CONCRETE ENGINEERING

Co-operation with Local Engineering Firms Aids Department.

By PROF. H. W. HAYWARD.

During the last few years very rapid advance has been made in concrete construction. It is not so very long ago that a reinforced concrete building was a novelty and attracted a great deal of attention both from the general public and the engineering profession, while now this type of construction rivals the steel, brick and other types that formerly were considered best, and in the future it bids fair to become one of the most common methods of construction for building and other structures.

The argument against concrete construction that can be advanced by the advocates of other types, is its liability to weakness from poor workmanship, due to inadequate inspection or because of carelessness on the part of the engineer or contractor in selecting the component materials.

On account of the great variation which is liable to arise in the materials entering into the construction of reinforced concrete slabs, beams, columns or footings and the fact that these materials have very different properties, the ordinary methods of design cannot be used and other theories and formulae are necessary.

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The complex nature of the material in question has given rise to considerable difference of opinion concerning the distribution of stress through various parts of structures. Several different theories have been advanced by eminent investigators in the United States and abroad and each has its advocates among engineers of construction. At present the desire of many engineers seems to be to have at hand a formulae which will give safe results without regard to theoretical exactness. All working formulae contain constants obtained from tests made on full sized specimens and from the nature of the material this will always be the case.

In view of the importance of reinforced concrete as a material of construction and the facts just mentioned, all graduates from engineering courses should have as clear knowledge as possible of the fundamental principles of design, the ability to carry out tests and to draw correct conclusions from the data thus obtained. In addition the man who intends to take up concrete work as a profession, should have an intimate acquaintance with the constituent materials obtained from close contact with them on the mixing floor and as poured on the forms.

Since 1901 there has been carried out in the Laboratory of Applied Mechanics at the Institute as thesis work, tests on six sets of beams, three sets of columns and two arches, and in addition quite a number of investigations have been undertaken concerning the bond strength between concrete and the reinforced steel, and on the strength of concrete in shear and direct compression. Many tests have also been made upon cement and mortar under varying conditions.

Lack of facilities at the Institute has made it necessary to secure the cooperation of engineering firms in the preparation of specimens for these tests. They have responded very well and this year another set of beams, a large number of compression and other specimens will be tested as thesis work in the Applied Mechanics Laboratory; these specimens being provided by a Boston engineering firm which hopes to settle some of its perplexing problems by this means.

At the present time any advance work in connection with reinforced concrete is limited to investigations undertaken as theses and the men doing this work are the only ones to get any experience in mixing, proportioning or placing, although all engineering students have an exercise in cement testing in their regular laboratory course.

The growing importance of reinforced concrete as a structural material will make it advisable in the near future for all men in the engineering courses at the Institute to have some laboratory instruction along the lines specified above, something which is now impossible owing to lack of room where mixing machines could be installed, specimens constructed and stored under different conditions before being tested.

GRADUATES OF COURSE II

(Continued from page 12.)

of small tools, electric specialties, pianos, textiles, thread and twine, paper, automobiles and motors, sewing machines, steam specialties, wood-working machinery, firearms, etc.

A small per cent. of the Course, though connected with manufacturing or engineering firms, are secretaries, treasurers, or financial agents whose duties do not call for technical knowledge of the output. Grouped with them are cost managers, shop organization specialists, and "production engineers." The two latter classes must necessarily study the product and process to a considerable extent, in order to recommend the changes in methods and organization which will increase profits. They are employed by manufacturing rather than engineering firms.

One man out of every thirteen that studied Course II, is now a teacher. For the most part they are connected with technical schools like our own, but some are in the high schools as teachers of mathematics, science, and mechanic arts.

In this list, less than three per cent. are classed as consulting engineers. The term has been restricted narrowly, to include men who advise, design, or superintend construction or who examine and test plants for their clients. If they were regularly employed by a firm, or if they carried out construction in works of their own, they would be classed in groups 1, 2, or 3.

Attention is called to the proportion of graduates engaged in patent law and in factory insurance engineering. The insurance men are engineers who investigate the merits of various devices and apparatus for protection against fire, and inspectors who make periodic surveys of mills and factories to see that the protective apparatus is kept in efficient condition.

Item 12 shows that only one man in eighteen has engaged in work of a completely non-technical nature, for which the course of study pursued at the Institute was not the best preparation and may have been a waste of time. This group includes merchants, brokers, artists, physicians and farmers. In some cases very likely the men gave up the work to which their school training naturally led them, because they realized they could not succeed; there are other cases, however, where it is known that through inheritance or by some mere chance, opportunities too good to lose came to these men, and they wisely chose the more profitable or more desirable openings.

For the majority of Course II's men, was the course they studied in school the best that could have been arranged? Probably not, for any one man or group of men; the course was planned for all. Mathematics, at least through the calculus, the elements of chemistry and physics, mechanics, drawing, mechanism, and mechanical design, are unquestionably advisable for all. Of equal importance are literature, history, economics, and the languages, studies that develop a man's general culture and bring him into closer understanding and sympathy with the world at large, and make him a better citizen. The more technical studies, applied mechanics, thermodynamics, hydraulics and the testing of machines or materials may be justified on two grounds: firstly, their value in training a man to think. Mathematics is supposed to fill this purpose, but the numerical problems of these applied sciences are not usually in the stereotyped form of pure mathematics, and the mental consideration of the various related conditions by which correct solutions of practical problems are effected, is probably of greater educational value than the study of mathematics per se. Secondly, the subjects just named have a direct value as information quite indispensable to men in certain vocations. But let us not overestimate this importance. Look at the list of men above. Most of the engineers, nearly all of the teachers, a very few managers and perhaps half the designers and draftsmen apply daily at least some knowledge of one or more of these subjects. The rest seldom have occasion to use this knowledge, so seldom that they cannot trust their ability to solve the problem correctly, so they turn it over to someone more expert. Nevertheless, these subjects, applied, thermodynamics, hydraulics, and engineering testing, combined with a study of dynamo electric machinery, probably form the best combination that can be arranged, from which a man can branch out along any of the lines which our graduates have followed.

The more strictly technical subjects, such as heating and ventilation, mill, locomotive, or marine engineering, industrial management, steam engine design, refrigeration, concrete construction and other professional work, could be studied to much better advantage if the student only knew which ones to select as directly applicable to his future work. But this he cannot tell, partly because while in school, he may not know just what he wants to do in after life, and partly because regardless of his desires, the work into which he will finally settle is so largely a matter of chance.

LABORATORIES.

(Continued from page 19.)

devices, or the relative advantages of different methods of construction.

In the case of the second class, a part of the investigations are of so much value to engineers, manufacturers, and others, that in many cases the owners of the plant have furnished the use of their apparatus and have often spent considerable money to fit it up.

As to opportunities for work, it will be sufficient to say that, notwithstanding the number of graduates in mechanical engineering is very large, the total number of those graduated in this department being thus far, nine hundred and sixty-five, the demand far exceeds the supply.

FRESHMEN LOSE AT BASKET-BALL

Winchester High defeated the Freshman Basket Ball Team at the Winchester High School last night, the score being 34 to 23.

The first half was played in good fast style, with lots of "slugging" mixed in. During the second half of the game, Crocker, left forward on the 1913 team, fell and hurt his leg.

The line-up of the Freshman team was:

R.F., Balch, Darling; l.f., Crocker; c., Johnston; r. b., Darling, Muther; l. b. Thompson.

Prospects so far for a winning track team this winter are not very good considering the small number of men who have shown up. The old men have evidently the idea that they do not need practice or feel sure of their places. Only thirty men have so far reported to Coach Kanaly for practice and these are mostly under-class men. These men have the right spirit and are showing it more than the upper-class men. Practice is held every Monday at the B. A. A. board track on Irvington Street, every Tuesday, Wednesday, and Thursdays at the Tech Gym. All the events will be practiced from 4.15 to 5.30.

Robert Contesse has been elected by the Swiss Parliament to succeed Adolphe Deucher as president of the Swiss Confederation for 1910. Maro E. Ruchet, a former president, was chosen vice-president to succeed Comtesse. Both executives are elected for the term of one year by the Federal Assembly in joint session of the national and state councils.

MECHANICS ARTS.

(Continued on page 21.)

fore the class just before the work is to be undertaken. As a rule the entire class is engaged upon the same or similar projects, and all work is executed from suitable working drawings.

In the planning of a series of exercises, care is taken not to embody too many operations in one project, the instruction in the elementary operations being the main end sought, rather than construction. Useful projects are, however, always introduced whenever practicable. Experience has shown that this method of instruction enables rapid advance to be made and that after completing the various courses students can do good commercial work.

Instruction in the mechanic arts was begun mainly through the efforts of President John D. Runkle, in 1876, when laboratories for instruction in chipping and filing and forging were established. In the following year, laboratories for instruction in carpentry, wood-turning, machine-tool work, and foundry work were added. These laboratories were the first established in this country to give instruction by the Russian method, which has the systematic instruction of the student as its aim, rather than construction.

Among the advantages to be derived from work in the mechanic arts may be mentioned the following:—

After having become familiar with the tools and appliances used, the student is able to judge what forms are easiest to construct and what processes are most economical of time and materials, and such knowledge is of great value in his future work in design.

The knowledge gained by actual work in the laboratories cannot be obtained by mere observation of the work of others. It is one thing to know how work should be done, and quite another to know how to do it. With such a foundation as the laboratory practice affords, it becomes an easy matter to obtain accurate information by the observation of processes or the work of others. One thus informed is enabled to judge what it is fair to ask of a mechanic as to quality and quantity of work and can if necessary show how faulty methods may be improved.

This work when properly carried on, developes the executive faculty, and leads to careful planning and clear thinking. Before starting on any work the student must, on consulting his drawing, make up his mind as to just what operations are to be performed and in what order, and then he proceeds to carry out his pre-arranged plan striving for good results and avoiding loss of time. For example, in the process of welding iron, he must carefully arrange his tools each in its proper place, ready at hand, for no time can be lost in this operation. He must properly arrange his fire to heat the pieces equally that they may reach the welding temperature at the same time, and finally when the proper heat is reached the work must be expeditiously done, without a false move to secure success. In forging the element of time always enters, it being necessary to work while the iron is hot; careful planning is necessary and the eye must be a guide as to shape and dimensions to a considerable extent. The order of operations is all important in machine work. Such training certainly begets habits of forethought and, judging from experience, is a more potent factor in this direction than ordinary laboratory practice.

The laboratories being conducted so far as practicable like model productive establishments, the student is made to be prompt in attendance, to keep tools and machines in order and clean, to keep a record of his time on each piece, and to conform to the rules of the laboratory, all of which tend to make him more systematic and to value his time as well as that of others. Where the students all work on the same or similar pieces, there is a spirit of friendly rivalry, which aids in stimulating the student to do his best and prepares him for similar conditions to be encounted later.

It is believed that the more training an engineer has in the mechanic arts, the more valuable will he be, and the better will he be able to successfully apply his theories.

Finally the man who understands how to execute work has confidence in himself, knows that the expected result will be obtained, and he thus begets the confidence of others. He is also more ready to appreciate the work of the skilled mechanic and is ready to learn from those who in general attainments may be far below him.