his slope term should undoubtedly be changed somewhat, the data available at present seems to indicate that such a correction should be included in some form. The rather clumsy coefficients appearing in the formula for the English system of units doubtless could be replaced by round numbers. However, it does not seem advisable to attempt any modification at present. Algebraic complications are of no particular importance, inasmuch as numerous tables and diagrams are available for use in determining *C*. Although the slope term should be modified, it would be better to wait until more data is at hand before attempting such an improvement.

Contracted Opening Estimates

When the drop in the water surface at a contracted opening amounts to one foot or more, and the length of the contracted section is so short that the friction head is either negligible or only a small part of the total head, the conditions afford a fairly reliable means of calculating the discharge.

The estimates are made by a simple application of the well-known Bernoulli theorem, that the sum of the pressure head, friction head, and velocity head is a constant. Briefly stated, the method consists in determining the velocity at the place of maximum contraction by adding the head due to the velocity of approach to the drop in the water surface at the opening, deducting the friction loss through the contracted section, and calculating the velocity corresponding to the remaining head by the well-known formula:—

$$V = \sqrt{2gh}.$$

This method has the advantage that it is not necessary to estimate a roughness factor. Under favorable conditions, about the only uncertain element connected with the computations is the determination of the friction head; and, in cases where the contraction is narrow and unobstructed and the surface drop amounts to a foot or more, this factor has a relatively small influence on the calculations.

Of course, if sharp edges or square corners exist at the entrance to the contraction, it will be necessary to apply a contraction coefficient; but the value of this factor will not, in general, be less than 90 or 95 per cent. Furthermore, this manner of calculating discharges has the advantage that the upper limit of possible error is always definitely known. It is certain that the velocity through the contraction cannot exceed the velocity corresponding to the total head at the opening.

This method was found to be especially valuable in determining the maximum rates of flow of the 1913 flood. Accurate estimates of the discharge were obtained by the aid of measurements at contracted openings, at places where results calculated by velocity formulas alone would have been very questionable. Even where the flood channels were remarkably well adapted to calculations by velocity formulas, measurements at contracted openings furnished excellent checks on the results.

No Satisfactory Experimental Test

It has not been possible, up to the present time, to secure a satisfactory experimental test of this method of measuring the flow of water. Only one experiment has been secured thus far. It was made at a contracted opening where the conditions were not suitable for an accurate estimate of discharge, the friction head amounting to about 67 per cent. of the total head.

However, the results obtained under these unfavorable conditions are not without value. The discharge calculated from the drop at the opening only differed from the value obtained from the current meter gauging by about 16 per cent.

This may be considered as a very satisfactory check on the accuracy of the 1913 flood estimates, since for those measurements the friction head, on the average, was only about 26 per cent. of the total head. The results of the experiment also show the feasibility of securing fairly reliable estimates of discharge by this method even under unfavorable conditions.

THE RELATION BETWEEN CIVIL AND MILITARY ENGINEERING*

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IT would be interesting to know which is the older, military or civil engineering. Were the first attempts at construction made for shelter or were they for protection against human or animal foes? Certainly both branches of the profession developed one with the other, and they do so to-day. The fundamental principles of both are the same. The same mental training is required for both. Of the two, military engineering is the more comprehensive, for there is not a branch of civil engineering which is not applied to military work, while to civil engineers in general the art and science of war is a closed book. The military engineers of to-day have organizations for the construction of ports; of port and interior terminals; for the construction and operation of railways, both broad and narrow gauge, both in the territory far from the enemy's fire and directly in the field of bursting shells; for the erection and repair of locomotives and cars; for highway construction; for quarrying; for mining; for general construction of buildings of all kinds; for water supply and sanitary works; for chemical and physical research; for electric power and lighting; for surveying and mapping; for camouflage work; for gas and flame warfare; for the production of lumber from the forests; and in addition in each division there is an engineer regiment for military work at the front and in each corps are bridge and searchlight trains. I am speaking now of the Engineer organizations serving with the army in France, and being prepared for that service. To obtain the personnel for all of this would have been impossible had not the members of the engineering profession of the nation responded most nobly to their country's call. But further, there is not one of these Engineer Reserve Corps men who does not now know that he could serve his country to better advantage had he had, beforehand, military training—training much beyond that possible in a three months' camp.

Fundamentals are the Same

The fundamentals of the course of study required for a civil engineer of all branches of the profession are the same as those for the military engineer. The foundation of all is the general education which gives thorough command of our own language, both for speaking and for writing. An engineer not only must have ideas, but also must be able to express these ideas clearly to others. I have yet to discover any engineering project which cannot be described as to be clearly understood by a non-technical man. Then, a knowledge of general history and of law is most valuable. Passing to the more technical studies, mathematics to and through the calculus, descriptive geometry, physics and mechanics, electrics, the principles of chemistry, some mineralogy and geology, and the qualities and nature of the materials of construction should be mastered before the special studies of any particular branch of the profession are entered upon.

In the examinations which have been held for some years of candidates for the position of Second Lieutenant in the Corps of Engineers of the Army, some interesting facts have developed. All candidates must be graduates from some approved technical school, and the questions to be answered in the written examination are such as should be answered by any man who has mastered his course. Yet the proportion passing these examinations is woefully small. At the last examination held, out of 190 candidates, the papers of only 36 could be accepted as up to or approaching the required standard. The failures were not in the most difficult studies only—topographical surveying frequently was a stumbling block. Descriptive geometry was so generally unknown that the impression was created that the value of this subject was underestimated by the schools themselves. Yet what study does so much in teaching the mind to make a mental picture

*From "Professional Memoirs."