; preliminary investigations incident to construction; principles of surveying and mapping peculiar to highway work; design of highways; drainage and foundations; construction and maintenance of earth, sand clay, gravel and broken stone roads, including a consideration of the materials which enter into their construction; general consideration of bituminous materials as such and their use in the construction of bituminous surfaces, and bituminous macadam, bituminous concrete, sheet asphalt and asphalt block pavements; the construction and maintenance of wood block, stone block, brick and cement concrete pavements; dust prevention, street cleaning and snow removal; construction of car tracks and pipe systems; comparison of roads and pavements; construction of sidewalks, bridges and culverts; and a general treatment of economics, highway administration and highway legislation.

Laboratory work should be limited to what is sometimes called lecture demonstration work by the officers of instruction. In other words, although it is advisable that the methods of testing all kinds of bituminous and non-bituminous road materials should be brought to the attention of

\* Presented before the American Road Congress at Atlantic City on October 3rd, 1912.

† Professor of Highway Engineering, Columbia University, New York City.