

LATERAL COLLAPSE OF EMPTY AND FILLED SQUARE TUBES

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CERTIFICATE

This is to certify that the thesis entitled "LATERAL COLLAPSE OF EMPTY AND FILLED SQUARE TUBES" by shri Purnendu Ray has been prepared under my supervision and has attained a standard required for a Ph.D. degree of the Institute. The thesis is a record of bonafide research work carried out by him and its contents have not been submitted to any other University or Institute for the award of any degree or diploma.



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ABSTRACT

Collision involving vehicles (automobile, aircraft, ships, railway coaches etc.), particularly those moving with high speeds, are among the major causes of damage to life and property. Public in general is becoming increasingly conscious of the losses involved and misery caused and therefore more and more attention is being paid by the researchers and designers to study the phenomena. The control of the rapid and uncontrolled dissipation of the kinetic energy produced during collision is the primary concern for mitigating the humane suffering and damage to costly equipment and structure. This problem may be overcome by providing energy absorbing devices to absorb a substantial part of the kinetic energy in a controlled manner and by making the vehicle structurally crashworthy.

It has been observed that, thin walled metallic tubular structures exhibit good capability of energy dissipation while undergoing large plastic deformations in different modes like bending, in-plane stretching and twisting. Local instability at different stages of collapse, strain hardening, and strain rate sensitivity of the material employed need to be considered while studying the collapse behaviour of the structures.

For proper utilisation of thin-walled metal tubes as energy absorbers, the study of their behaviour under quasi static as well as impact loading is very essential. This study is also important in the context of the crash worthy designs of vehicles because the structural behaviour of most of the vehicles can be idealized to that of thin walled metal tubes. Several studies have in the recent past appeared in literature which deal with both axial and lateral collapse of round and square tubes.

The present work deals with the behaviour of empty and infilled aluminium square tubes of different sizes under lateral quasi-static and impact loading. Depending on the manner of load application and tube supporting arrangement, the experiments presented here are divided into three categories

- 1) Empty and infilled single tubes being compressed between two overhanging rigid platens.
- 2) Tubes compressed between a platen and an orthogonally placed short width indenter as well as tube compressed symmetrically between two orthogonally placed short width indenters.
- 3) Empty and infilled square tubes loaded laterally in three point beam bending.

Collapse and post collapse responses of the tubes, both empty and infilled with rigid polyurethane foam and wood (Indian Kail), when compressed in their as received and annealed states, were investigated. Static tests were carried out in an INSTRON machine

and the impact tests were done in a DROP-HAMMER set up.

Load compression graphs were obtained on INSTRON chart recorder. Load-time and acceleration-time signals records in the impact tests were obtained by employing quartz load-washer, accelerometer and other necessary instrumentation. Deformation history of the specimens in a quasi-static test was recorded by using a number of specimens and compressing them upto different stages.

Analysis based on the formation of both stationary and rolling plastic hinges has been presented for different cases of tube compression mentioned above.

Results obtained for both peak and post collapse load-compression curve have been presented in each case and compared with the experiments. Influence of various parameters have been considered. Effects of filling of polyurethane foam and wood on both the mode of deformation and load compression curves have been discussed.

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