CUTTING EDGES ON BLADE GRADERS

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SYNOPSIS

There are no standard specifications or methods of tests for the quality of grader blade cutting edges and the replies to a questionnaire sent to all of the states indicate a considerable range in practice. In view of the large sums spent each year on this item by states, counties and towns, it is important that research work looking toward the development of specifications and methods of tests be carried on. Substantial savings for both consumers and producers should result. Some investigations in the field and laboratory by the Minnesota State Highway Department and the University of Minnesota are reported. The report also includes descriptions of apparatus used in various laboratories, and a bibliography of published investigations.

Most materials used to any extent by Highway Departments can be purchased under satisfactory open specifications which are based on facts established by research and experience. When this cannot be done there is endless confusion. There is no yardstick for measuring value. One of the most important of the materials on which there is no generally accepted specification is the steel used in cutting edges on blade graders.

In order to ascertain the practice in the various States and the relative importance of the subject, I recently sent out a questionnaire to all of the state highway departments and have summarized the following information from the 28 replies.

(1) State highway departments spend annually more than $600,000 for cutting edges to be used on state roads. I was unable to get any definite estimate of the amount spent for this item by counties, municipalities, townships, and contractors. It must be considerably larger than that of the state highway departments, for not only is the mileage much greater, but there is also less hard surface.

(2) Eighteen States specified the quality of the steel according to a chemical analysis which was about as follows:

Carbon	0.80–1.00%
Manganese	0.50–0.90%
Phosphorus	Maximum 0.05%
Sulphur	Maximum 0.05%
Silicon	Maximum 0.30%

This is the same chemical composition that Mr. V. L. Glover of Illinois adopted after extensive correspondence with steel companies and companies manufacturing road graders This specification was distributed as information in 1931 by the Committee on Materials of the American Association of State Highway Officials

Ten States specified Brinell hardness, with limits of 225 to 355

(3) I also asked in the questionnaire for research work and experimental data that pertained to the quality of steel to be used Some States have carried on research work, but to date I have not received any definite information on this subject Several States replied that they hoped suitable specifications would be written, and volunteered to cooperate in any research work which might be carried on

The adequacy of a specification which depends primarily on chemical composition is questionable, for the abrasive resistance and toughness of cutting edges may depend also on heat treatment and other methods of manufacture Furthermore, it is not easy for the purchaser to make the necessary tests to find out whether or not the specified material is being furnished It would be much more satisfactory if some physical tests could be developed whereby the cutting edge could be tested to find if it possessed the necessary resistance to abrasion and toughness The ideal test would be of such a nature that it could be made on the entire blade, which if found to pass the test could then be used It might be desirable to have different test limits for different grades so that then the purchaser could select the most suitable material for the class of work for which the cutting edge is to be used

Before a method of testing the entire blade can be developed, it will probably be necessary to find out what steels give the best resistance to the abrasion and repeated blows that a cutting edge gets in service When this is determined, it may be possible to develop some tests for the entire blade, such as a deflection under load, dropping a weight on one end, Brinell hardness, and others

The first method, that naturally occurs to one, for ascertaining the relative quality of different steels is to measure the wear in actual use As is the case, however, with many field investigations, there are so many variables which affect the results that it is difficult to evaluate the particular item, in this case the steel, which is being tested Figure 1 shows the loss of weight compared with the mileage used of five identical blades tested on gravel road maintenance in Minnesota The wear on the blade depends on the texture of the road surface and whether it is wet and dry, the difference in operators, and the speed at which the machine is moving We concluded from this investigation that there were so many uncontrollable variables in the field that it was very difficult, if not impossible, to get accurate information relative to the quality of the steel, although the more extensive the investigation, the more effectively these variables could be ironed out Blade No 7, which is represented by the upper line, lost about 20 pounds in 350 miles of travel, while blade No 10, which is shown on the lower line, lost 28 pounds in about 70 miles of travel

In laboratory investigations where a more accurate control can be obtained, there is considerable question as to what type of apparatus, and what size and shape of specimen to use When obtaining a small specimen out of a blade, care must be taken that the quality of the steel in the small specimen is the same as that in the blade from which it was obtained, for instance, cutting out with an acetylene torch would change the character of the material

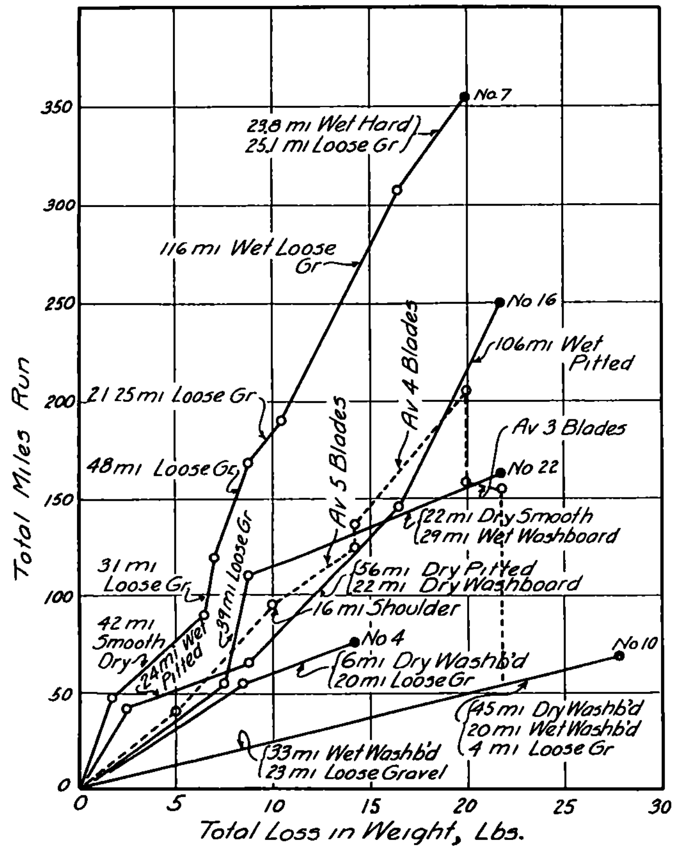

Figure 1. Results of Grader Blade Tests in Service

Some types of apparatus which have been used in testing specimens cut from grader blades, are shown in Figures 2 and 3

Figure 2 shows a machine devised by J A Brinell (3) The specimen (*A*) is clamped on a slotted plate (*B*) mounted on a carriage, to which is attached a cord passing over a pulley and carrying weights This arrangement gives constant pressure on the specimen Sand from hopper (*H*) is fed in between a rotating iron disk (*E*) and the specimen The loss in weight of the specimen after a certain number of revolutions of the disk measures resistance to wear.

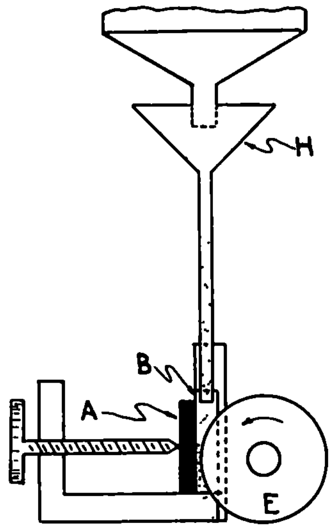

Figure 2. Brinell Abrasion Test of Steel

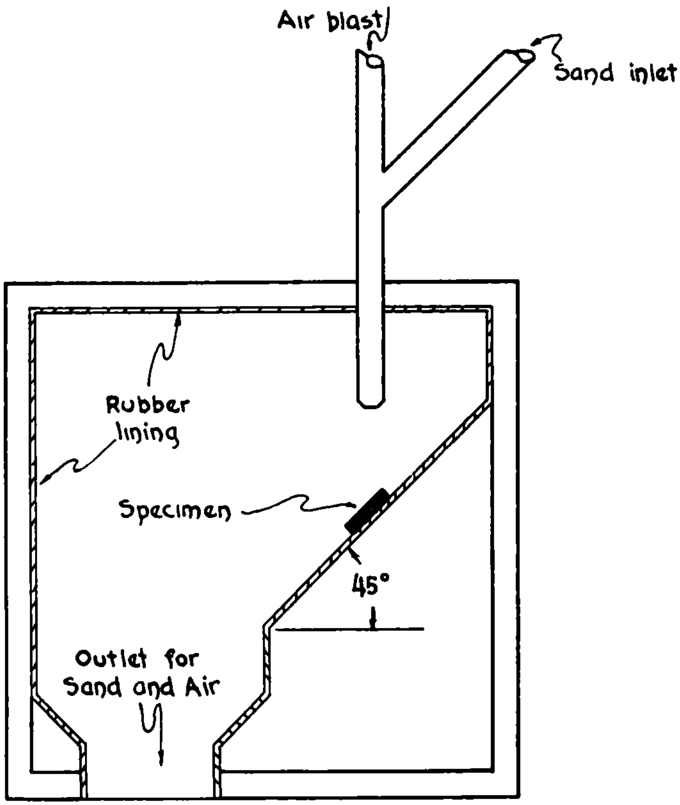

Figure 3. Sand Blast Method for Testing Steel

Figure 3 shows the sand blast method (5). Here the specimen is held in place at an angle of 45 degrees to the bottom of the box. A mixture of sand and air under pressure blasts upon the specimen for a given time. The loss in weight of specimen during test is taken as a measure of resistance to wear.

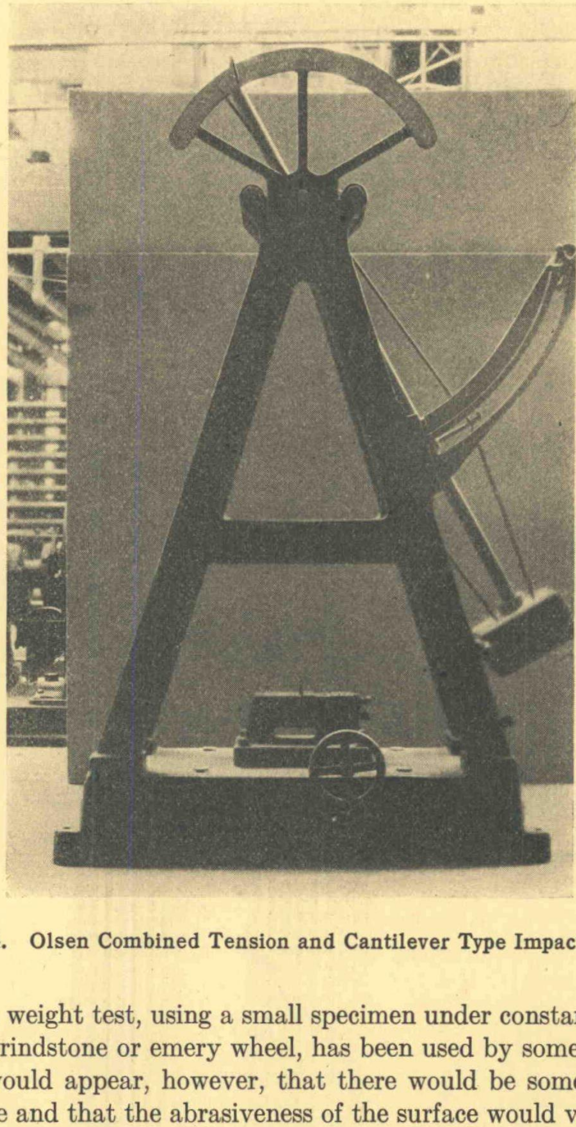

Figure 4. Olsen Combined Tension and Cantilever Type Impact Tester

A loss in weight test, using a small specimen under constant pressure against a grindstone or emery wheel, has been used by some investigators. It would appear, however, that there would be some variation in the stone and that the abrasiveness of the surface would vary during the test. This would made the results of doubtful value.

The Iowa highway department reported an attempt to develop a test for cutting edges which gave the force necessary to shear a shaving of metal from the edge of the specimen.

Some experiments including both toughness and resistance to wear tests were made by the University of Minnesota.

The machine used for the impact test was an Olsen Combined Tension and Cantilever Type Impact Tester as shown in Figure 4. It consists of an anvil to which the specimen is clamped. The specimen is ruptured by the fall of a pendulum weight striking the specimen with a blow of 120 foot pounds. The work in foot pounds to cause rupture is read directly off the circular scale and is the absorbed impact energy.

The abrasion machine used to measure resistance to abrasion was a modified Dorry Hardness Tester for stone (figure 5). It consists of a motor driven rotating platform (*A*), 24 inches in diameter. The specimens were screwed on a special wood filler which is clamped to this platform. When rotating, it sets in motion the 6 x 2 inch steel wheel (*B*), which rests on the specimen. The disk is attached to the boom in such a manner that its plane of rotation is at 20 degrees to the tangent of its path at the point of contract. This angularity results in a combined rolling and sliding friction between the disk and the specimen. The boom supports the weight (*C*), which may be changed if various pressures are wanted on the steel disk. The sand hopper (*D*) supplies a continuous stream of fine sand directly in front of the steel disk. An air line (*E*) keeps the specimen clean of the ground sand. The platform moves at a constant rate of $37\frac{1}{2}$ rotations per minute, which is equivalent to approximately two miles per hour. This apparatus is not intended to give an accelerated abrasion test, but one which subjects the tested steel to conditions similar to those encountered in the field.

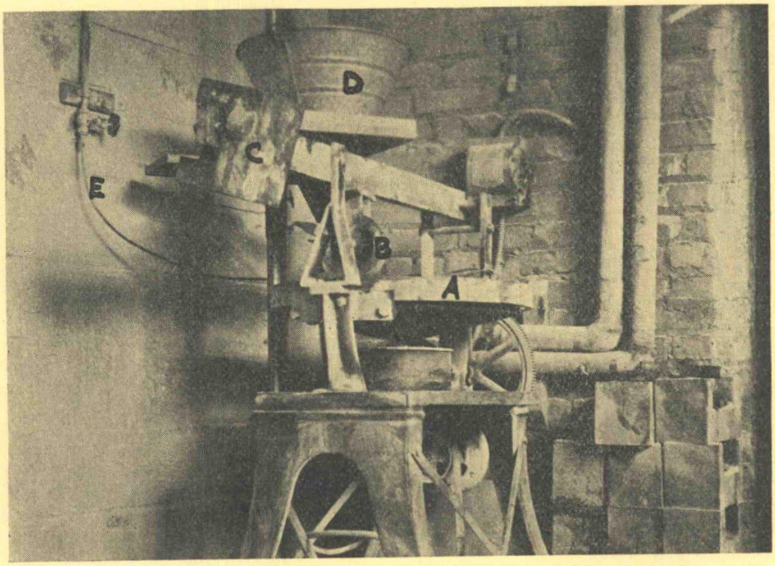

Figure 5. Modified Dorry Hardness Testing Machine

The Caterpillar Tractor Company of Minneapolis supplied eight groups of specimens having composition, hardness and heat treatment shown in Figure 6.

There were eight abrasion specimens and four impact specimens in each group. The impact specimens were of the size and dimensions

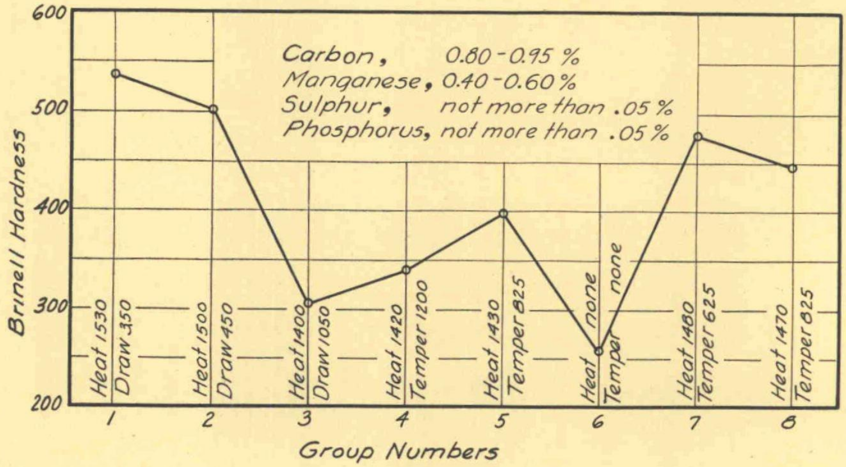

Figure 6

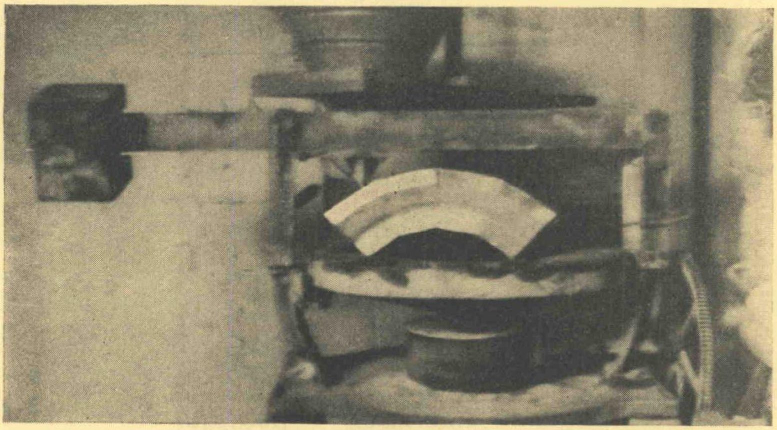

Figure 7. Arrangement of Four of the Abrasion Specimens

specified for the notched bar test on the Olsen Impact Tester. The abrasion specimens were so shaped that sixteen, fitted together, formed an annular ring. This permitted testing two specimens of each group at a time.

Figure 7 shows four of the abrasion specimens. The dark area was subjected to abrasion. In the abrasion test each specimen was weighed and two of each group (16 in all) fastened to the revolving platform Dry quartz sand, of the following sieve analysis, was fed at the rate of 60 grams per minute to the abrasion track.

Passing No 40 sieve	99 5%
Passing No 50 sieve	92 1%
Passing No 100 sieve	10 3%
Passing No 200 sieve	0 4%

Three runs were made In the first run, the weight on the boom was such that the pressure under the steel disk was 165 pounds This overloaded the motor and the test was terminated at 62½ hours The pressure under the disk for runs 2 and 3 was 95 pounds and they were continued 100 hours After testing, each specimen was again weighed and the change in weight reduced to grams loss per square inch of abraded

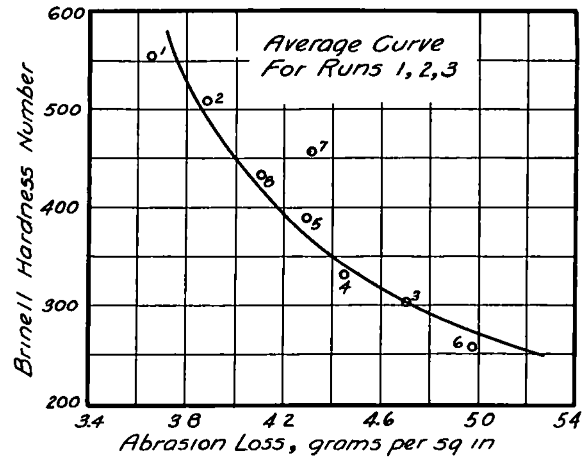

Figure 8

surface The Brinell hardness numbers were determined by taking two readings on each specimen

Figure 8 shows the abrasion loss for runs 1, 2, and 3 There was good relationship between hardness and wear, except for specimen No 7 which did not check on any of the runs It would appear that, within the limits of this test, the harder the heat treated steel, the longer it will wear Specimen No 6 was untreated

That the harder the steel the lower is the absorbed energy is shown by Figure 9 The impact value or toughness increased very slowly until the specimens are softer than a 400 Brinell hardness It is interesting to note that the untreated steel with a Brinell hardness of 255 had the same toughness or impact value as a treated steel having a hardness of 525 The abrasion loss of a treated steel of this hardness (525) is 3 8 grams per square inch as compared with 5 0 grams per square inch for the untreated steel These figures are decidedly favorable toward heat treatments

The results obtained from this test indicate that:

The resistance to wear of heat treated, high carbon steels increases with hardness, while the toughness (impact value) decreases

The resistance to wear, as well as the toughness, of untreated steels is relatively low

Heat treated steels with a hardness number of 500 possess an impact value equal to that of untreated steel with a hardness number of 255

This paper is a progress report on this subject It is the hope of the

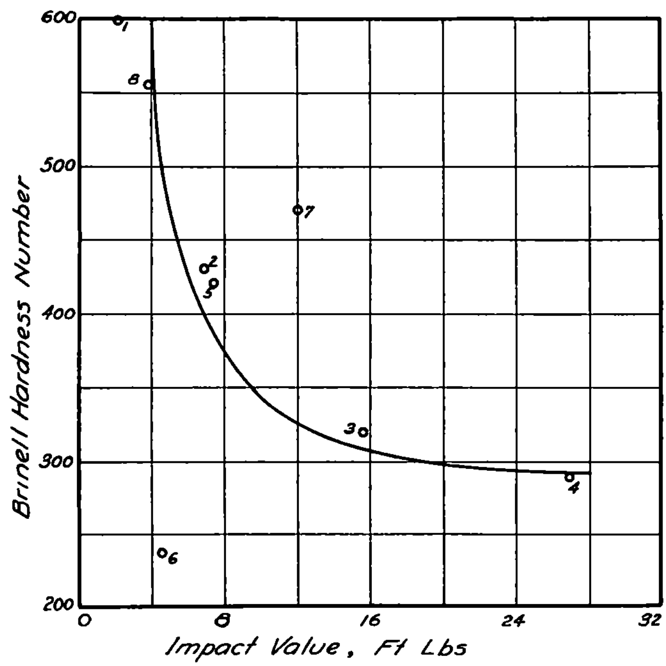

Figure 9

writer that some well organized research may be carried on which will furnish information on which to base a specification Those who are at present attempting to purchase cutting edges for highway work on an economical basis are very much confused They hear the arguments of those wishing to sell various grades of steel and alloys for this purpose, and yet they are without a satisfactory method of evaluating the different types to ascertain on which they will get the most value for the money.

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DISCUSSION

ON

CUTTING EDGES FOR ROAD GRADER BLADES

MR R E PIDGEON, *U S Forest Service.* Something over a year ago the Forest Service bought some grader blades After having had some trouble with them, samples were sent to the Bureau of Standards for tests One of the points which the Bureau of Standards made in its report was relative to the practice of manufacturers of having raised letters showing their name on that portion which comes in contact with the moldboard The tests made by the Bureau of Standards developed that this practice interfered with uniform contact of the cutting edge and increased bending stresses in the cutting edge, thereby tending to cause failure