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THE SIMULATION OF ACCIDENTAL IMPACT WITH STONES FROM ROAD TRAFFIC IN CASE OF NOISE BARRIERS MADE OF DIFFERENT MATERIALS

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ABSTRACT
In this paper are presented the results of dynamical behaviour of panels from structure of sound barriers. The simulation of an accidental impacts with stones from road traffic was performed. The material of panel in terms of physical and mechanical properties was varied. The FEM analysis revealed the variation of displacements, the strain energy and the stresses Von Mises from each type of panel.
Keywords: impact, finite elements method, soundproofing, panel

1. INTRODUCTION
The sources of noise are numerous and complex: from industrial areas where noise is produced by various type of machinery (fan, stem pressure, drilling machine, stamping, road breaking), characterized by high or low frequencies; from transportation noise in terms of road traffic noise with remark that the main sources are the engine and the frictional contact between tires and road bed or contact between vehicle and air; from rail traffic where the most important sources of noise are generated on shunting operations or in station; from air traffic noise produced by turbo fan engine on get off and landing; from sonic booms which are developed in air due to the supersonic flight of aircraft and another type of noise sources is from construction, public works (such as garbage disposal, street cleaning) and military noise (from heavy vehicle and from small or large fire arms). Other unpleasant sounds are generated inside or outside the buildings by ventilation and air conditioning plants, heat pumps, elevators, domestic noise, or noise from leisure activities (motor-racing, motorboats and water skiing, discotheques and rock concerts) (2). All these have a significant impact on human health, especially in the urban area. In this sense, the sound barriers play an important role in reduction of traffic noise. The structure of acoustic panels must fulfill both sound insulation and resistance role.
The purpose of the paper is to emphasize the structural behavior of the panels under the action of accidental impact with a stone coming from road traffic.

2. LITERATURE REVIEW
Numerous studies approach the efficiency of different configuration, materials and shapes of noise barrier [1, 2, 3]. Some aspects about dimensions and geometry of sound barriers are standardized in EN 1793-3 [8]. Ishizuka & Fugiwara studied the performance of noise barrier with various edge shapes (T shape, branched barriers, double cylindrical barrier and barrier with side panels), shown that absorbing and soft edges improve significantly the efficiency of the panels comparison with configuration modifications (distance between the barrier and source lane and position of receiver, height and distance from the barrier, the topography and acoustic properties of the ground, the

presence of other obstacles, the atmospheric conditions) [4]. Peyrard investigated the combination between type of asphalt (porous or dense) and sound barriers with 2m high and he noticed that the maximum benefit were obtained in case of porous asphalt and barrier – the maximum sound pressure level L_{Amax} (dB)A decreased with 12.4 dB (A) [5]. The acoustical properties of materials have been studied by many researchers, but each approach differs by the objectives of analyses, the method, types of tested structures or the features of materials. This study bring into focus the evaluation of dynamical behaviour of sound panel to impact stresses by means finite element method (FEM) [6,7].

3. NUMERICAL MODEL OF SOUND BARRIER

The constructive elements of soundproofing devices are: the structural elements – with support and resistance role and the acoustic elements –for reduction of traffic noise. The pillars have I profile which assure a proper jointing with acoustic panel. The panels are characterized by rectangular shape and plane faces. Were analyzed three different types of structures in terms of Young's Modulus and density (Table 1).

The structure was modeled with Nastran program, being meshed into hexahedrons finite elements, and the lower part of structure made from beams and panels was rigid fixed in order to simulate the real boundary conditions (Fig. 1).

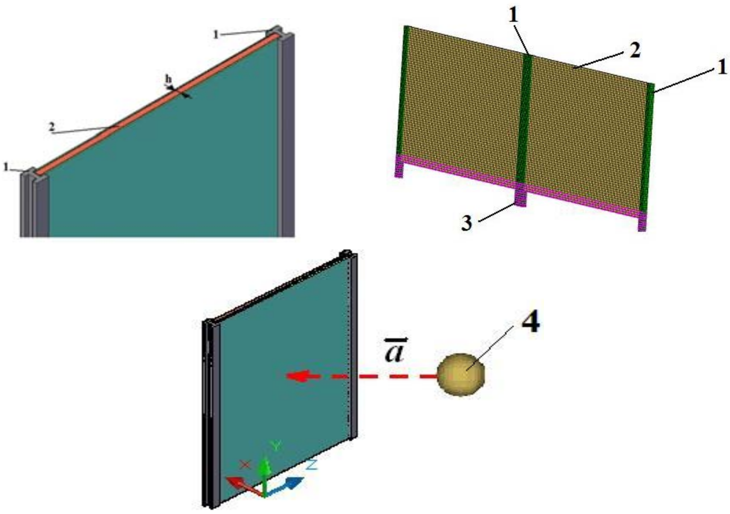


Figure 1. The geometrical model of sound barrier (1- pillar, 2 – panel, 3 – foundation, 4 – the stone)

To simulate the accidental impact, some hypotheses were considered. Thus, the direction of stone trajectory is perpendicular to the outer surface of the panel. The stone with 30 mm diameter was considered as infinitely rigid (non-deformable). The stone speed was adopted as equal to 30 km/h and the movement starts at 300 mm distance from the panel, with an initial speed at the start of analysis. The stone hit in the center of panel. The duration of impact analysis for capturing the phenomenon is considered equal to 0.5 seconds.

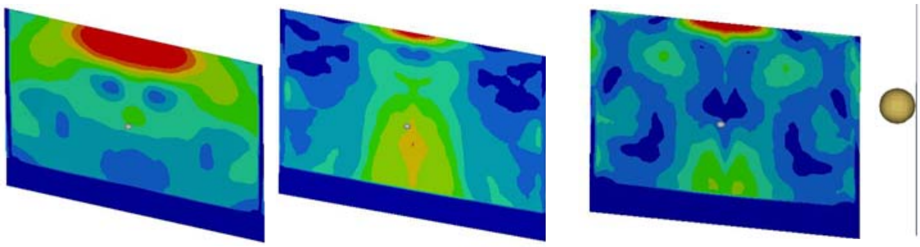
In Table 1 are displayed the input date used in preprocessing step. Overall the structure with geometry as Figure 1 was designed, with dimensions scale 1:1 (length L = 3m, H = 2 m high).

Table 1.The properties used in preprocessing step

Characteristics	*Structure 1 (S1)*	*Structure 2 (S2)*	*Structure 3 (S3)*
Young's Modulus [MPa]	14000	70000	140000
Density [Kg/m^3]	500	1000	1500
Poisson's Coefficient	0.3	0.3	0.3
Wind Pressure [N/m^2]	1000	1000	1000
Dynamic pressure of air	650	650	650

4. RESULTS AND DISCUSSION

The distribution of stresses field in the each panel structure are presented in Figure 2. Based on the result of impact analysis, it can be seen that the overall effect recorded by panels in terms of stress is within admissible limits, the values of stresses being quite small compared with the yield stress of the material.



S1 S2 S3

Figure 2. The distribution of stress due to the impact, for each type of panel

In Figure 3, are presented the displacement variations of panel in the impact area with stone. It can be noticed that the global displacements recorded in the panel are small (about 7 mm) and can not be considered dangerous related to the global dimensions of the panel.

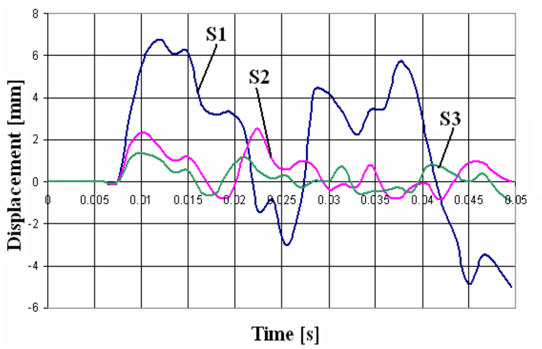


Figure 3. The Displacement variation of panels in the impact area during of 0.05s time period

From Figure 4 it can be noticed that the vibration frequency due to dynamical impact increase with stiffness of panels. This dynamic response influences the efficiency of panels to absorb the strain energy.

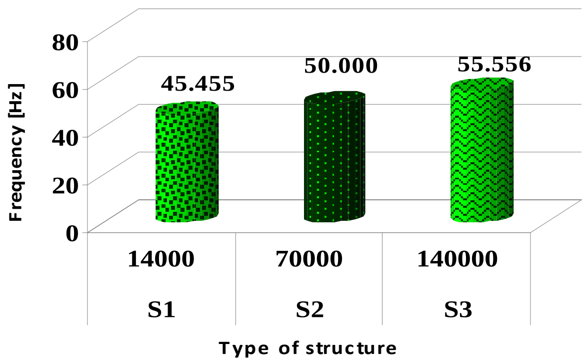


Figure 4. The frequency response of the structures

The features of materials used in sound barriers structures plays an important role in quality of acoustic insulations and in structural behavior of them. So, the higher elasticity modulus of the material is, the smaller is the internal strain energy. This aspect can be noticed in variation of strain energy presented in Figure 5.

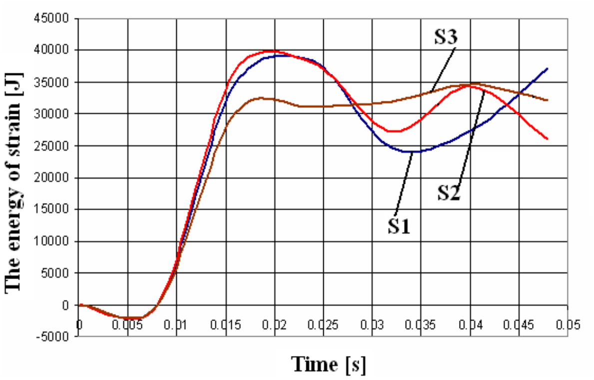


Figure 5. The energy variation of the deformation of the panel

4. CONCLUSIONS

Sound barrier structures are subjected to cumulative action of several forces (static, dynamic, aggressive environmental factors). In the paper were presented results of modeling the dynamic behavior of the panels to impact with a stone. It noticed that 10 times increase in stiffness of panels leads to storage of strain energy with 5 kJ.

They showed that the impact effects are reduced, but in reality the several factors act simultaneously on these types of structures, which involve either complex modeling or the use of safety factor in design and building structures.

5. ACKNOWLEDGMENTS

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