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Technical reports

A Study of Rolling Resistance Measurement and Effects on Heavy-duty Vehicles Fuel Consumption on Concrete Pavement

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Keywords: cement concrete pavement, asphalt concrete pavement, fuel consumption, coast-down test, running resistance, rolling resistance

Reducing the emissions of greenhouse gases including CO_2 has been one of the most pressing issues on the global agenda. In Japan, the emission from automobiles accounted for 88% in the transport sector in 2006, which was equivalent to approximately 20% of Japan's total.

Meanwhile, it has been reported in Canada that the fuel consumption of heavy-duty vehicles varies depending on the type of pavement surface. Proper selection of pavement types and materials may therefore serve as a means to help alleviate global warming in Japan.

This paper reports on the results of a research conducted in Japan on the effects of pavement surface type (cement concrete vs. asphalt concrete) on rolling resistance and fuel consumption of heavy-duty vehicles.

Taking note of the results of the Canadian research, the authors investigated the feasibility of carrying out similar research in Japan and decided to adopt a different approach -- measurement of running resistance of vehicles to evaluate the rolling resistance between the road surface and the tires of vehicles.

In this study, running resistance was basically measured by coastdown tests in accordance with JIS D 1012 (Automobiles -- Rate of fuel consumption test methods).

The following three sites were chosen for the current study: taxiways in the Narita International Airport (NRT), a testing course owned by the National Institute for Land and Infrastructure Management and, from actual roadways, a newly constructed section of the Doto (Eastern Hokkaido) Expressway.

Figure 1 shows running resistance curves against vehicle speed obtained at the NRT. Running resistance was found to increase with the increase in vehicle speed, with almost constant differences between the three pavement types irrespective of the vehicle speed. Because a same test vehicle was used at the test site, these differences in running resistance were considered to be attributable to the differences in the rolling resistance generated between road surfaces and tires. This allows for a conclusion that the rolling resistance of concrete pavement is lower than that of asphalt pavement.

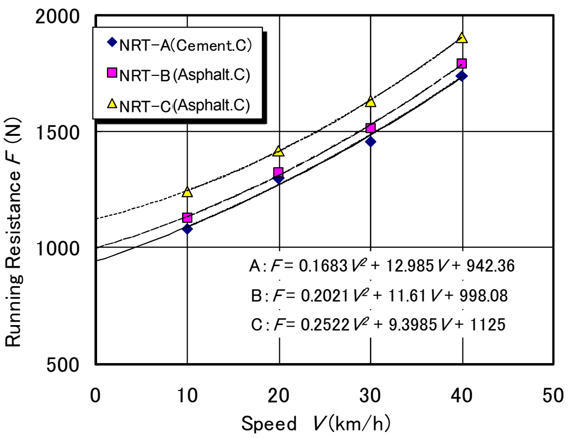

Fig.1 Result of running resistance at the NRT

Photo1 View of running resistance test

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Technical reports

Quality Evaluation Study of Crushed Stone Powder by Fresh and Hardened Mortars Using as Parts of Fine Aggregates

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Keywords: crushed stone powder, 150-micrometer sieve, mix design, fresh mortar, compressive strength, percent flow, activity index

Crushed stone powder is limited to what passes through a 150-micrometer sieve in which the by-product is separated and/or ground at the time of manufacturing of a crushed stone and/or a crushed sand by dry process in the plant. Such crushed stone powder can be a promising material used for the purpose of increasing the qualities of concrete.

Quality evaluation studies of crushed stone powder were carried out in which study items were flow, air content, bleeding, setting and hardening time, and compressive strength. 14 samples were collected and tested after researching of actual quality compatibility conditions of 50 representative samples in the previous technical report. Mortar mix proportions were designed as ones of not only 8cm slump concrete but also 18cm slump concrete equivalent.

Crushed stone powders which passed through a 150-micrometer sieve increased hardly a required unit content of water to maintain a same flow value of mortar. The remarkable decrease in flow value was hardly observed when a replacement ratio of crushed stone power was lower than 5 %. An influence degree of replacement ratio of crushed stone powder on air content of mortar was small though the air content was decreased scarcely with an increase of replacement ratio of the powder.

A setting and hardening time was hastened by an addition of crushed stone powder due to a decrease of the amount of bleeding. The amount of bleeding of mortar was decreased remarkably in a case with high water-cement ratio and small amount of finer part in mortar.

A compressive strength was increased by replacing crushed stone powder in the case of water cement ratio being high though the increase of compressive strength could not observed remarkably in the case of water cement ratio being low.

Relationships between percent flow specified in JIS A 5041(Crushed stone powder for concrete) and flow value of mortar are presented. Relationships between activity index in JIS A 5041 and compressive strength of mortar are also presented.

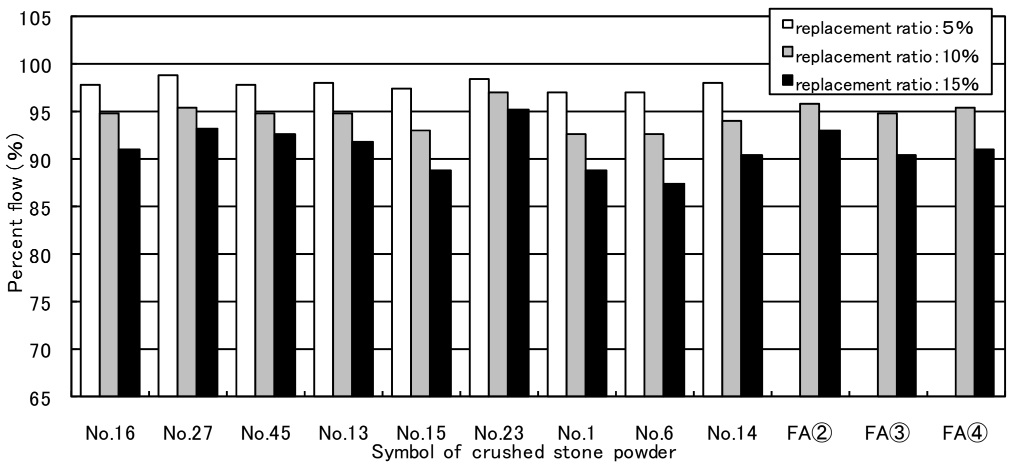

Fig.1 Percent flow of mortar with equivalent slump 8cm, W/C=0.55, crushed sand (normal)

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Construction records

Application of Mortar Spraying Method for Constructing Secondary lining of Sewerage Pipe

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Keywords: shield tunnel, secondary lining-integrated segment, steel segment, secondary lining, lining spraying method

1. INTRODUCTION

In constructing secondary lining-integrated segments and shields with omission of the secondary lining, stringent construction requirements are usually adopted because of the low lining thickness for sections containing steel segment. In a recently implemented method, a specially-developed mortar is sprayed over to fill up the narrow space inside steel segments. The surfaces of segment and the sprayed mortar are then overlaid accordingly by spraying with high quality mortar used for shield tunnel construction purpose. The overlay is then plastered to complete the construction of new lining. This method aims to increase the quality of conventional in-situ concrete casting procedure, by building highly durable lining through ensuring complete filling of space inside steel segment and void found on the interface between segment and lining.

2. OUTLINE OF LINING SPRAYING SYSTEM

First, the steel segment is applied with primer, followed by spraying and filling with high performance inorganic mortar incorporating hardening accelerator (referred to as filling mortar hereafter). To prevent peeling and cracking, reinforcements are then arranged before sulfate-resistant mortar is sprayed over. After plastering, surface curing agent (silane type) is applied to the finished overlay.

The filling mortar is sprayed from the tip of a nozzle by pressurized air containing liquid hardening accelerator. With the effect of hardening accelerator, continuous filling is possible because the material will harden soon after spraying and without concern for peeling and fall out of mortar. The blending and pumping of mortar can be achieved at a speed of 2.0 m^3/ hr using a mixer with continuous mixing capability as well as a pressure pump.

3. IN-SITU APPLICATION

A tunnel for sewerage pipe facility was applied with the lining spraying method. To fulfill the required performance of tunnel, filling mortar was sprayed inside the space of steel segment, and the anti-corrosion surface layer was overlaid with sulfate-resistant mortar. Reinforcement was located at 50 mm from the surface layer by placing wire mesh. For surface curing agent, silane-type curing material with water repellent and anti-carbonation characteristics was used.

The spraying of filling mortar and sulfate-resistant mortar are as shown in Photo 1 and Photo 2, respectively. Since the amount of dust generated from spraying of filling mortar and sulfate-proof mortar was low, the condition of segment filling and surface layer can be visually inspected by the nozzle operator to ensure satisfactory construction.

Photo.1 Spraying of filling mortar

Photo.2 Spraying of sulfate-resistant mortar

Photo.3 After construction

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