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The Classification of the Graduation on Railway Construction.

By Professor B. J. Dalton.

At the recent annual meeting of the Kansas Engineering Society, Prof. B. J. Dalton, of Lawrence, Kan., read a paper on this subject, a copy of which he has kindly furnished us, as follows:—

The classification is one of the most difficult problems for the young engineer. It is a subject that cannot be taught in the class room. A young man starting out for himself after graduation may, within the first year, work for two men, both working under the same specifications, yet their classification will be entirely different.

Several years ago, during the construction of a certain line of railway through this and adjoining states, a dispute arose between the contractor and the division engineer over the classification. The difference in their estimates amounted to \$25,000 or \$30,000. The chief engineer appointed a commission of three of the oldest and best engineers on the line to go over this particular piece of work and classify it. They were men of many years experience in railway construction, yet they differed greatly in their estimates, so finally allowed an average of the three classifications. There must be some reason for this difference, and I believe that it is due to the indefinite wording of the specifications, and each man's interpretation of them.

Here is a sample specification for solid rock used by a number of the large railway systems:—
"Solid rock shall comprise rock in solid beds or masses in its original position, which may be best removed by blasting, and boulders or detached rock measuring one cubic yard or over." Even under these specifications I have seen indurated clay classified as solid rock, and I believe justly so.

The Santa Fe Rd. specifications are more explicit. They read:—
"Solid rock shall comprise: First, rock in solid beds or masses in its original or stratified position. Second, boulders or detached masses of rock exceeding one cubic yard, and all other material which in the judgment of the chief engineer cannot be removed without continuous drilling and blasting, and which is as difficult and expensive to remove as solid lime or sand stone. The fact that blasting may be resorted to by the contractor, or be the most economical method of working a material, will not of itself entitle such material to be classified as solid rock." This specification leaves out soft sand stone which is too hard to be plowed, but which may be blasted and then taken out with wheelers. This material is classified by some men as solid rock, and by others as part solid rock and part loose rock.

One specification for loose rock reads:—
"Loose rock shall comprise all rock, which, in the opinion of the engineer, requires for its removal the use of steam shovel or pick and bar, without blasting, although blasting may be resorted to at the option of the contractors, and all detached masses of rock of more than one cubic foot, and less than 18 cubic feet."

Another one reads:—
"Loose rock shall comprise all boulders or detached masses of rock, measuring more than one-fourth cubic foot and less than 18 cubic feet each; also indurated and cemented material, slate, shale, hardpan, soft and decomposed rock in ledges or

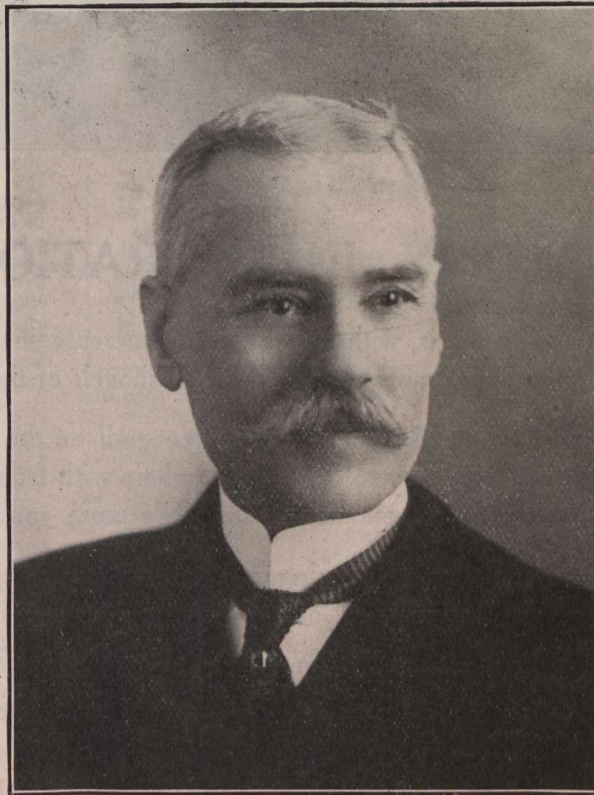
sification entirely to the judgment of the engineer, and the result is that contractors, in bidding on work, bid more upon the reputation of the engineer in charge of the work than upon the specifications.

The material that the contractor actually receives loose rock classification for is any material that requires more than three teams on the plow, but which he does not have to blast. If it is too hard to plow it is blasted and classified as solid rock, or part solid rock and part loose rock.

All material that is not classified as solid rock or loose rock is called common excavation or earth excavation. Several specifications read:—
"Common excavation shall comprise all other materials of whatever nature that do not come under the classification of solid rock or loose rock, or such other classification as may be established before the award of the contract."

Another one reads:—
"Earth shall include any and all kinds of material which, in the judgment of the engineer, is not so compactly united or hardened as to prevent plowing or loosening with a 10-inch grading plow drawn by a well handled team of six good, strong, heavy horses or mules, with one strong, capable man at the plow handles and another one on the beam. It is understood and agreed that material shall not be classified other than earth because of its small quantity; or because of its position, or because rocks, stones, logs, roots or the presence of frost render plowing impracticable or inadvisable. Plowing is not intended to mean turning a furrow for any specified length; nor shall material be classified other than earth because plowing is not attempted or performed. Any material not clearly described as loose rock or solid rock shall be classified as earth." This last specification is entirely too rigid for earth. In many places cuts are composed of a mixture of clay and large boulders, so interwoven that the only practical way of removing the material is to blast it and then handle it as a solid rock cut. Although the earth may constitute as much as 25% of the whole mass, it must be handled exactly the same as the rock, and at the same cost, therefore it should be classified as solid rock.

In some places we find the rock in ledges separated by layers of earth. Under these circumstances the earth should be classified as solid rock. The classification should be made in accordance with the intent of the specifications, rather than with the exact wording. For instances, the specifications on a certain 50 miles of line, specified earth as sand, loam, clay, or a mixture of clay and boulders that measured one cubic foot in size, and that could be plowed



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masses, and boulder or gravel deposits or beds, which are so indurated or compactly united that, in the judgment of the engineer, such material cannot be plowed, as set forth under the specifications for earth, but which can, in the judgment of the engineer, be removed or loosened by a moderate use of explosives; but, if, in the judgment of the engineer, an unnecessary quantity of explosives is used, such fact shall not modify or influence his judgment in making the classification, or entitle the contractor to a higher classification."

All these specifications leave the clas-