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ON FUNCTIONAL BLOCKS

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Note: The following is the notation used in this paper: (.) for decimals and (   ) for thousands.

Summary

This paper is about a system of blocks, which can supply the road surface with liquids using ordinary traffic, such as passing vehicles. The study was started from the problem of skidding on ice in cold regions. Intersections and highways can be hazardous in winter due to compacted snow, which can make a flat surface. Bridges over the rivers and the entrance areas of tunnels in the highlands are often the most dangerous locations. Salt or deicing liquids are spread by sprinkler trucks, only to have a considerable amount washed into the roadside gutters. Thus, a system to daub a fluid deicer on the road surface would be a major improvement.

The liquid supply techniques are applicable to also solve problems in other fields. For example, the heat island phenomenon can be mitigated by the system. It is also applicable for dust prevention as well as cleaning tires of trucks from muddy construction sites. Antiseptic solution from the system can disinfect wheels of vehicles in order to counter an epidemic such as bird flu. The block paving may be appropriate to give specific functions to a limited area. The functional blocks consist of concrete and elastic materials, excised from discarded materials such as conveyer belts or automotive tires. Inverted, the combination can give additional characteristics from a noise reduction to the enhanced friction coefficients. On top, a liquid absorbency is lowered to extend the daubing distance. Related to the application, the experimental results are shown.

The object is to solve not only traffic problems but also environmental issues in processing waste. In addition, the construction and maintenance might cost less, since passing traffic can daub a considerable length of road from a single, limited patch. Past trials have required solving basic problems ---how to overcome the random distribution of the thickness of the materials and the difficulties controlling the supply of liquids. These are reviewed to prove the feasibility of the system. It is proposed that rubber pieces of random thickness can be connected to adjusting materials of concrete to form a block surface of designated thickness. This practice showed a stronger and more durable adhesion, since the boundary between the concrete and elastic materials is not flat. The drawbacks in the conventional methods of shredding and solidifying with chemicals may be solved. The functional mechanism to daub the road surface with liquids will be discussed from the application point of view. Regarding the control, a proposed design of the Torricelli tube is used to keep the liquid surface constant. This system may be applicable to various situations, sparing the complicated liquid control devices in the past.

1. INTRODUCTION

The study has two basic points: one, it solves the need for traffic to have liquids under the tread of vehicles, and another is it reduces pollution by using discarded materials. Most discarded rubber pieces from industrial products are used for fuel. However, trials have been made to make more efficient use of rubber pieces by recycling them. One of these has so far been an application to surface layers of roads in order to reduce noise, echoing, abrasion, ice formation, black ice, etc. In the conventional method, discarded tires or belts of conveyors are first shredded into rubber grains, which are then solidified to make a plate as a surface piece with the bonding agent. The durability of the solidified plates of rubber grains will drop considerably from that of the tire rubber so that usually these have been used only for pedestrians, not for highways used by vehicles at high speed.

A method was proposed to make the blocks for motorways, using discarded tires for the surface and the bottom without shredding them. The blocks enable us to limit the rubber area only on the driving lanes, solving problems in holding rubber pieces on the road surface. Sparing the two procedures of shredding and solidifying contributes to the economy of the practice. The rubber on the block surface extends the daubing distance, since it does not absorb liquid. The rubber at the bottom allows blocks to sink when trodden by vehicles. Combined with the automatic liquid supply, the sinking blocks would moisten tires of vehicles.

2. TECHNICAL BACKGROUND

Regarding questions frequently asked about the system of blocks, some information currently available is as follows:

2.1 <u>Abrasion</u>

Little has been published about the abrasion between rubber treads of tires and the rubber surface of a block. An estimation should be found only in similar conditions. An example can be found in the subway of Sapporo, Japan, which has been running for about forty years, since 1971. The wheels of the trains have been covered with rubber treads and run on the resin plate. The diameter of the wheels is either 0,90 m or 1 m. The tire rubber is replaced every 300 000 km, according to the regulations. The controlling office claims that no discernable abrasion has been reported. If the allowable depth is 5 mm, the rubber on a lane can survive over 50 million wheel passes or even more if in the similar conditions except for specific locations such as intersections. The blocks are easy to replace if the abrasion should show warning signs of problems. Therefore, the rubber surface may be semi permanent, as far as the abrasion due to traffic is concerned.

2.2 <u>Noise</u>

The traffic noise can be reduced considerably by using rubber as reported by Inuzuka (2006). Although the effect depends on the roughness of the surface, the traffic noise can be reduced by 5 db as shown in Figure 1. The advantage of the block paving is that only two narrow paths, 0,8 m wide each, can work as a lane divided by a 1,5 m gap in order to reduce the noise caused by vibration on highways. The width, established by the trial and error tests, can be narrowed further, since the operators would choose the driving path even with one lane. Compared with other means of sound insulation such as walls, the rubberized block paving proved to be competitive from the view point of cityscape or sunshine rights, let alone considering the lower costs.

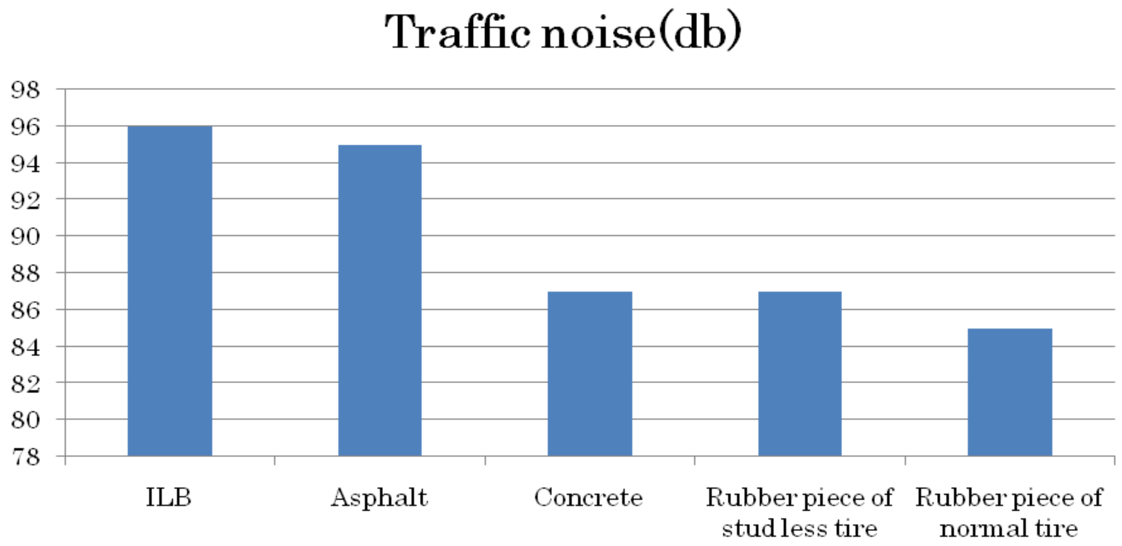

Figure 1. Noise Comparison in db.

2.3 Skidding

Inuzuka (2006) shows the friction coefficients between the tread and the rubber surface of blocks. As shown in Figure 2, the joints play an important role to guarantee the value over 0.5 even in wet conditions. If it were not for the joints, the rubber planes would be accompanied with the hydro-plane phenomenon and hazardous driving conditions.

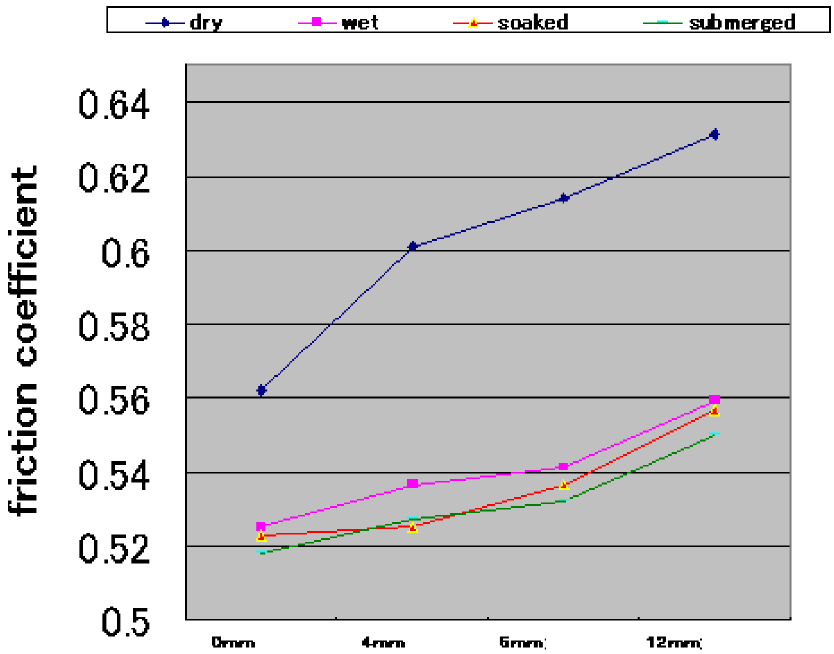

Figure 2. Relation between friction coefficients and notch depth of tire tread.

2.4 Separation

The proposed practice comprises the steps of forming an asphalt layer between the rubber layer and concrete. The direct contact produces a bond between layers, even though asphalt is not tacky when concrete is placed on it. The use of concrete is the key to adjusting the thickness of blocks. In addition, a dovetailed part grabbed by concrete is effective in keeping the connection as shown in Figure 3. The interactive action between these layers can enhance the adhesive durability. The adhesion of the asphalt layer is not strong. It has, however, a characteristic merit of adhesion recovery at warm temperatures, so far as it is in close contact with the object for a period of time. The strength over 0.1 MPa will prevent stripping due to traffic.

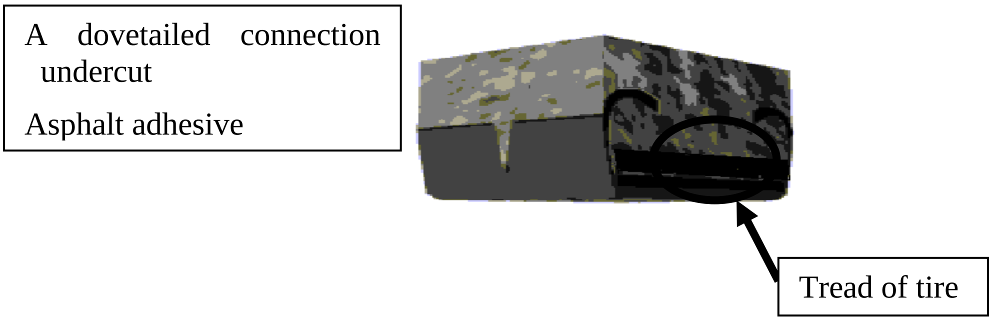

Figure 3. Connection between concrete and rubber.

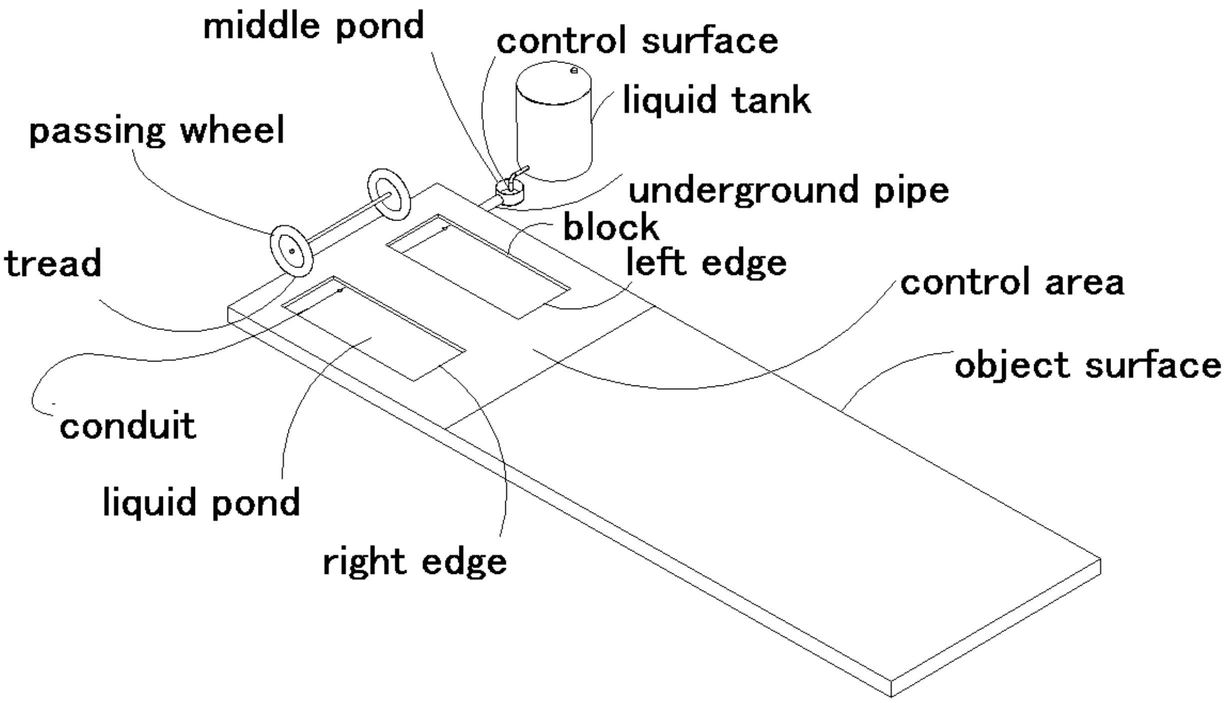

Figure 4. Outline of daubing system.

3. LIQUID DAUBING

A tire of a passing vehicle daubs liquids on the road surface, since the rubber tread can keep an amount of liquid in the tread patterns. Figure 4 shows how to prepare a deicer and blocks, which are to be laid in a watertight pond for each wheel. Two wheels of a passing vehicle are about to get in the liquid pond, pressing down the surface of the blocks for the treads to get wet in the ponds. Completing a revolution, the wheels will go ahead to daub the object surface. A daubed amount is supplied from the liquid tank, which is airtight. The surface of the water in the pond is controlled by water in the middle pond from which water comes through the conduit underneath. The control surface in the middle pond is controlled with the Torricelli tube.

3.1 Daubing system

Blocks can be displaced downward by the wheel weight with the elastic material at the bottom. Deicer liquid absorbed in the tread is daubed on the adjacent area of the object surface and supplied from the tank, since the control surface is kept constant in the pond. It is necessary to keep the surface as high as possible to prevent a dilution due to the molten snow or the rain. If dilution is not prevented, the system might stop functioning because of freezing. Therefore, a combination between the appropriate gutters and the accurate height control of the surface of the liquid is required to prevent the return of floodwater. The deeper the soaking depth, the longer the covering distance gets. The cross sectional view of blocks, shown in Figure 5, may elucidate the deicing mechanism. A choice of liquids depends on its use. It is not difficult to change from deicer in winter to water in spring or vice versa.

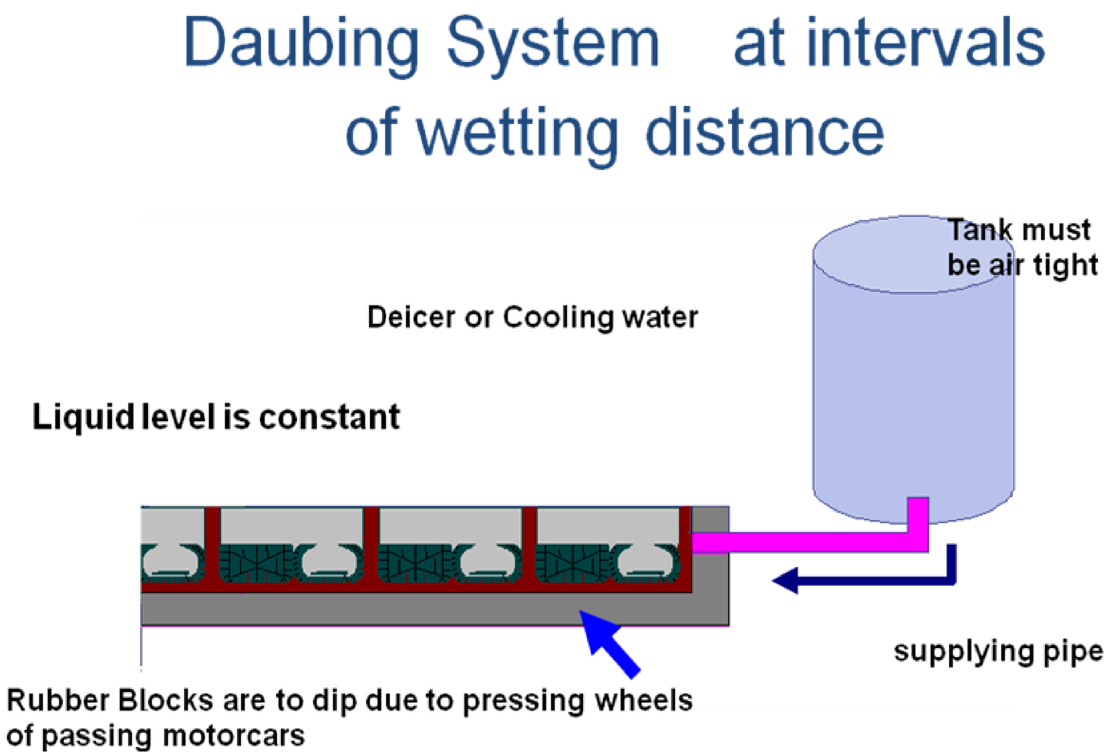

Figure 5. Daubing system of sinking blocks.

3.2 Daubing tests

3.2.1 Experimental conditions

The daubing distance depends not only on the temperature and on humidity of the atmosphere but other given conditions of influential factors. From the vehicles, tread patterns, contact areas of the tread and the passing velocity are the main influential points. On the road surface, the soaking depth, a pond length and the liquid viscosity are the main factors. The daubing distances were measured with the experimental system. The blocks were arranged in the small dent. These and other materials used in the test are shown in Figure 6. Each block has a surface of 400 mm x 400 mm and a depth of 150 mm. The width of each joint is 20mm. The water surface height is equal to that of a block. The experimental truck has a single tire. The front tire weighs 750 kg and the rear one weighs 500 kg so that the total weighs 2 500 kg. The tests were carried out by measuring a wet discernible distance on concrete, each time ten vehicles passed over the system and advanced at 30 km/h to the adjacent concrete surface.

Figure 6. Blocks and equipments for daubing.

3.2.2 Experimental results

The relation between passing vehicles and the daubing distance on concrete is shown in Figure 7. The distance is approximately doubled on the rubberized blocks in compact experiments.

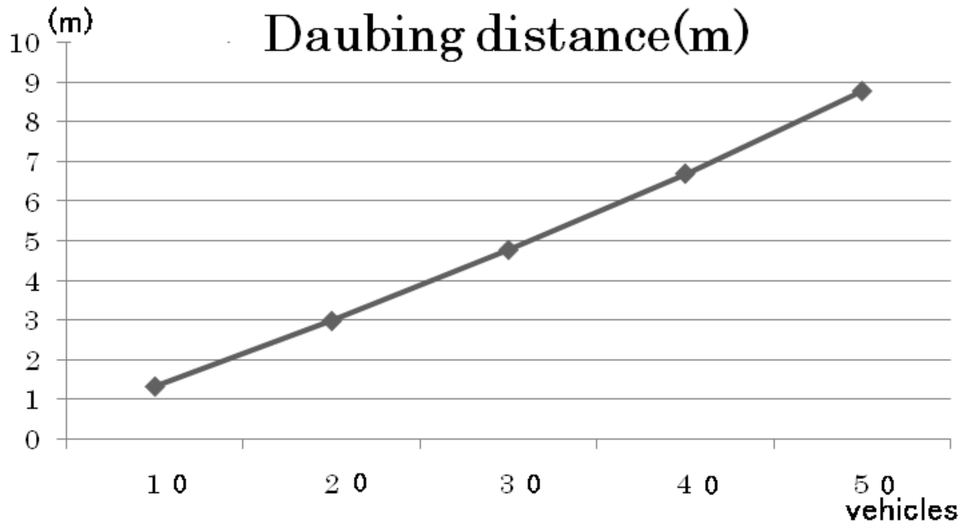

Figure 7. Daubing distance and passing vehicles.

3.3 Deicing

The tests were carried out by using a calcium chloride solution available in the market. The ice layer, 50 mm thick, was prepared on the concrete surface by compacting snow. Deicing liquid, daubed out from the system, melted ice unevenly as shown in Figure 8. This photo shows the result after 20 vehicles passed over the system of 460 mm length. It is not realistic to have that thickness of ice before the system begins to work so that a much shorter length may be all right in the busy cross road. Therefore, the tested system may be enough, so far as it begins to work when the temperature falls to subzero and the side snow is removed before it melts. Being diluted by melted snow or rain, the liquid makes an ice, solidifying the joints and causing the system to cease functioning.

Figure 8. Ice removal by passing vehicle.

4. DISCUSSION

Daubing a liquid by passing wheels is accompanied with scraping so that a short system can cover a considerable distance, depending on other conditions. The treading wheels were of the same diameter and the experimental tread length soaked in a liquid by the system was approximately a quarter of the total tread length. Several repetitions of passing, however, formed one wet zone, connecting separate wet patches. The distance also depends on the surface conditions of the object area, since a theoretical assumption suggests that a spot of the system could cover a considerable distance if it were not for dissipation or evaporation. Although these were influential, only limited factors were examined to show the effects of the design on the soaking length and sinking depth to cover a required distance. A pair of small sized patches of the system with an area of 460 mm x 460 mm for a tread may cover over twenty meters with traffic of 70 vehicles, unless there is excess dissipation. Sprinkling water on a road surface with the system, the problems of heat island or dust may be solved.

For the use of deicing, other factors must be taken into account. The first is a dilution, which freezes the joints to halt the system from functioning. The second is the over flow which will increase the amount of consumption. Therefore, a system for processing a liquid with a steady flow must be maintained. The system placed at the higher position is to facilitate the function. The same is applicable to tire disinfection with an antiseptic solution.

5. CONCLUSION

- A daubing distance is directly proportional to a number of passing vehicles up to the limit.
- The limit depends on absorption and evaporation on the object surface.
- A small sized daubing system can cover a considerable distance with liquids in appropriate conditions.

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