Introduction of Product

Super Long Life Edge (Cutting Edge for Snow-Removal Moter Grader)

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Snow-removal motor graders widely used in cold districts with heavy snowfall are the main machines indispensable for removing compacted snow (fresh snow hardened by running vehicles) or grading the road surface (removing unevenness of the surface of compressed snow on road). These are used under severe conditions. As a result, the cutting edge (snow-removal edge) mounted on the blade tip wears severely , and increase of service life is strongly demanded. To meet such needs, we developed a super long life edge , which is outlined below.

Key Words: *Snow Removal, Motor Grader, Cutting Edge, Wear Resistance, Long Life, Composite, Cemented Carbide*

1. Introduction

Having the excellent function to cut snow surface , snow removal motor graders are used in the most severe cases of snow-removal operations , such as compacted snow removal and road grading , which levels the road surface by cutting the unevenness of compacted snow. As a result, snow removal cutting edges mounted on blade tips wears severely. Depending on site condition (the condition of the road) , the wear allowance can be lost during only a single mobilization.

If the service life of snow-removal edges can be increased,

- Continuous operation without parts replacement becomes possible during a heavy snowfall.
- The troublesome of parts replacement becomes unnecessary.
- The judgment of whether or not to replace the cutting edge before mobilization becomes unnecessary. (Misjudgment can result in expiration of service life in the middle of operation.)
- The waste of residual wear allowance can be eliminated. (Conventional cutting edges are replaced if the residual wear allowance is insufficient for the grader to go and return.)

Due to these advantages, the operator can devote himself to snow-removal work without worrying about the cutting edge. Authors are working with the development and application of wear resistant materials for soil and rock. As part of our study, we chose the snow removal cutting edge and succeeded in increasing the service life to a large extent. This report outlines our achievement.

2. Wear Resistant Material

Though snow-removal edge is used on snow, it suffers wear by facing the asphalt or concrete road beneath the snow. Therefore, material that shows excellent resistance to asphalt and concrete are required. The proposed cutting edge employs a Composite material called “Cemented Carbide composite”, designed under the following concept.

2-1 Structure of material

In general, wear resistance of materials increases in proportion to its hardness, but hardness and toughness conflict. Therefore, a composite material of tough copper alloy embedded with Cemented Carbide grains was developed. Its structure is shown in **Photo 1**, which has the following features:

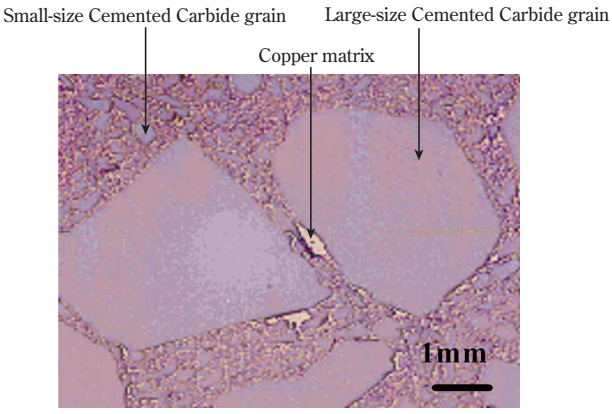


Photo 1 Structure of Cemented Carbide Composite

(1) In order to obtain wear resistance equivalent to Cemented Carbide blocks, Cemented Carbide grains are distributed as densely as possible. Namely, large-and small-size Cemented Carbide grains are mixed to achieve a high density of 65%.

(2) Large Cemented Carbide grains are approx. 5 mm in size. As shown in **Fig.1**, grains (that are sufficiently larger in size than the evidence mark of wear) are used to prevent the entire grain from rubbing out.

(3) For matrix metal, copper alloy is used. Copper alloy is less likely to react with Cemented Carbide grains and deteriorate them. In addition, copper alloy has high wettability so it can fill gaps between densely packed Cemented Carbide grains and create sure bonds without defects.

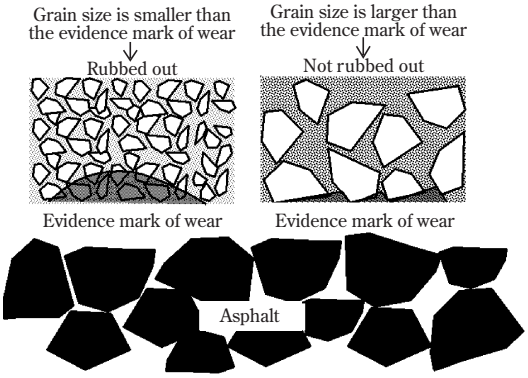


Fig. 1 Sketch drawing for the relation between grain size and the evidence mark of wear

2-2 Wear resistance

The wear resistance of "Cemented Carbide composite" was evaluated by the method shown in the graph of **Fig. 2**. Namely, a test block with the contact surface of 40x20 mm was pressed against the surface of asphalt road under contact pressure of 21kg/cm^2 and slid at the speed of approx. 10km/h. Test pressure was determined by assuming the blade load of the actual machine as 8 tons when contact pressure acts uniformly over the entire width of the cutting edge. Test sliding speed was determined, from the actual operating speed under heavy load during compacted snow removing and road leveling works. Road surface was wetted by spraying water.

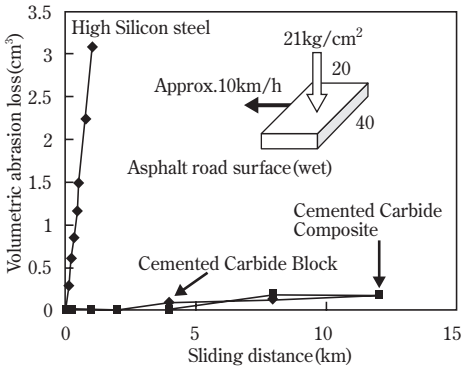


Fig. 2 Abrasion test of various materials against asphalt

For this test, 3 types of test pieces were prepared: "High Silicon Steel" (quenched and tempered, with hardness HRC55) that KOMATSU has conventionally been using for the cutting edge, "Cemented Carbide Block" and "Cemented Carbide composite". **Fig. 2** shows the relation between sliding distance and volumetric abrasion loss. The smaller the gradient, the higher wear resistance becomes. It is understood from this graph that "Cemented Carbide composite" far excels "High Silicon Steel" and is equivalent to "Cemented Carbide Block" in wear resistance.

3. Structure of Cutting Edge

Photo 2 shows the appearance of "Super Long Life Edge". The "Cemented Carbide bar" mounted on the base edge is structured as shown in **Fig. 3**. Its features are described below:

3-1 Cemented Carbide composite bar

Snow-removal edge receives a strong destructive impact force when the grader passes uneven road surfaces, and joints of bridges. Therefore, to protect "Cemented Carbide composite" its periphery are covered with steel plates, and internal reinforcements are arranged at equal intervals. (**Fig. 3**)

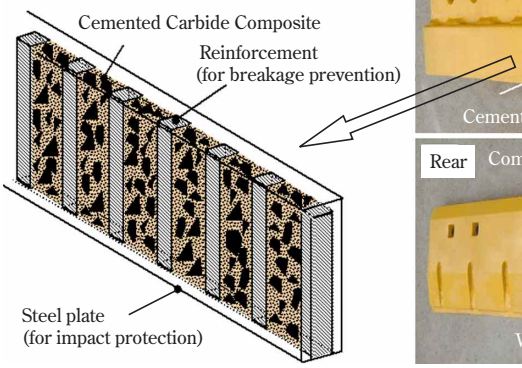


Fig. 3 Structure of Cemented Carbide Composite bar

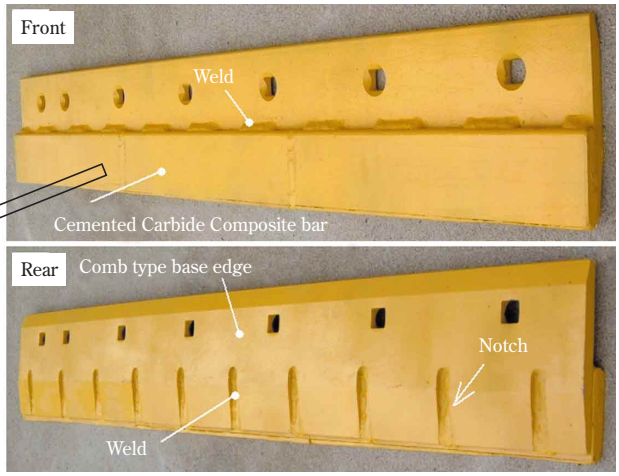


Photo 2 Appearance of Super Long Life Edge

Photo 3 shows the microstructure of the boundary at which steel plates and reinforcement are bonded. Fe phase grew to make a strong bond. (Diffusion bonding) **Photo 4** shows the boundary at which steel plate and "Cemented Carbide composite" are bonded. The columnar phase of Fe-Co-Cu-W-C alloy grew to make a strong bond. Due to these bonds, "Cemented Carbide composite" is strongly integrated with highly ductile steel, giving "Cemented Carbide composite bar" sufficient strength against destructive impact load.

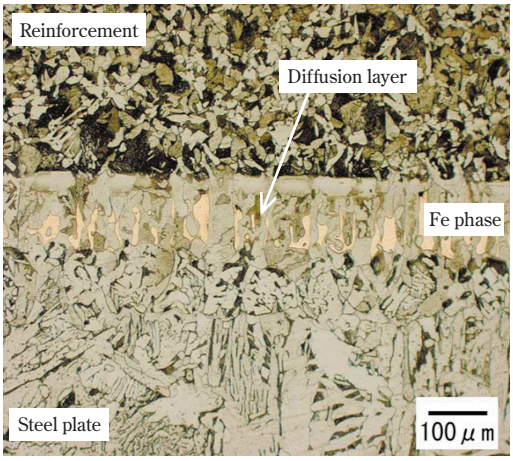
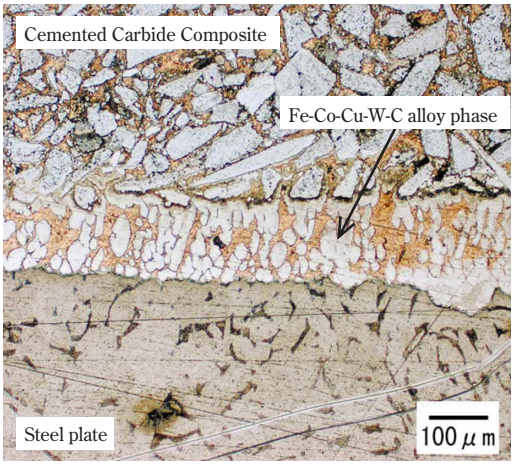


Photo 3 Microstructure of the boundary at which steel plate and reinforcement are bonded



Phto 4 Microstructure of the boundary at which steel plate and Cemented Carbide Composite are bonded

3-2 Mounting the Cemented Carbide composite bar

The comb type edge that has slit-like notches on the lower part was employed, and the Cemented Carbide composite bars are welded utilizing these notches. (**Photo 2**) The Cemented Carbide composite bar has a steel jacket, which enables strong and sure mounting by welding.

4. Result of Actual Operation

4-1 Service life under wear

This edge was tested and evaluated with actual machine at various sites shown in **Fig. 4**. The sites were selected mainly from principal national roads where GD705 (blade width 4.0 m) or GH320 (blade width 4.3 m) are operating.

Fig. 4 Sites where Super Long Life Edge was tested

The result is shown in **Fig. 5**. The axis of abscissa is the service life of KOMATSU's conventional edge; the axis of ordinate is the service life of the newly developed edge. Each point is the results of operation at these sites. The positively sloping line drawn on the graph represents the service life of new edge as 10 times greater than that of the conventional edge. The new edge showed 10 times or longer service life than conventional edges at many sites.

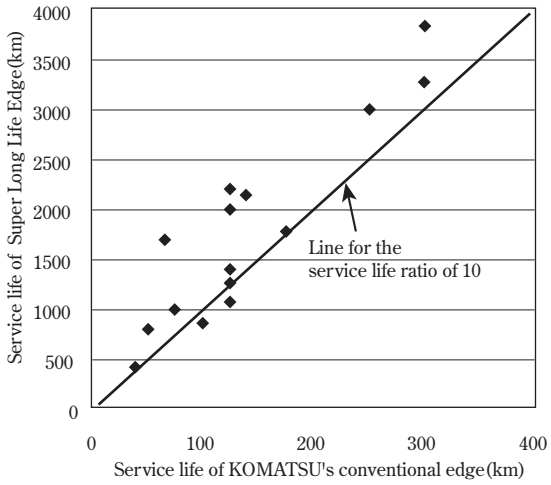


Fig. 5 Scatter diagram for the test result of Super Long Life Edge

4-2 Resistance to breakage

Photo 5 shows the appearance of the new edge during use. Right side photo shows the contact surface, where black portions are “Cemented Carbide composite”. Left side photo is the edge viewed from the front side. No Cemented Carbide composite bars were broken or dropped. This was recognized at all sites.

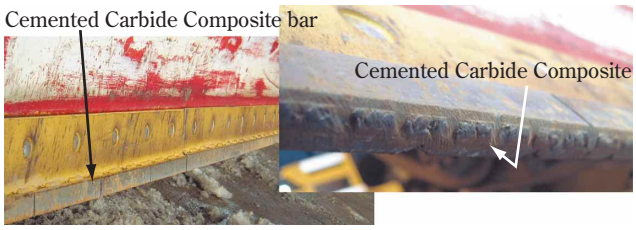


Photo 5 Super Long Life Edge in use

5. Conclusion

Using excellent wear resistant “Cemented Carbide composite” and employing a robust structure withstanding destructive impact force, dramatic increase of service life was accomplished. At some evaluation test sites using the actual machine, the new edge was able to work continuously for more than one season without replacement. We gathered information on operability through an interview, which revealed that operators tend to feel small running resistance, compared with KOMATSU’s conventional edge. This could be because the friction coefficient between Cemented Carbide, the main component of “Cemented Carbide composite” and the road surface is small.

Finally, the authors wish to thank the staff of Komatsu All Parts Support Ltd., the distributors of various districts, the persons related to snow removal at the sites, and many users for their hearty guidance and cooperation with our development of new edge.

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[A few words from the writers]

At a glance, it looks like an ordinary edge merely covered with steel plate, but its content is a fruit of various efforts and devices made to combine wear resistance and impact resistance. We frequently visited the sites in the course of developing this product. Owing to this, we became familiar with the situation of snow districts though we live in Osaka. However, it is a difficult work for us to correctly hear or understand the true dialect spoken among the country people.