

Design of Korean-Type Road Debris Remover Instrument

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ABSTRACT

Road debris would greatly threaten safety of traveling vehicles and drivers. Road kill such as dogs, cats, and other wild animals represents the largest proportion of the road debris. Such things on the road should be removed in advance in order to provide better road service to users. This research proposes the need to develop the Korean-type instrument for removing road debris and its final design based on a novel approach different from that used for existing ones. This can work when a vehicle with an instrument is travelling. A regular truck such as 2.5ton and greater can be used by attaching an instrument. In addition, this instrument can remove road debris in roadside without lane changing. These efforts will hopefully contribute to guaranteeing safety of road workers and enhancing quality of road service to a higher level.

Keywords: Road debris, road kill, road worker, road service, safety

1. INTRODUCTION

Road debris refers to objects on roads or roadsides that are not supposed to be part of the general road environment. They includes objects from travelling

vehicles, facilities on roadsides fallen by strong wind, or damaged goods from vehicle accidents scattered around the roads. Table 1 shows statistics on road debris on highways in South Korea.

Table 1: Statistics of road debris on Korean highways

Year	Number of road debris collected	Number of accidents related to road debris (death)	Number of reports on bad loading
2010	312,829	20(0)	50,964
2011	314,080	33(0)	65,800
2012	313,605	44(0)	87,070
2013	273,026	64(0)	83,527
2014	290,764	43(1)	60,789

Source: Data from Parliamentary Land, Infrastructure and Transport Committee's regular audit of Korean Expressway Corporation

Road kill accounts for the greatest number of road debris on the roads. Primary victims on highways are elks, followed by raccoons and others. In cities, cats, dogs

and other wild animals fall under prey to road kill. Table 2 presents data on highway road kill from 2009 to 2013 and road kill in Seoul from 2012 to 2014.

Table 2: Accidents related to road debris on highways and in the city of Seoul

Year	Number of road kill by year	Number of road kill by year
2009	1,895	-
2010	2,069	-
2011	2,307	-
2012	2,360	4,163
2013	2,188	5,158
2014	-	2,548

Source: Korea Expressway Corporation and Yonhap News

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Vehicle accident data associated with road debris associated with road debris on the roads as well. in the U.S. also suggests high frequency of accidents

Table 3: Accidents associated with road debris on the roads in Colorado, U.S.

Year	Total Fixed and Other Object(s) Related crashes	Crashes caused by: vehicle debris/cargo	Crashes caused by: Large Rocks of Boulders	Crashes caused by: Debris and Rocks
2007	8,167	486	265	751
2008	7,534	481	291	772
2009	7,930	452	262	714
2010	7,159	424	287	711
2011	7,261	449	250	699

Source: CDOT Rapid Debris Removal Research Project (2014)

Road debris can pose a serious safety threat to vehicles and drivers. Therefore, such risk factors need to be removed ahead to ensure that a higher level of road service is provided to users. In this regard, this research proposed a novel approach in arguing for the need to develop the Korean-type instrument to collect road debris on roads and its final design.

2. EXISTING INSTRUMENT

Road debris remover used in Korean roads has a simple structure that can be effortlessly attached to vehicles but it is far from being commercialized because critical test on vehicle driving safety is not fully established. Furthermore, the instrument has been developed by road authorities based on their designated objectives. Fig. 1 represents a layout of instrument employed by the City of Seoul and Korea Expressway Corporation.



Figure 1: Instrument used at the city of Seoul and Korea expressway corporation

A road debris remover in Fig. 1 is vehicles that have attachable sweeper-shaped instrument. They shape like a small-capacity cylinder and are attached to the front of patrol vehicles. Since they collect road debris at high speed, types and capacities of road debris they can collect are limited (e.g. Tire fragments, small dead animal bodies, etc.). Bigger instrument for road debris on roadsides are attached to front of garbage trucks, which drive at low speed. Instrument being used in other countries are no less different but the size of attachable instrument is bigger to enable collection of road debris bigger in size or heavier in weight. The instrument developed by the U.S Gator Getter shown in Fig. 2 is 48 X 72 inches in size. It costs \$15,995 per equipment and camera system can be mounted to the front as optional.



Figure 2: Road debris remover instrument used in the U.S.

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It can apparently remove road debris but maintenance and fuel cost varies by size of attached equipment and vehicle. Its cylinder shape keeps removed objects from getting out but it cannot collect slanted road debris because it cannot rotate. Fig. 3 shows the roadside trash remover used by the U.S. Caltrans.



Figure 3: Roadside trash remover used by the U.S. Caltrans

As such, efforts to remove road debris on the roads are underway all around the world but most of the instrument in use are limited in speed and shaped against collecting very small objects such as screws, papers or vinyl. Also, they can cause sanitation issues because they are unable to remove road kills separate from other objects.

3. ESTABLISHED DESIGN CONCEPT OF THE PROPOSED ROAD DEBRIS REMOVER

This research established the concept for road debris removers capable of removing road debris on roadsides without changing lanes and of removing road kill while travelling with a storage attached to a vehicle (2.5 ton or heavier) to collect and load road debris.

Unlike the existing instrument that are attached to front side of vehicles, the instrument proposed in this study is attached to a vehicle' s central bottom to support absorption and collection of road debris at the same time.

It is designed to enable rotation in both directions to minimize inconvenience observed during collection. In addition, it comes with a searchlight on vehicles top to assist collection during nighttime, and GPS control to monitor its location and sensor. In addition, it provides various sensors if needed based on user choice, to detect and video record road debris. The biggest technological difference from the existing ones is collection method and remover size. The existing ones have to go through tough approval procedures from government offices and loading size is too small, both of which can be addressed by the new instrument proposed in this study. Also, what differentiates the proposed instrument concept is its ability to separately remove road debris and road kill. Table 3 indicates how related bodies are dealing with road kill.

Table 3: Road kill treatment policy

The City of Seoul	<ul style="list-style-type: none"> ·Runs dead animal disposal equipment with road debris instrument(since Aug. 2009) ·Receives and handles reports on road kill through Dasan Call Center(#120) for disposal
Gyeongsangnam-dogovernment and relevant local governments	<ul style="list-style-type: none"> ·Rewards citizens reporting road kill ·Runs environmental VoC program (#128) <ul style="list-style-type: none"> →Receives and handles reports on road kill through adjacent local governments for disposal
Korea National Parks Authority	<ul style="list-style-type: none"> ·Transfers to road management agencies in charge ·Samples and stuffs endangered species (for educational purpose)
National Land Management Office under the Ministry of Land, Infrastructure and Transport	<ul style="list-style-type: none"> ·Uses emergency phone service for road complaints ·Receives reports via smart phone application “chuck chuck service” (handle within 24 hours)

Korea Expressway Corporation runs guidelines on disposing of dead wild animals, which it enacted. The guidelines are divided into collection method, temporary storage and third-party disposal as follows for sanitary and quick road kill disposal.

<p>Step 1: Collection method</p> <ul style="list-style-type: none"> - Put the dead animal in a bag (burlap bag + sanitary plastic bag) upon discovery and seal - Use disposable plastic gloves and equipment to prevent any infectious disease from spreading - Ensure quick collection via a safety patrol vehicle or atool vehicle (within one day) <ul style="list-style-type: none"> ※ Legitimately dispose of endangered species (like otters, mountain goats, flying squirrels) subject to Cultural Properties Protection Act. <p>Step 2: Third-party disposal of waste</p>
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<Temporary storage>

- Hand over the removed dead animal bodies to a waste disposal agency as soon as possible
- Use an exclusive storage facility or a storage device to separate them from general waste when they cannot be transferred immediately or storage period gets longer.

※Install freezing facilities, if necessary, or consider direct transfer of dead animal bodies to a waste disposal agency

<Third-party treatment>

- Dispose of dead animal bodies in accordance with living waste disposal guidelines
- Prepare management ledger on final disposal and the relevant third-party agency

In the light of the foregoing guidelines, concept of a road debris remover is proposed as shown in Fig. 4. Proposed equipment collects the road debris using the vacuum tube of located under the vehicle of 2.5ton truck unlike conventional road debris equipment.

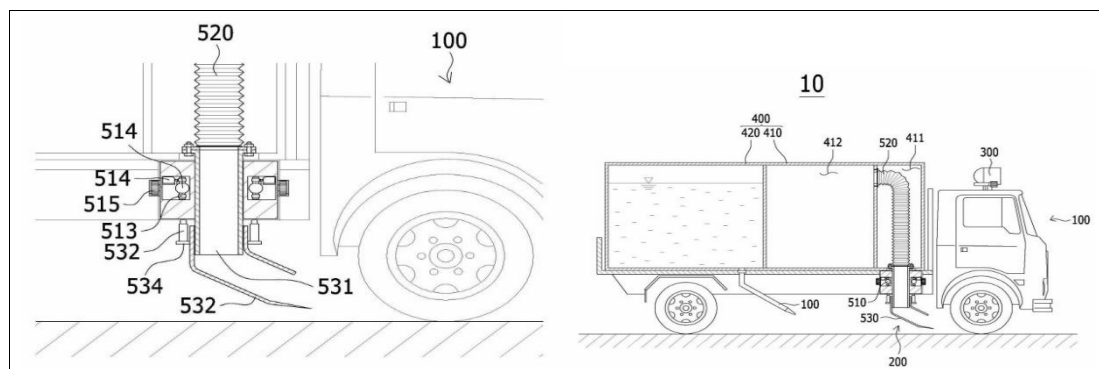


Figure 4: Basic concept of road Debris remover

4. CONCLUSION

Road pavement repair and road debris remove on roads are an important part of road management. In fact, both account for the largest part of road management.

Instrument, systems and knowhow related to road pavement and repair are quite sophisticated but road debris remover works still relies on manual labor.

Furthermore, removing road debris in highways or high speed roads is extremely dangerous to road workers with an increase in the number of related accidents every year. Vehicle accidents caused by road debris or by avoiding them are also a matter of serious concern. This research proposed the need to develop road debris removers that fit road conditions in Korea and the direction for the development. Instrument design that will be aided by national R&D underway will hopefully go a long way in securing safety of road workers and taking quality of road service to a higher level.

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REFERENCES

- [1] CDOT Rapid Debris Removal Research Project, Colorado Department of Transportation, 2014.
- [2] Korea Expressway Corporation, Guidelines on Disposal of Dead Wild Animal Bodies, 2012.
- [3] Korea Institute of Construction Technology, Year One Report on Technology to Mitigate Collision of Vertical Structures on Roadsides and Road Worker Risk, 2016.
- [4] Korea Expressway Corporation, Parliamentary Audit Report on Road kill, 2012.

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