

GRADUATE WORK

By PROF. C. B. BREED.

While the regular four year course of instruction given at the Institute fits the young civil engineer for a favorable beginning in the practice of his profession and gives him the fundamentals of the common problems met in practice, still the student who has applied himself to a more extended study of his profession through a graduate year, as outlined in the advanced work given in Course I, is endowed with a distinct advantage over the ordinary graduate. Many of the vital problems which have been recently solved in studying the Additional water Supply for the City of New York, in the investigation of the Quebec bridge and of the Blackwell's Island bridge, in the studies attending the design of the great railroad terminal and rapid transit problems of New York and Boston call for men especially trained in advanced civil engineering work. So important and so useful is the application of the training gained in the extra year that it is sure to



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pay good dividends on the investment of time and money given to it. Throughout this extra year the student gains a broader view of his professional work and at the same time acquires a more specialized knowledge of structures and of railroad, hydraulic and sanitary engineering. Those assistants in the civil engineering who teach these advanced subjects have found the year or two spent in this capacity most advantageous.

The advanced structural work is largely devoted to the study of statically undetermined structures. The study of flexure of structures, of stresses in draw spans, an exhaustive treatment of the arch, various methods of computing the elastic arch and other fundamental principles of advanced structural design are taken up.

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Advanced courses are given in Railroad Engineering and Design and in Sanitary and Hydraulic Design. In the subject of Water Power, Irrigation, and River Works, advanced study in the flow of water in pipes, canals, flumes, and over dams is taken up and the testing and efficiency of turbines. Many typical existing municipal plants are studied in detail in connection with the subject of Water Purification and Sewage Disposal. A thesis is required which shall be of a more advanced grade than that required of the regular fourth year student.

Four years of training similar to that given at the Institute are necessary to prepare for this year of graduate work. Its standard is not like the graduate work given in many colleges, where it is required only that the student shall have graduated from some other recognized college to fit him to take an advanced course. Graduates from other colleges before they are properly fitted to enter upon this advanced course find it necessary as a rule to take two years of undergraduate work at the Institute, in the civil engineering department. Twenty-six per cent of the present senior civil engineering class are college graduates.

G. E. SOCIETY

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The society has grown from the small number of twenty-three present at the first meeting in 1889 till now, practically all of the fourth and third year men, and many second year men enjoy the privileges of its membership, some two hundred or more names being on the roll last year. Owing to the fact that the ground covered during the year is of lasting value to every member in the course, the eligibility requirements are restricted to a nominal fee, and the signing of the constitution, so that any one so desiring can become a member. The society's large membership and its hearty endorsement by the faculty are evidences enough of its worth and of the place it is filling in undergraduate life at the Institute.

HYDRAULIC ENGINEERING

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of engineers or contractors, or on municipal, state or national works. Several are in the Corps of Civil Engineers of the Navy, a considerable group in the Reclamation Service, and with the Board of Water Supply of New York, at the head of each of which great undertakings is an Institute graduate; and if the foremost hydraulic engineer of the country at the present time were to be singled out there is little doubt that he would be found to hail from M. I. T.

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RAILROAD ENGINEERING

By PROF. C. FRANK ALLEN.

The importance of Railroad Engineering as a branch of Civil Engineering may be gathered from the fact that a count made a few years ago indicated that about one quarter of our graduates in Civil Engineering are engaged in railroad engineering; and a similar canvass of the members of the American Society of Civil Engineers made a like showing. In view of the fact that a very considerable part of the bridges built are needed in connection with railroads or with electric railways, the real importance of the railroad in creating opportunities for the employment of Civil Engineers becomes manifest. Aside from the pure engineering work, many of the railroads are coming to depend more and more upon graduates of engineering colleges for the executive positions to be filled. The railroad superintendent or manager can far better administer his duties if he has a clear knowledge of the behavior of materials such as may be acquired from the study of Applied Mechanics; and of the laws underlying power and its use, such as he may acquire from studying Steam Engineering, Hydraulic Motors, and Dynamo Electric Machinery. On some of the best handled railroads such men are sought for advancement and promotions to the higher positions made from among them; better methods of organization are adopted when men of this sort are available. There is not room here to discuss the question whether executive ability is a gift or is partly acquired.

It is not the training in railroad curves or in any such special lines that makes the successful railroad man; it is the all-around training such as the Institute offers and of which the purely railroad instruction, to be sure, constitutes a part, and it may reasonably be claimed an important part. In fact a considerable portion of the work given under the name of railroad engineering in the third year is more properly denominated Location, and is useful, or rather necessary, for running in pipe lines, conduits, sewers, streets and roads and for various purposes. The writer was once called to take charge of reservoir construction, in part and perhaps largely because the engineer previously in charge felt himself incapable of laying out a short curve for laying pipes. In Sanitary Engineering, in Highway Engineering, in fact, in almost any line of engineering work, the principles involved are likely to confront one.

One is inclined to think that a large part of the railroad system of the country is already constructed, and yet from time to time important long lines are projected like the Western Pacific, or the Grand Trunk Pacific, requiring trained locators. Aside from this there are constantly in progress revisions of line involving re-location, so that the principles of location cannot be relegated to the rear as a lost art. The inter-urban electric lines are also multiplying and they too demand skill in location. Then, maintenance of way is a constant problem, with unsolved elements ap-

pearing with frequency. Railroad signaling, again, is almost in its infancy. The changes and the progress in signal work are so marked that even the specialist, the signal engineer, is hard put to it to keep pace with what is doing. A side line of work which will require much attention in the near future (in fact already to a considerable extent) is the abolition of grade crossings, involving also all sorts of engineering, including especially sewerage, and drainage and also highway engineering to some extent. In the department, this feature of railroad engineering has proved definitely attractive to the teaching force, and every year some project for separation of grades is selected for Thesis.

Another subject which attracts the teachers of railroad engineering is the arrangement of yards for sorting, storing, loading and discharging cars. Much progress has been made in late years in designing important handling yards, but much wastefulness of effort and much congestion of traffic is constantly occurring in less important yards, not really designed at all, but which like Topsy have "just grown." Thesis work in this line has not been uncommon and station and yard design is selected as one of the subjects to receive additional attention in the advanced courses.

Another subject which has attracted much attention for the last twenty years especially, is the Economic Theory of Railroad Location, in which an effort is made to trace the effect upon a straight and level line, such as additional "distance," or the introduction of "curvature," or the use of steep "gradients." Somewhat extended attention is given in the course to this subject, which is a vital one in the revisions of line and grade which become necessary from time to time, not always because the earlier work was faulty, but oftener because new conditions of traffic make a new alignment or grades justifiable because now more economical. The writer is in a position to believe that important changes are likely to soon come about in the basis for the allowance to be made for such items, and the study is of considerable interest. Those engaged in teaching railroad subjects at the Institute are at present in good position to keep pace with such changes.

Specialization in railroad instruction, or any specialization is often looked at askance by educators and with good reason. Nevertheless, so far as one specialization is accomplished without the sacrifice of fundamentals, and so far as the instruction given contains the proper elements of training value, the specialization is likely to prove profitable. A constant danger in all education is that it may scatter in the effort to secure breadth; there is often more danger of failure from neglecting to secure depth than there is of securing proper breadth. The work in railroad engineering is arranged with a definite purpose to avoid just cause for criticism upon this point.

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