NUMERICAL SIMULATION OF THE BEHAVIOUR OF THE SAFETY BARRIERS AND EXPERIMENTAL VALIDATION

Petru Dumitrache 1),

1) “Dunărea de Jos” University Galați, Engineering Faculty Brăila
Calea Călărașilor 29, 810017 Brăila, Romania
Corresponding author: dumitrache.petru@gmail.com

1. Preliminary

Moreover, referring strictly to the mechanical structures, at present, the current FEA software platforms allow numerical simulation of the behaviour of structures under various dynamic actions. Thus were created the foundations for achieving virtual experiments, the main advantage being that of the considerable reduction in costs related to manufacturing and testing of experimental prototypes.

However, in order that a numerical simulation to have acceptable prediction value for real system behaviour, it is necessary to validate the assumptions used in modelling. If after validation is concluded that the simulation gives results with acceptable level of concordance with reality, it can be applied to all similar problems.

Experimental study of road safety barriers is prohibitive in terms of material costs and the simulation of behaviour for such systems is a viable alternative.

Below are given some key issues which were considered in numerical simulation of the behaviour of road safety barriers and experimental validation of hypotheses made.

2. Numerical simulation and experimental validation

Experimental evaluation of road safety barriers is regulated by the standard EN 1317. Under this standard, experimental evaluation of safety barriers is made on the basis an acceptance test that is chosen depending on to capacity and level of containment imposed.

Our numerical simulation has take in account TB11 acceptance test. This test is performed in accordance with the principle diagram shown in Figure 1.

In accordance with TB11 acceptance test, \( v = 100 \text{ km/h} \), \( \alpha = 20^\circ \), \( m = 900 \text{ kg} \). Distance between supports was considered \( l = 3 \text{ m} \).

The goal of the numerical simulation was the behaviour of the road safety system in worse case operating conditions. Therefore, we had taken into account following hypotheses:

- The impact is produced to the middle of the road safety barrier (with W shape in cross-section).
- The entire impact energy is absorbing by road safety barrier (impact body is considered perfectly rigid).

Since in real impact, the fraction of the impact energy which is dissipated by friction between the barrier and the vehicle is insignificant compared with the total energy of the impact, numerical simulation has consideread a frontal impact between a barrier and an impact body with regulated mass, but with correspondingly reduced speed (see Figure 1).

The FE model associate to acceptance test described above was performed in accordance with the following assumptions:

- The used material model for safety system was steel with isotropic hardening.
- Analysis type: large displacements.
- Convergence criteria: displacement only.
- Duration of the simulation: 0.24 sec.
- Number of time steps: 80 (corresponding to 0.003 sec. capture rate).
In accordance to the above mentioned hypotheses, for impact body was used 3D-kinematic finite elements. Also, for the impact body was used a simplified geometry, which only follow impact region. Consequently, for the material assigned to impact body was declared the proper mass density in order to achieve the regulated mass.

In order to focus the simulation over the phenomena that occur during impact and after, it was imposed that the contact between impact body and barrier to occurs after 0.006 seconds, which corresponds to only two time steps of 80 totals.

Movement of the impact is made in gravitational field (on Y axis). In order to achieve the speed at impact in 0.006 seconds, for the impact body was declared the appropriate initial velocity.

Briefly, after running the simulation were obtained the following results:
- The impact time is nearly 0.075 sec.
- The maximum von Mises stress in middle area of safety barrier (see time history, Figure 2) is \( \sigma_{\text{vonMises max}} \approx 270 \, N/mm^2 \) in moment when is produced end of impact. This value for maximum von Mises stress suggests that the safety barrier has necessary strength capacity.

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\sigma_{\text{vonMises max}} \approx 270 \, N/mm^2
\]

\[d_{\text{sim max}} = \pm 304 \pm 4 = 308 \, mm\] (see Figure 3).

Experimental validation of simulation was done by comparing of the maximum residual displacement in barrier obtained by simulation, with the similar displacement obtained by TB11 acceptance test. In Figure 4 is shown the testing plant before the impact and in Figure 5 is shown residual the displacement which is obtained: \(d_{\text{exp max}} \approx 316 \, mm\).

\[d_{\text{exp max}} \approx 316 \, mm\]

![Fig. 4: Testing plant before impact in TB11 acceptance test](image)

![Fig. 5: Testing plant before impact in TB11 acceptance test](image)

Note that the displacement value obtained by numerical simulation differs by only 2.5% compared to similar displacement value obtained by experimental test.

3. Remarks

The obtained numerical results are confirmed by experimental study. Good concordance of numerical results with reality validates the numerical simulation of the behaviour of safety barriers which are subject of shock loadings.

4. Acknowledgements

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5. References