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# PEDESTRIAN SAFETY AT CROSSINGS

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**Abstract:** The article deals with the evaluation of selected pedestrian crossings in terms of their functional parameters**.** Road safety is still a highly debated issue in all countries with a developed automobile transportation. Risk are the group of participants, with a team that drivers and passengers in motor vehicles are more or less protected by the vehicle itself, cyclists and motorcyclists are partially protected for example, helmet. But pedestrians are not protected at all. Thus pedestrian is the most vulnerable road users. In Slovakia, die each year from an average of 200 pedestrians. The most frequent causes of pedestrian accidents are the entrance to the roadway approaching the motor vehicle from the sidewalk and miscalculation when passing communication.

## 1 Introduction

Road safety is still a highly debated issue in all countries with a developed automobile transportation. Risk are the group of participants, with a team that drivers and passengers in motor vehicles are more or less protected by the vehicle itself, cyclists and motorcyclists are partially protected for example, helmet. But pedestrians are not protected at all. Thus pedestrian is the most vulnerable road users.

On the road in Europe die each year more than 8,000 pedestrians, of which every fourth accident happens at a pedestrian crossing over a road [1].

In Slovakia, die each year from an average of 200 pedestrians. The most frequent causes of pedestrian accidents are the entrance to the roadway approaching the motor vehicle from the sidewalk and miscalculation when passing communication.

Recently in the media withstand criticism on the quality of horizontal road signs (VDZ) on pedestrian crossings. Especially in winter they are very slippery, possibly they are so worn that they are almost not visible on the road [2].

## 2 Requirements for road markings

Materials for road marking are in accordance with the Act no. 133/2013 Z.z. construction products. On the Slovak market may be mentioned only product that meets the requirements of this Act and the relevant standards, namely:

- STN EN 1436 + A1: Materials for road marking of roads,
- STN 01 8020: Traffic signs on the road.

Before placing a product on the market, the manufacturer must ensure that the assessment of functional parameters. The evaluation and verification features VDZ and the materials used in their manufacture is carried out in test laboratories and test section according to EN 1824: Materials for road marking of roads [3], [4].

Road signs produced on the highway by the test material is measured and evaluated local color, VDZ reflection in daylight and / or the path and retroreflectivity. These parameters are measured the new road marking and road marking after test on the test section according to EN 1824 [3], [4].

Samples of various types of material are applied to the test section in the dosage indicated by the manufacturer or importer. The dosage was given for materials for the production of road marking materials and for the additional gritting. The test section in accordance with DIN EN 1436 + A1 and EN 1824, the following functional parameters measured by the CGI made from the material:

- Coefficient of retro-reflection $R_L$ dry or wet;
- Luminance factor in diffuse light Qd;
- Color: $\beta$ coefficient luminance and the chromaticity coordinates *x*, *y*;
- Slip resistant - the value of SRT;
- Removability (only removable - ready-made materials);
- Index wear.

Materials intended for road markings have all the time trials (one year) meet the requirements of the standard STN EN 1436 + A1 and STN 01 8020 / Z2.

Currently, the production of longitudinal road signs most commonly used include the following materials:

- Material which is applied in liquid form, such as the color or the color of synthetic water-soluble;
- Thermoplastic materials, i. j. material blocks, granules or powder which are heated up to melt the hot-melt and be surface travel;
- Cold setting materials (cold plastic), that is Two-component materials in liquid, pasty or solid form,

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which are applied to the road surface after mixing the components in the prescribed ratio;
- Ready-made material applied to the road surface by means of heat, pressure, adhesive, or other means.

For road signs additional scattering is used glass beads, antiskid aggregates or a mixture of glass beads and anti-slip additives. Initial type testing of glass beads and anti-skid additives used the production of road marking are in terms of technical specification STN EN 1423 [1], [4].

Granularity (particle) glass beads and anti-skid additive is reported as the rest of the detainee% test sieves of metal wire cloth ISO 2591-1 [1].

This test assesses the specal categories glass beads applied to improving the properties thereof. The resistance to water is assessed in accordance with Annex E, flotation coating of Annex F in EN 1423. Bonding and any other coatings for glass beads are tested by test method agreed between contractors and building authority [1], [4].

Additional gritting VDZ must be tested together with the material to which they will be in the production of road marking apply [1], [4].

Road signs produced on the highway by the test material is measured dimensions and geometric accuracy, which must meet the requirements of Art. 5.2, 5.3 and normative Annex C; STN 01 8020 [1].

The visual appearance is evaluated VDZ a distance of 1.5 mA determine if they are exactly VDZ enclosed and has a monolithic surface without bubbles and cracks and seamlessly peeling. In the production of the VDZ It establishes the thickness of wet and dry deposition under Art. 6.2.6 in STN 01 8020 [1].

It should be stressed that SK - certificate of conformity is only material and not made horizontal traffic sign. The quality of the material for road markings and the manufacturer is responsible for the quality produced horizontal road signs contractor responsible brand [1], [4].

*Figure 1 street Tvrdého*

*Figure 2 street Orolská*

*Figure 3 street Veľká okružná*

Factory production control is permanent internal control of production by the manufacturers, which ensures that the production of materials for the production of CGI was in compliance with the Act. 133/2013 Z.z. and technical specifications. Monitoring compliance and effectiveness of factory production control system applicable producer performed by an authorized person as initial inspection and continuous surveillance. requirements the FPC system is in § 12 of Act no. 133/2013 Z.z. [1], [4].

The purpose of the initial inspection is to establish whether the manufacturer is creating an effective internal control and they are created by organizational and technical preconditions for sustainable maintenance of quality of production material for the production of road marking. Within the framework of assessing is the initial inspection and factory production control, relating to the production of material for the production of road marking. Result initial inspection and assessment of the effectiveness of factory production control shall include in a written report, which it shall also indicate whether the application of internal control is trustworthy and whether it is consistent with the Act. 133/2013 Z.z. and the technical specifications. Initial inspection is generally performed at the start of manufacture of construction products [2], [3].

For ongoing inspections is to monitor whether the application of internal control of the manufacturer, during production of material for the production of road marking in accordance with the Act. 133/2013 Z.z. and the technical specifications and that the manufacturer has complied with the measures imposed by the authorized person during the initial inspection or during previous interim inspections. Running inspections are carried out on the basis of a written report of the initial inspection deadlines as planned continuous surveillance by an approved person. Between two continuous surveillance shall not be more than 12 months. Running inspections are performed outside the plan: - Upon notification of a change in the manufacturer's production, - Based on the shortcomings identified in the activities of continuous surveillance of factory production control or control by market surveillance authorities in the quality of the material for the production of road marking [2], [3].

The contents of each interim inspection shall be stated in a written report. If during the interim inspection that uses a system of factory production control is not consistent with the Act. 133/2013 Z.z. and the technical specifications and deficiencies can not be removed on place the authorized person shall request the producer to them within the specified time limit. After a specified period conduct further continuous surveillance, primarily aimed at controlling removal shortcomings. If during the interim inspection that the manufacturer fails to correct irregularities, authorized person initiates proceedings for revocation of the certificate of conformity and notified body of state control of the internal market, the declaration of conformity by the manufacturer is in breach of a designated technical specification. The manufacturer is obliged to immediately inform the authorized person of any changes in production technology material used for the production of road marking or in the raw materials and intermediate products, which may affect the properties or quality of the material for the production of road marking [2], [3].

## 3 The quality of markings depends on many factors:

Type of paint. The most commonly used synthetic and water based paints. The disadvantage of these materials is their short lifetime, ie period in which to meet the required performance parameters according to EN 1436 + A1 and STN 01 8020 / Z2. The passages are subject to the double wear. One is the wear that occurs the passing vehicles and the wear caused by the pedestrians themselves.

The roughness is ensured in the first place to the additional scattering material (glass beads, glass beads, and the mixture additives), although higher roughness of the marking are obtained by using materials with a certain extra scattering portion roughen ingredients. Another factor influencing this parameter is the roughness of the substrate - the road.

This fact is especially important in restoring signs of color when the horizontal road sign applied to existing data center marking layer that reaches the surface roughness of communication. Especially at road crossings cover a relatively wide area VDZ, where especially in bad weather (rain, snow and frost) is created for pedestrian's risk of slipping and injury.

Most synthetic substances used for CGI has a low slip properties. On SK - certificates indicated that they cannot use the materials themselves, but only with additional sanding - glass beads or anti-skid aggregates. In practice, this figure is not respected and in order to save the cost of marking is used without an additional coating material spreading.

Application of climatic conditions (air temperature, substrate temperature, relative humidity, etc.). Producers in their data sheets report the optimum application conditions to be met. The surface must be dry, clean and free of oil. Track temperature must be above the dew point.

Method of application. Machinery systems have different application materials to the additional scattering. Both in terms of kinetic energy and the adjustment of dosing of consumables. Simple machinery to adjust the amount of material per unit area of only approx. The amount depends on the working speed of the machine, the additional scattering material is added is integrated and free-of paint only to the force of gravity.

For use, the currently used devices that meet the highest requirements - automatically adjusting the amount of paint, the amount of glass beads, and the pressure adjustment in which the glass beads applied to the label. The type of glass beads. The level of retroreflectivity is substantially affected by the incorporation of sufficient material to glass beads.

Effect of a type used glass beads, material properties and technology applications. When applying glass beads it can be built into the material either only through its gravitational energy or kinetic energy for interaction.

It has a great influence and size of individual beads of glass beads. Smaller balls are in a 'sunk', while larger diameter balls will be mounted only a small part of its surface, which will result in their crumbling and subsequent loss of retroreflective road marking and roughness.

The quality of the road surface and its maintenance. The quality of markings affects road roughness, depth textures, potholes, cracks, a sign of old balances. Maintenance of way - the type and quantity of spreading material, maintenance roads snow plows, conditions of application, etc.

Traffic volume. The traffic is intense, the more wear occurs VDZ. It has a great influence traffic intensity especially trucks [2], [3].

*Figure 4 street Milcová*

*Figure 5 street Tvrdého*

## 4 Conclusions

Functional requirements of pedestrian crossings shortly after application conform to STN 01 8020. Their quality with time is rapidly declining in case of paints. Already after a month and a half since applications road markings do not meet parameters - slip resistance and retroreflectivity.

When deciding what kind of material on road markings used for the application of pedestrian crossings principals have several options. The purchase price is in most cases a decisive parameter, but it is important to take into consideration other parameters such as material quality, durability, price maintenance, usability and disposal. These parameters may be incurred in the future to reduce costs.

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