

Summary

For the development and introduction of slurry injectors suitable for Hokkaido, the distribution condition, generating factor and the reduction method of towing resistance acting on an injector disk were analyzed. Experiments were conducted to reduce the towing resistance of a disk type slurry injector for the purpose of increasing working speed and reducing fuel consumption.

In order to analyze the effects on the disc towing resistance by a change in the different disk shape and the cutting depth, three thicknesses (6, 9, 12 mm) and three diameters (200, 250, 300 mm) of solid disks were used in the experiments. The horizontal and vertical forces acting on a disk and gauge wheels were measured at 20, 40 and 60 mm cutting depths. Experiment was conducted in loam soil. Towing resistance was measured by a load cell for disk axis which was installed between the disk and the frame. Towing resistance of the disk was found to increase with the increase of cutting depth. As the cutting depth of a disk increased, the upward vertical force applied by the soil to the disk increased, and the vertical force supported by the gauge wheels decreased. This phenomenon is important in analyzing the generation of the resistance. The towing resistance was also reduced when the thickness of an injector disk was thinner or the diameter was larger. Towing resistance of the disk

thickness of 6 mm was 29% smaller than that of 12 mm when the cutting depth was 60 mm and the disk diameter was 250 mm. Towing resistance of the disk with a diameter of 300 mm was 34% smaller than the diameter 200 mm when the cutting depth 60 mm and the disk thickness was 12 mm.

Towing resistance acting on the disk is considered to be the sum of cutting resistance by the cutting edge and the frictional resistance by the side wall. In order to clarify the generation of frictional resistance of the disk side wall, the experiment was performed with changing the cutting depth with three directional force transducer installed on the disk side wall. When the cutting depth increases, the maximum value of the frictional pressure from 40 to 60 mm acting on one point of the disk side wall was almost the same as 124 kPa. The resistance increases when the contact area of the side wall increases with the increase of the cutting depth. Furthermore, in order to analyze the generation of frictional resistance and cutting resistance, the cutting edge resistance of 30 ° of the disk circumference (diameter 250 mm, thickness 12 mm) was measured with a newly developed transducer. The device only detects the cutting resistance of the disk edge, so that it make the towing force possible to measure the frictional resistance and the cutting resistance separately. When the cutting depth were 20 mm and 40 mm, the cutting resistance by the cutting edge of the entire disk was found to be almost 80% and the frictional

resistance by the side wall was about 20%. The disk cutting edge is a part of supporting the injector weight, so that the reduction of the cutting resistance of the cutting edge is thought to be difficult. If the frictional resistance reduces, twenty percent of towing resistance could be reduced.

The reduction of the frictional resistance of disk side wall would be effective to reduce towing resistance of the injector disk. A side wall grooved disk that the disk edge only comes in contact with the soil was manufactured. The experiments were conducted to compare the towing resistance of side grooved and solid disks. Through the experiment the towing resistance of the grooved disk was reduced about 10% smaller than that of a solid disk. The side wall of the grooved disk does not come in contact with soil, so that frictional force was reduced. However, load bearing capacity in the vertical direction was also reduced. Consequently the grooved disk easily sink into soil and the cutting resistance was thought to increase. If a disk does not sink into soil more than the setting cutting depth, towing resistance could be expected to decrease 20%. From the above results, it is effective to reduce the towing resistance by grooving the side wall of the disk.

Dynamics analysis of disk type slurry injector was conducted to develop the optimal injector for Hokkaido. The towing resistance was reduced when the thickness of an injector disk was thinner or the diameter was larger. Furthermore, towing resistance

acting on the disk is considered as the sum of cutting resistance by the cutting edge and frictional resistance by the side wall, and the ratio of cutting resistance to frictional resistance was found to be 4:1. In addition, it is possible to reduce 10% of the total resistance by the reduction of the generation of frictional resistance with a side wall grooves disk.