Quasi Static Energy Absorption Capacity of Polymer Filled Aluminium Tubes

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Abstract- *Impact energy safeguards are superfluous mechanical auxiliary components, which are brought enthusiastically to scatter the dynamic energy in case of an undesirable crash. These go about as mechanical breakers to constrain the heaps, which may follow up on the fundamental structure quickly after a crash. The utilization of aluminum tubes and tubular structures for use as effect energy safeguards in various designing applications is empowering. This is a result of their prepared accessibility in various cross segments and sizes, and furthermore has high energy retention limit under semi static and dynamic burdens.*

In this present review, trials are led on round aluminum tubes under semi static, hub pressure. The diverse methods of disfigurement of these tubes are analyzed in two separate cases. Case 1: when the tubes packed pivotally between a level platen and formed kicks the bucket of various radii. Case 2: when the tubes packed pivotally between two level platens. Passes on of various radii are utilized to assess the proficient method of distortion.

The energy retention limit under semi static stacking conditions is assessed in the above cases to assess the energy ingestion limit and to look at the energy assimilation of aluminum tubes in view of the distinctive distortion modes. The aftereffects of the review are helpful in the plan of effect energy safeguards.

Keywords- Energy safeguards, Aluminium tubes, quasi-static, load-displacement curves.

I. INTRODUCTION

The significant test in the outline of effect energy safeguards (IEA) is to set up the connection between the predetermined compel level to the geometric and material properties of the effect energy safeguard.

The choice of a suitable energy safeguard depends especially on its application and the coveted reaction upon effect. Along these lines, for an IEA to perform adequately it ought to have the accompanying qualities:

- Undergo huge plastic deformation at controlled rates.
- An unsurprising level load-twisting trademark under semi static and dynamic stacking conditions.
- High particular energy engrossing limit (energy assimilated per unit mass). This makes it preferably reasonable for applications in car and air ship businesses.
- High energy dissemination thickness (or energy assimilated per unit volume). This is required concerning defensive claddings in static structures or to retain the motor energy of a falling lift.

1.1 Aluminum tubes as effect energy safeguards

Round tubes are utilized broadly as energy engrossing components, the primary fascination being their prepared accessibility in an extensive variety of measurements and materials and also the extensive variety of distortion modes which can be produced. Contingent on the method of misshaping, it is conceivable to get conduct extending from a low compel long stroke trademark to a high constrain - short stroke trademark from a similar tube.

Fundamentally tubes can be subjected to diametral (or sidelong) pressure or pivotal pressure. The horizontal pressure modes which create the moderately low compel long stroke twisting attributes have been looked into by Reid et al [1] and an especially effective variation of this mode has been portrayed by Reid et al. [2]. With respect to pivotal pressure, the tube might be subjected to pressure between two level plates or between a level plate and a formed kick the bucket. In the previous case, which has been considered by many creators, the tube distorts by dynamic locking in an asymmetric, concertina mode or in precious stone crease designs [3].

Strong et al. [4, 5] have inspected the conduct of square-segmented tubes gone ahead to a formed kick the bucket. Breaks are started at the corners and splits engender along the edges of the tube while the level strips so framed twist up as the pressure proceeds. It was watched that such a energy retaining gadget has a long stroke.

1.2 Aluminum tubes under axial pressure

The conduct of a pivotally compacted tube relies on upon the end apparatuses gave. For instance a tube might be settled at both its end; or it might be given basically bolstered conditions by putting the tubes in reasonable notches; or it might be compacted between two level plates; or it might be packed between two formed kick the bucket installations; and any blends of these are conceivable. Tubes smashed under pivotally connected deposits through two level plates demonstrate a dynamic plastic collapsing conduct. The end states of the tube just influence their conduct amid the initial segment of the squash uprooting.

One of the earliest analyses to be done on the buckling of the thin walled cylinders was presented by Alexander in 1960. The main objectives of Alexander's [6] work were to predict the necessary dimensions for cylindrical shell that were to be used as energy absorbers in the vertical fuel channels of nuclear reactors. He proposed a simple model of collapse, in which a general fold other than the one near the edge consisted of two straight-sided convolutions by virtue of the simultaneous formation of three fully plastic circumferential hinges . The following are the assumptions made in Alexander's model are as follows:

- The tube material was assumed to be rigid perfectly-plastic, hence ignoring all elastic and strain hardening effects.
- The deformation process was governed by the Von -Misses yield criterion.
- The value of the material yield stress in both tension and compression are equal.
- The material is deforming under plain strain conditions.
- The folds are formed in sequence one at a time and are either fully outward or fully inward with respect to the original tube wall.

II. METAL TUBES FOR ENERGY ABSORPTION: A BRIEF LITERATURE REVIEW

Reddy et al [7] have concentrated the conduct of thin sheet metal tubes for purge and wood filled conditions.

They have examined and recommended a distortion system for dynamic pulverizing of wood filled tube.

The aftereffects of the glorified model is then contrasted and the test results and found a sensible assertion.

Reddy et al [8] built up the connection between the dynamic and semi static load-distortion attributes of thin-walled metal tubes packed along the side between unbending plates was investigated with reference to the utilization of such tubes in effect energy retaining frameworks. The subsequent definition is utilized as the reason for acquiring the outcomes on mellow steel and aluminum containers of a similar ostensible measurements.

Hanssen et al [8] have demonstrated that, the energy retention in the crash boxes was not influenced when worldwide bowing impacts happened amid the devastating procedure.

Reddy T.Y [1] have concentrated that the tubes parts into number of hub breaks from the started splits bringing about strips because of bowing and curlings. They have contrasted and a straightforward systematic approach and the part tube gadget has the upside of a level load diversion trademark and works effectively with an extensive variety of tube properties and tube and kicks the bucket geometries.

Johnson and Reid [7] have concentrated the clasping of roundabout barrel shell under hub load is established issue in strong mechanics especially in the plastic district under both static and dynamic conditions. From the perspective of energy assimilation limit and accessible stroke length, it has been discovered that round tubes under pivotal pressure to give one of the best gadgets. Alexander [7] gave an inflexible plastic examination for asymmetric plastic clasping of a container of certain breadth and thickness. Johnson, Soden and Al-Hassani [6] have considered a basically in extensional method of misshapening and computed the relating mean fall stack. As far as the conduct of containers of different cross-sectional shapes, round ones are interesting in having basically a similar method of disfigurement in both static and dynamic pressure. Misshapening is for the most part aggregated toward the finish of the round tube which is incautiously stacked.

III. EXAMPLE ARRANGEMENT FOR EXPLORATORY REVIEW

Examples of round aluminum tubes were sliced to a length of 150 mm from the stock as gotten from the market. The closures of the tubes were done to close level surfaces by handing the tubes over the machine and the finishes were at long last grounded. In this manner the tubes have an angle proportion (l/d) of 3. The surfaces of the tubes were investigated for any defect and cleaned with lamp oil.

IV. EXPERIMENTAL PROCEDURE

4.1 PREPARATION OF ALUMINIUM SPECIMENS:

The metal tubes as received are cut to the aspect ratio (L/d) of 3.

The tubes were then annealed, during this they are soaked in a furnace at a temperature of 360^o for aluminum for half an hour time duration.

Fig 1:- Non annealed and annealed aluminium tube

Fig 2:- Polyester and vinyl ester filled annealed aluminium tube.

Fig 3:- Shore 45, 60 and 70 Elastomer filled annealed aluminium tube.

4.2 AXIAL COMPRESSION OF EMPTY METAL TUBES UNDER QUASI-STATIC LOADING CONDITIONS

The tubes were tested under uni-axial compressive load in a 50kN electronic version UTM at elongation rate of 1mm per min.

The crushing behavior was observed, the load- displacement and stress-strain curves were plotted.

The energy absorbing characteristics like crushing load, energy absorbed during the plastic deformation were recorded.

Theoretical values of the initial crushing load, energy absorbed, specific energy absorbed were calculated.

The theoretical and experimental values are compared results are tabulated.

The axial compression tests were carried out to obtain the energy absorption capacity of different materials using electronic universal testing machine.

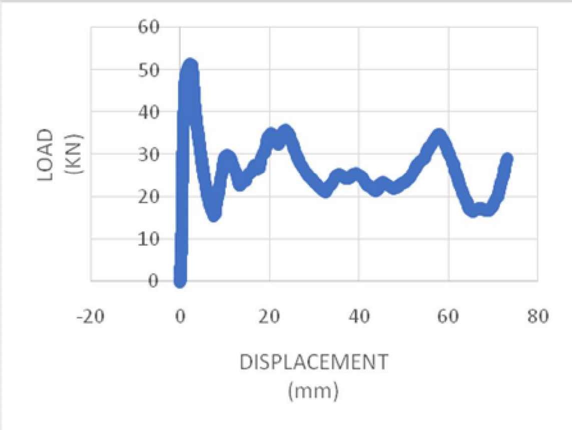

Fig 4:- Load vs displacement curve of Non Annealed empty aluminium tube

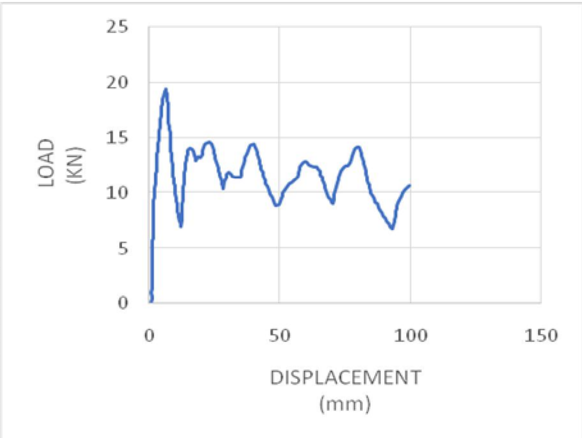

Fig 5:- Load vs displacement curve of Annealed empty aluminium tube

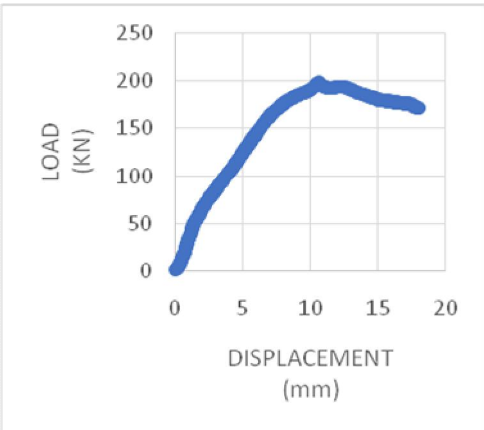

Fig 6:- Load vs displacement curve of vinyl ester filled aluminium tube

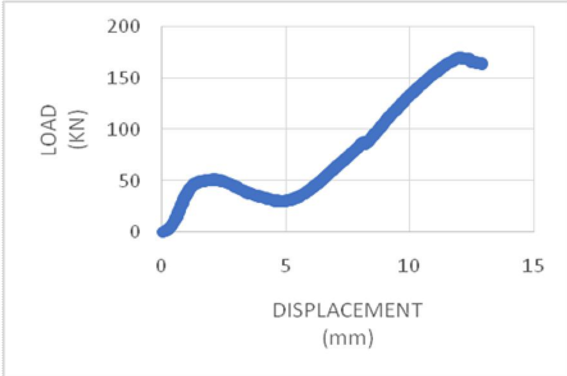

Fig 7:- Load vs displacement curve of polyester filled aluminium tube

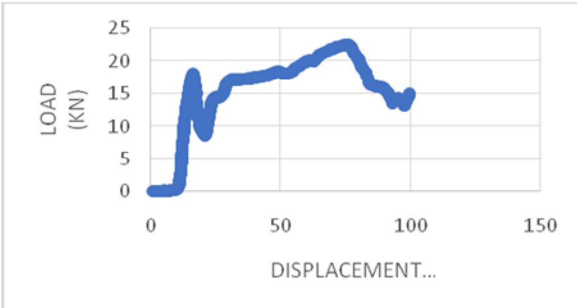

Fig 8:- Load vs displacement curve of shore 45 elastomer filled aluminium tube

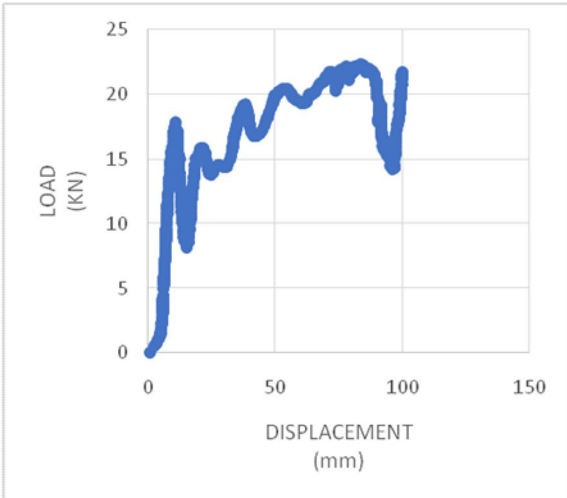

Fig 9:- Load vs displacement curve of shore 60 elastomer filled aluminium tube

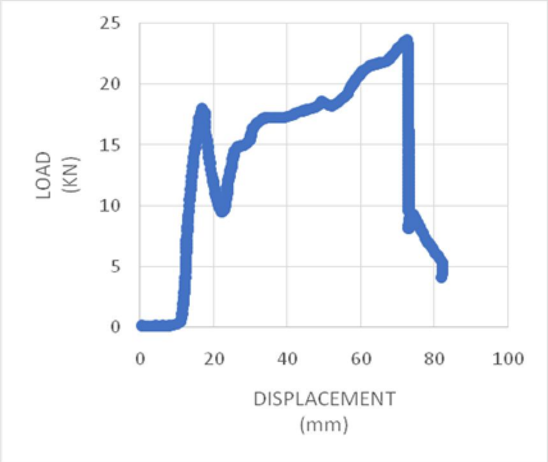

Fig 10:- Load vs displacement curve of shore 70 elastomer filled aluminium tube

Table 1:- Energy absorption capacity of different test specimen

TEST SPECIEMENS	ENERGY ABSORBED UNDER QUASI STATIC TEST (KJ)
EMPTY ALUMINIUM TUBE (NON ANNEALED)	1.917
EMPTY ALUMINIUM TUBE (ANNEALED)	1.098
POLYESTER FILLED TUBE	1.057
VINYL ESTER FILLED TUBE	2.650
SHORE A45 ELASTOMER FILLED TUBE	1.688
SHORE A60 ELASTOMER FILLED TUBE	1.523
SHORE A70 ELASTOMER FILLED TUBE	1.160

V. DISCUSSIONS

Axial Compression tests were conducted and the load displacement curves were obtained for each of the test material. From these curves the energy absorbing capacities are determined by tracing the area under the average load line. It has been observed that, it is not possible to predict the beginning of deformation of tubes, whether it occurs from bottom or top side of the specimen.

VI. CONCLUSIONS

Experiments were conducted to understand the behavior of metal tubes under quasi-static axial compression load conditions.

The Aluminium tubes are tested for empty and filled conditions.

The plastic crushing of thin tubes resulted in Euler type of buckling. From this it can be concluded that the deformation modes depends on material properties of materials.

A comparison is made on the specific energy absorbing capacity and means crushing loads of Aluminium tubes.

The specific energy absorption capacity and mean crushing loads obtained during investigation can be used as data in designing the energy absorbers for various engineering applications like impact energy absorbers, crash pads.

These Quasi-static test results can be taken to predict quasi-static behavior of the metal tubes under impact loading conditions.

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