POLISH ACADEMY OF SCIENCES - COMMITTEE OF MATERIALS SCIENCE
SILESIAN UNIVERSITY OF TECHNOLOGY OF GLIWICE
INSTITUTE OF ENGINEERING MATERIALS AND BIOMATERIALS
ASSOCIATION OF ALUMNI OF SILESIAN UNIVERSITY OF TECHNOLOGY

Conference Proceedings

12th INTERNATIONAL SCIENTIFIC CONFERENCE
ACHIEVEMENTS IN MECHANICAL & MATERIALS ENGINEERING

Computer aided measuring system of „Crash-Test" experiments

J. Gronostajski, P. Wiewiórski

Wrocław University of Technology, Lukasiewicza str. 3/5, 50371 Wrocław, Poland

In the paper the elaborated computer aided measuring system of „Crash-Test" experiments and its application in the few cases of dynamic compression of different geometry elements were presented.

1. INTRODUCTION

For a few years in the Engineering Forming Department of the Wroclaw University of Technology the scientific investigations of phenomena taking place during dynamic loading of samples in the „Crash-Test" experiments have been performed. The main aim of the works is the examination of energy absorption by elements of different profile and construction fulfilled by plastics foam of different density. It has been found that the energy absorption is dependent on the geometry of elements and plastics foam density. The round tube elements [1], which until now are very rally used in the car body construction, in the future, because their properties can be drastically changed by plastics foam filling [2], such elements amount could be applied for better safety of car body compartment.

The main aim of the paper is to present the elaborated computer aided measuring system of „Crash-Test" experiments and to show its application in the few cases of dynamic compression of different geometry elements.

2. COMPUTER AIDED SYSTEM

The elaborated computer aided measuring system of „Crash-Test" experiments was applied to investigate the compression tests realized by drop hammer. As a sensor the prototype system basing on the laser transmitter of red light with special detector and electronic assembly was used. The system is alternative against more expensive acceleration sensor. The advantages of the elaborated system are simple service and possibility of very high acceleration recording thanks to non-contact measurement.

As a results of early experiments connected with construction of the stand for compression of samples in „Crash-Test" experiments the three independent measuring systems were applied. That are: rate generator, piezoelectric sensor produced by PCB and computer aided measuring system composed of two laser transmitters with wave length of 630 nm (red beam), optical matrix with gaps and striates put on alternately and measuring device for recording the laser signals. The computer aided measuring system is the results of the teamwork engaged in described investigation.

The investigation stand is shown in Fig. 1. It contains:

- Automated drop hammer with ram weight from 58.5 to 206 kg according to the amount of bobs.
- Computerized data acquisition system with adequate sensors and devices for signals recording during sample deformation.
- Software for presentation of the test results.

Computer program was created for data handling coming from measuring devices. The completed system is very useful for service of experiment, because just after the test all results can be visualized. The Drop Hammer Program (DHP) can be used also for dynamic parameter of drop hammer during sample deformation determination. It was written in C language. It advantages are very high speed of data handling and simple service. The program gives possibility to determine all needed factors for analysis of dynamic compression test with application of drop hammer.

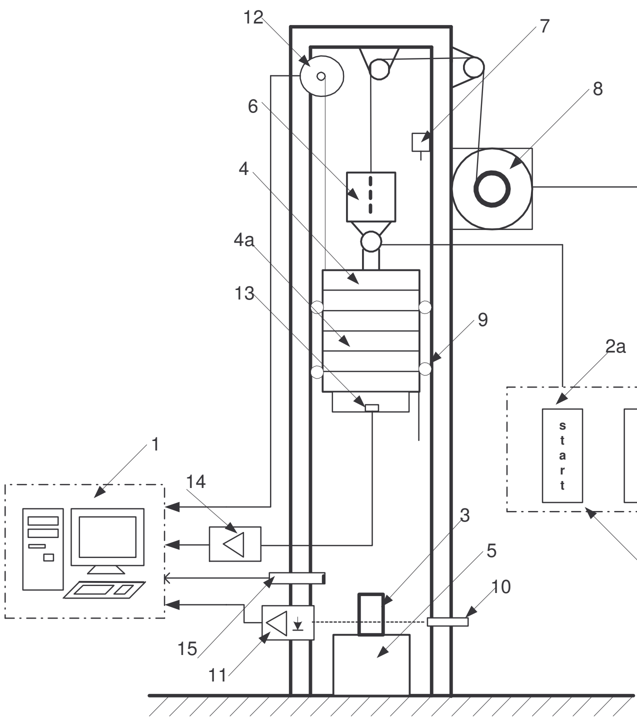

Figure 1. Investigation stan scheme: 1–data acquisition system, 2–hand control of ram displacement, 2a–ram release, 2b–ram position setting, 3–sample, 4–ram, 4a–hammer bobs, 5–anvil, 6–electromagnet, 7–limit switch, 8–electric motor, 9–rolling bearing, 10–laser transmitter, 11–exalted receiver, 12–rate generator piezoelectric sensor, 14–piezoelectric sensor amplifier, 15–distance sensor release

The ram was drop from the high of 1.95 m, that is the distance between working surface of ram (4) and upper surface of samples. The samples (3) of 200 mm high were located on the anvil perpendicular to anvil surface. The ram (4) was raised by driven system (8) until to contact with limit switch (7). By using hand ram release (2) the electromagnet (6) was switch on and the ram-holder jaws were opened. At that moment the ram starts to fall. To diminish the friction force between guide poles (9) and rolling bearing that could decreases the ram velocity the guide poles were lubricant coated. At the proper high the distance sensor release

(15) was fixed and when the ram drops to near distance sensor the signal was sent to data acquisition system and rate generator (12), piezoelectric accelerator sensor PCB (13, 14) and optical detector (10, 11) were recorded the signals. The deformation of the samples proceeded very quickly. Therefore the requirements for sensor and measuring system were very sharp.

The above described system was used for investigation of behavior of round tube specimens with single and double walls fulfilled by plastics foam of different density.

By comparison of behavior and energy absorption of each sample the usability of different geometry and technology solution of the real elements in car body construction was determined.

3. EXPERIMENTS AND RESULTS

The effect of plastics foam density in single wall tube on the dissipation of kinetic energy with deformation time is shown in Fig. 2 and with deformation displacement in Fig. 3. From Fig. 2 it can be seen that the time f energy dissipation decrease with plastics foam density. The course of energy dissipation as a function of time of empty tube specimens (R01) shown in Fig. 2 is similar to those tubes fulfilled by plastics foam. For the tube specimens with plastics foam density lower than about 100 kg/m^3 kinetic energy - deformation time relationship is nearly linear and with decrease of density these relationship become concave. In the case of empty tube specimens the time of full dissipation of kinetic energy is about 30 times longer than for specimens with highest applied foam density equal to about 240 kg/m^3.

The relationship between kinetic energy dissipation and deformation displacement of samples for all applied plastics foam density is nearly linear (Fig. 3). The differences between displacement of empty tube specimens and those with highest used foam density is not so large as in the case of kinetic energy-time relationship and is less than two times shorter.

The appearance of tube specimens before and after deformation shows that the most regular deformation of specimens, it means the regular folds creation along axis of tube specimens, takes place when plastics foam density is over 80 kg/m^3. Therefore it can be concluded that from the point of view of most uniform energy dissipation such tube specimens should be the best. The application of tube specimens with double walls decreases the time of energy dissipation.

4. CONCLUSIONS

The intensity of energy dissipation increases with increase of plastics foam density [3]. Unreasonable increase of plastics foam density causes decrease of plastic displacement of thespecimens and simultaneous significant increase of acceleration, that is bad solution from the point of view of safety of car passengers because of the active forces increase. Therefore the future investigations should be performed to find such density and kind of foam to obtain at low ram acceleration the lowest possible deformation of specimens [4].

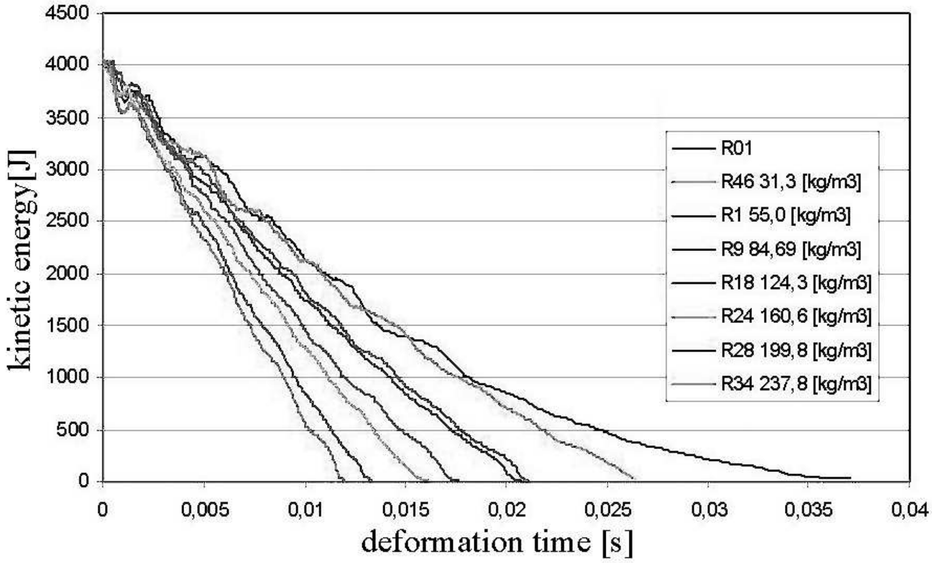

Figure 2. Relationship between kinetic energy and deformation time of round tube specimens with single wall. The symbols of the specimens contain the specimen's number and density of plastics foam.

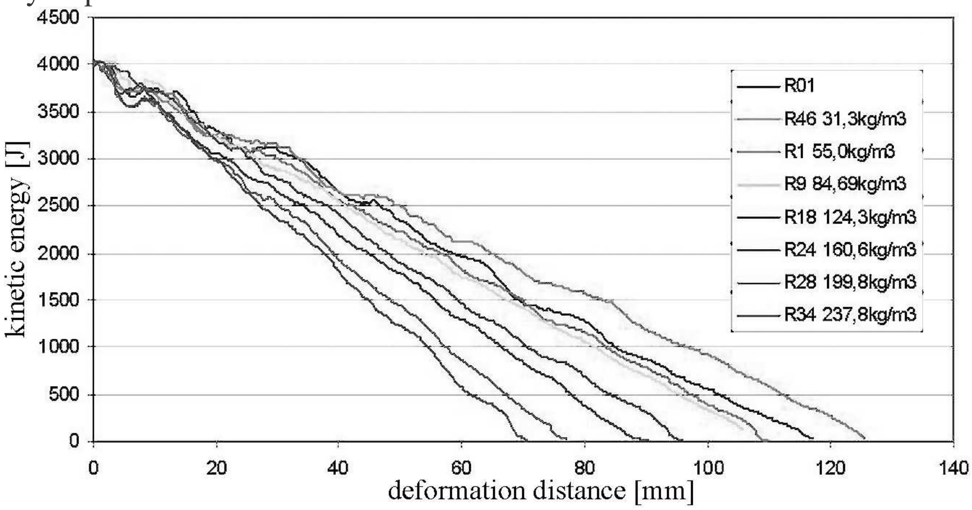

Figure 3. Relationship between kinetic energy and deformation distance of round tube specimens with single wall

The described system has developmental character. In the near future by using described system and FEM simulation it would be possible to elaborate the "intelligent" elements for strengthened the car body and to assure the better safety of car passengers.

REFERENCES

1. W. Abramowicz, N. Jones, Int. J. .Impact Eng. No. 2 (1984) 179
2. T. Wierzbicki, W. Abramowicz, J. .Applied Mech. 50 (1983) 72
3. M. Avalle, G. Belingardi, R. Montanini, Int. J. Impact Eng. 25 (2001) 455
4. H.W. Song, Z.M. Wan, Z.M. Xie, X.W. Du, Int. J. Impact Eng. 24 (2000) 385