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EXPERIMENTAL ANALYSIS OF ELASTIC-PLASTIC FREE VIBRATIONS OF PLATE MODELS CAUSED BY IMPACT

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ABSTRACT

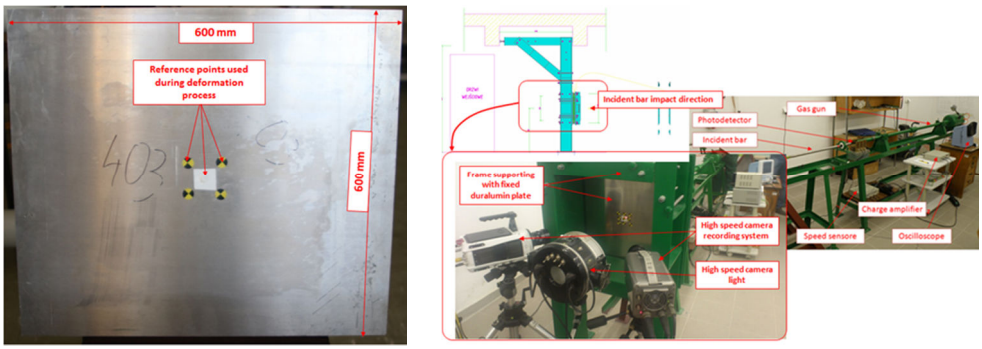
The experimental analysis presents elastic-plastic vibration behaviours of duralumin square plate models of with various boundary supports and their thicknesses, under impact force loaded at the middle for slabs. The applied impact loading on models of slabs was obtained from tests carried out on the Hopkinson measuring bar. The strain gages readings during the impact were recorded and used to determine the impact time-force curve. The experimental setup was equipped with two high speed cameras and one laser vibrometer during physical experiments. Next, transverse displacements, velocities and accelerations of some surface points of slabs after impact were obtained by the software of these cameras and vibrometer. Recorded images played back in slow-motion show clearly both the vibration of tested slabs. The main experimental results of presented experiments with striker velocity consist of following curves that describe for the impact location: the impact force, transverse displacements, velocities and accelerations of some surface points of tested model of square slab, and comparison of transverse velocities of surface points of tested model of slabs, as well as permanently deformed above models of slabs after experiments. The dynamic experiments show that the plastic deformation in models of slabs, adjacent to the impact location, is due to dominant bending modes. Most of the plastic deformation is confined to the impact zone of tested models of slabs. The plastic strain magnitude and distribution near the impact zone is similar for all tested impact locations. The conversion of impact energy into kinetic, elastic strain energy and plastic dissipation work is characterized for various boundary conditions of models.

Keywords: free vibrations, square plate models, Hopkinson bar, elastic-plastic material.

EXPERIMENTS AND RESULTS DESCRIPTIONS

The results of experimental studies for elastic-plastic free vibrations of duralumin plate models are presented here. The tested plate models were made of duralumin type EN AW-6063. One of several plate models used during the physical experiments is presented in Fig. 1.a). Square plate models of 600 mm x 600 mm were supported in two boundary configurations, i.e. freely supported and full fixed boundary conditions. First support on the perimeter of plate model was free on external edges and the second one: all edges were full fixed. Plate models were of three thicknesses: 5 mm, 10 mm and 20 mm. Laboratory experiments were performed with the use of Hopkinson measuring bar to dynamic loading of tested plates as well as to register dynamic force for free vibrations, as important element of

an experimental set-up [1] - see Fig. 1.b) as important element of an experimental set-up used also in previous experiments for testing of free vibrations of beam model (Jemielita el al., 2016). The experimental set-up has following four measuring systems. First, optic gate was used to measure the striker bar impact velocity. Second, incident bar has impact force gauge measuring system. And finally third and fourth, deflections of plate were measured using two high speed cameras and laser vibrometer.



(a) (b)

Fig. 1 - Duralumin plate model of 20 mm in thickness, used in laboratory experiment No 403 (a); Hopkinson measuring bar (b)

RESULTS AND CONCLUSIONS

Some examples of experimental results for determining dynamic forces causing elastic-plastic free vibrations of duralumin plate models, obtained from Hopkinson measuring bar are presented in Fig. 2.

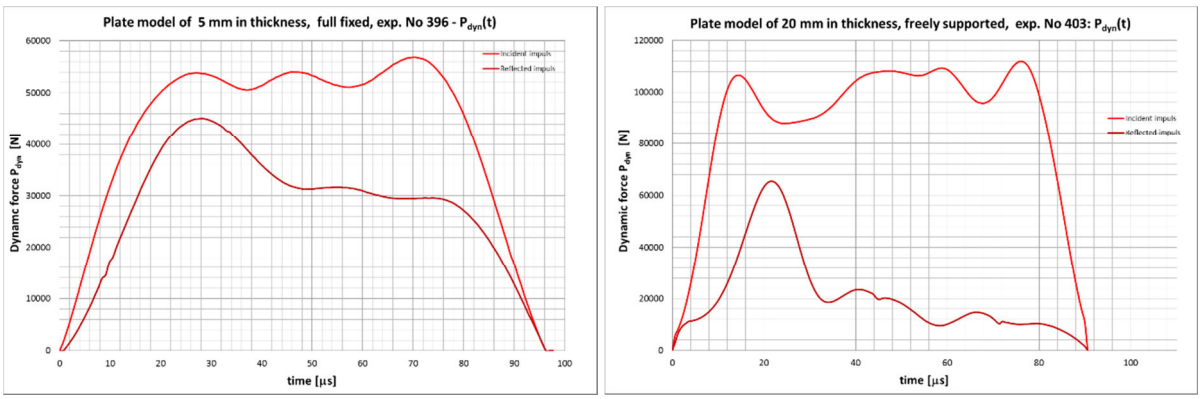


Fig. 2 - Time history of dynamic forces for two examples of tested plate models.

Due to limited volume of the abstract, more results of elastic-plastic vibration behaviours of tested plate models of with various boundary supports and their thicknesses will be presented in details during M2D2017.

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