



## ASSESSMENT OF THE HIGHWAYS FENCING IMPACT ON THE SNOW DEPOSITS FORMATION AT SNOWSTORMS

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### ABSTRACT

The main consumer properties of the road are the ability to drive a vehicle at high speed, safety, and comfortable traffic movement. The general trends in the automotive industry are such that the performance of the passenger car fleet increases approximately every 7-8 years. At the same time, roads are modernized only every 20-30 years, while in Russia this period is even longer for most public roads. It is important to determine what needs to be done on the roads in order to increase the speed of modern passenger cars while maintaining safe driving conditions. From statistical data, it is known that approximately 22-25% of the total number of road accidents are associated with unintentional exits of cars from the roadway. The consequences of such accidents are particularly severe, accounting for 20% of deaths and a large number of injuries, while the material damage is characterized by a significant deterioration of vehicles and goods transported. One of the main ways to reduce the severity of these consequences and improve traffic safety is the installation of fencing devices, which could retain the car, which has lost the driver's control, on the carriageway, and not just to retain the vehicle, but also to exclude departure on an oncoming lane, reduce consequences from a road accident, and exclude fatal cases.

**Keywords:** road barriers, standard road topping designs.

### INTRODUCTION

In world practice, three types of road barriers are used: metal barriers, cable fences, and parapet made of precast or monolithic concrete.

For different road conditions, fences with different retaining power, height, and allowable deflection should be used.

On Russian roads, there are mainly metal barrier fences, produced by about 30 manufacturers in accordance with the requirements of GOST R 52289-2004 (2006) and GOST R 52607-2006 (2007).

Foreign and Russian practices in using parapet fences made of monolithic and precast concrete showed their high efficiency exactly on speedways (Bligh, *et al.* 2005; Aesthetic concrete barrier design, 2006; Concrete safety barriers: A safe and sustainable choice, 2012; Zain and Jasim 2015) because parapet fences are characterized by a number of advantages, namely:

- completely prevent vehicles from entering the oncoming traffic lane, even with regard to the heaviest trucks;
- do not cause long traffic delays during the repair because of the rare damage (which is very important for highways and speedways);
- require relatively low maintenance costs, operating costs are also low;
- are characterized by long service life (up to 50 years); the service life of parapet is 2.5 times longer than that of metal barrier fences since up to 70% of the total length of the metal barrier railings must be replaced within 20 years.
- ensure good guide exposure effect on drivers;
- significantly reduce the dazzle of drivers by the headlights of oncoming cars.

### METHODS

In Russia, unfortunately, the monolithic concrete parapet is not yet widely used. This situation has several reasons described below:

- a) Low level of knowledge of experts about the design features and consumer properties of the parapets. In the bodies that carry out the examination of projects on construction, reconstruction, and overhaul of roads, preference is given to conservative solutions of the traffic organization and securing its safety.
- b) Lack of objective data on the service life of parapet, as well as statistics on the number of road accidents and the severity of their consequences in accidents involving fencing devices.
- c) Negative practice in the use of parapet on some roads due to violations of the construction technology during their installation and the lack of appropriate maintenance.

For speedways with a permitted speed of 130 km/h, the correct and reasonable choice of the road fencing type is necessary.

It is obvious that in order to improve the competitiveness of parapet in comparison with barrier-type fences or concrete enclosing structures, it is necessary to substantiate the regulatory requirements for the retaining power, height, and allowable deflection of parapet fences. To do this, it is necessary to conduct full-scale tests of new parapet type structures and develop appropriate regulatory documents for their application.

It should be noted that the parameters of the road arrangement elements affect the formation, nature, and volume of snow deposits. On roads of higher categories in the winter season, any snow deposits on the carriageway are inadmissible.

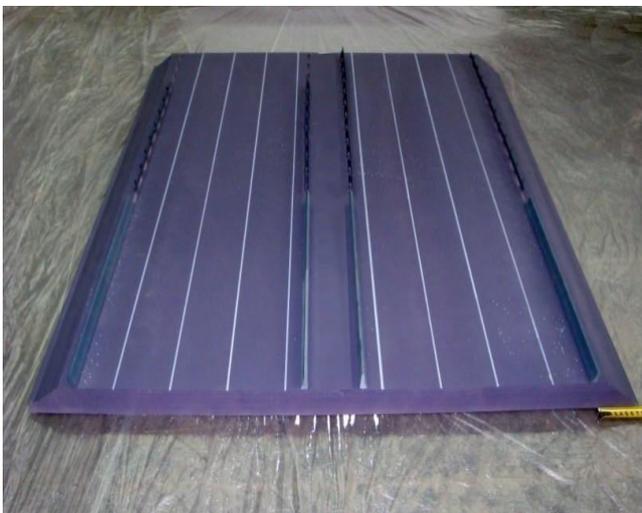


Ensuring protection against snowdrifts of the express roads and motorways is of utmost importance. When assessing the degree of difficulty of snow-fighting and the developing snow protection measures on express roads and motorways, one should take into account the presence of road barriers on the median strip and roadsides, as well as a significant width of the roadway and roadbed (Gladysheva, *et al.* 2003; Ushakov and Korneeva 2014). Transverse profiles of embankments of express roads and motorways are poorly streamlined by wind flow, and thus, vortex zones are formed on the carriageway surface (Ushakov and Korneeva 2015). The flow velocity is usually insufficient to blow off the snow that has fallen on the carriageway.

To assess the impact of road barriers on the snowdrifts of express roads and motorways, the staff of the Construction and Roads Operation Department of the Moscow Automobile and Road Construction State Technical University (MADI) conducted special studies based on modeling the snow deposits formation in the area of various types of road barriers (Liang, *et al.* 2010). Carrying out such full-scale measurements of snow deposits directly on the road carriageway is extremely difficult and insecure.

Thus, the models of earth bed, parapet (made of gypsum), and metal barrier fence (made of plastic) were created by means of 3D printing. Parapets of the New Jersey type with a height equivalent to 0.81 and 1.10 m were made in accordance with ODM 218.6-2011 (2012). Metal barrier fences were made in accordance with GOST 26804-2012 in two designs: one-sided single- and two-tier fences with the height equivalent to 0.75 and 1.10 m (GOST 26804-2012, 2014).

Cross-section of the highway model corresponds to the IA highway category with six lanes and a median strip 6.0 m in width. The model scale ratio is 1:40 (Figure-1).



**Figure-1.** A highway model.

To ensure compliance of the aerodynamic characteristics of the created model with the aerodynamic

characteristics of real structures, the basic laws of the transition from model to natural objects were observed (Lü, *et al.* 2012; Zhang, *et al.* 2012; Florescu, *et al.* 2011). Accumulation of blowing snow was modeled by spreading industrial synthetic powder, composed of the following components:

- phosphates 15-30%;
- anionic surfactants 5-15%;
- nonionic and cationic surfactants, about 5%;
- polycarboxylates;
- zeolites;
- enzymes;
- flavoring agent.

The powder was sprayed by means of a fan with a power of 120 W and a rotation speed of 1400 rpm, which was installed at a distance of 175 cm from the test model. The powder was sieved through a sieve for 20 minutes.

The following three combinations of road barriers were tested:

a) Metal barrier railing with a height of 1.10 m installed on the traffic strip, and those with a height of 0.75 m on the roadside;

b) New Jersey type parapet, 1.10 m high installed on the traffic strip, and that of 0.75 m high installed on the roadside;

c) New Jersey type parapet, 1.10 m high installed on the traffic strip, and that of 0.81 m high installed on the roadside;

## RESULTS AND DISCUSSIONS

From the first minutes of blowing on the carriageway with a metal barrier fence on the median strip and the roadside, snow banks are formed on the lanes both on the windward and leeward sides. This is due to the fact that the metal barrier fence works as a barrier with enlightenment. The largest deposits are formed on the extreme right lane on the windward side. In terms of snowdrifts, this option of road barriers installation is the most unfavorable.

When installing New Jersey type parapet on the median strip and the roadside, deposits on the carriageway are virtually absent. Parapet type fences work as a continuous barrier, which allows preventing snow-drifting flow on the roadside and the slope, as well as gives an advantage in time to road services to clean the carriageway covered with snow by snow grooming equipment until complete removal of snow from the parapet.

In case of the presence of a road barrier only on the median strip, the use of a parapet adversely affects the snowdrifts of the highway, since the accumulation of snow deposits will no longer occur on the roadside and road border, but directly on the extreme left lane.

With the combined installation of parapet and metal barrier, deposits are observed only on the windward side of the lanes. The largest deposits are formed on the far right lane, similarly as in the first option of the road barriers installation.



## CONCLUSIONS

The conducted experimental studies have made it possible to draw the following conclusions:

- a) Cross-sections of express roads and motorways are aerodynamically poorly streamlined.
- b) Road barriers on express roads and motorways create additional obstacles to the snow-drifting that leads to the formation of significant snow deposits on the carriageway.
- c) The most unfavorable combination in terms of snowdrifts is the installation of metal barriers on the median strip and roadsides. When installing New Jersey type parapets on the median strip and the roadside, deposits on the carriageway are virtually absent. At the combined installation of parapet and metal barriers, deposits are observed on the lanes from the windward side. If parapet is installed only on the median strip, its impact on the formation of the deposits will change in an unfavorable way.
- d) When developing measures to ensure road safety in winter season on express roads and motorways, the type of road barriers installed on the median strip and the roadside should be taken into account.

The obtained research results on the formation of snow deposits near road barriers will serve the basis when developing requirements for the use of parapet barriers on motor-roads.

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