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# Finite Element Analysis Of Epoxy-Graphite Powder, Epoxy-Ms Powder, Epoxy- Ms Lathe Scrap(Ms Flakes) Filled In A Circular Hollow Aluminium Column

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**ABSTRACT:**
Main objective of this paper is to prepare composite material filled hollow Al columns and test them for their compressive strengths and compare the results with Rankine's columnar theory and Finite Element Analysis using Ansys 2014.

The idea of filling the particulate polymer composite material in an aluminium tube is taken from a research paper presented at **14th international conference on computing in civil and building engineering in Moscow, Russia (27-29 June 2012)** by **Feng Zhou** and **Ben Young**, in which they filled the Al tube with concrete and conducted Finite Elemental Analysis. The composites used in the project are Epoxy-graphite, Epoxy-MS powder, Epoxy-MS flakes, all these three samples are taken in a hollow Al CHS tube. Another two specimens were prepared by using epoxy-graphite powder and epoxy-MS powder without using Al tube. These specimens were subjected to crushing force and the readings obtained were compared with the results obtained by conducting Finite elemental analysis in ANSYS.

The applications include columns in buildings, columns of bridges, and as columns in earthquake zones as the outer hollow metal has the capability to withstand heavy loads and dampens the vibrations.

## I. INTRODUCTION:

Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure.

We come across various instances of members subjected to compressive loads. These members are given different names depending on the particular situation in which they are placed. Columns are vertical members used in building frames.

When a short column or strut is subjected to a gradually increasing compressive load it fails by crushing. During this process the stress in the member is **(P/A)** where P is the axial compressive load and A is the cross sectional area. But if the column is long, then it will buckle out laterally at a load P considerably less than what is required to crush the column material. The lateral deflection increases while the load practically remains constant, and the column fails near its mid length by bending. This can be illustrated as below.

Materials fail in compression in many ways depending on their geometry and support Buckling – hollow cylinders and long cylinder with high length to diameter ratio

- Bending – long rod or a panel
- Shattering – heavily loaded glass or wood.

Compressive strength of material

a) Under compression a beam will fail either by crushing or buckling, depending on the material and L/d; e.g., wood will crush if $L/d < 10$ and will buckle if $L/d > 10$ (approximately).

b) Crushing: atomic bonds begin to fail, inducing increased local stresses, which cause more bonds to fail.

c) Buckling: complicated, because there are many modes.

Concrete filled aluminium tube columns can effectively take advantages of these two materials provide both high strength and high stiffness. These findings have reported by Zhou and Young (2008) for concrete filled aluminium square and rectangular hollow section stub column tests.

Taking this as a base to our project we replaced the concrete mixture with composite materials and found out how well these composite materials confined in a hollow metal column will with stand the compressive loads later we simulated the experimental results by using finite elemental method using software Ansys.

## II. FABRICATION OF PARTICULATE COMPOSITE FILLED IN HOLLOW Al COLUMNS:

The epoxy and the particulates (graphite powder, MS powder and MS flakes) are taken in the ratio 60:40 by volume and mixed in a jar thoroughly by using a stirrer until both the matrix and the particulates form a pasty mixture. Then this mixture is poured in a hollow aluminium tube closed at one end carefully without disturbing the aluminium tube. It is then left to dry for about 24 to 48 hours. The schematic representation of the procedure is shown in the figure below.

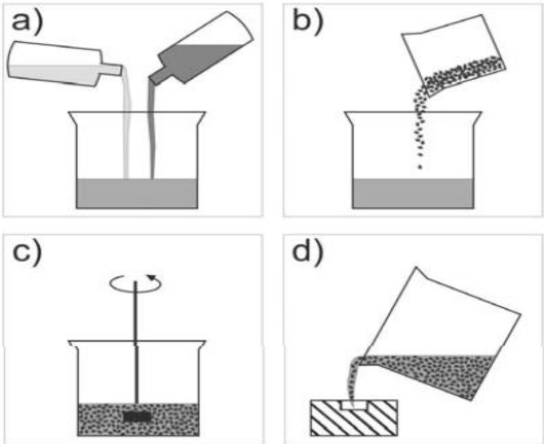
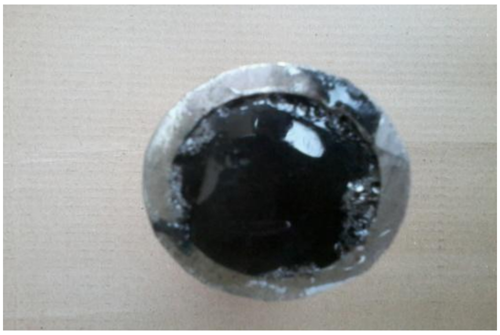



**Fig: Schematic of specimen preparation**

The specimens prepared are

1. Epoxy+Graphite Powder filled in Hallow Al column
2. Epoxy+Graphite Powder without Al column
3. Epoxy+MS Powder filled in Holow Al column
4. Epoxy+MS Powder without Al column
5. Epoxy+MS Lathe Scrap filled in Hallow Al column

All the above specimens are prepared by using general procedure shown in the above fig.




## III. STATIC AND FEA OF COLUMNS:

The performance of a material is judged by its properties and behavior under compressive, tensile and bending constraints these properties are also known as static mechanical properties of the materials. In our project we are subjecting cylindrical composite test specimens to compressive loads because all structural columns are primarily subjected to compressive loads

Table showing the Ultimate compressive stress

| S.NO. | Specimen | Ultimate compressive load(KN) | Compressive stress (MPa) |
|---|---|---|---|
| 1 | Al (Epoxy + graphite powder) | 162.6 | .91 |
| 2 | Epoxy + graphite powder | 28.02 | 17 |
| 3 | Al (Epoxy +MS powder ) | 177.96 | 90.59 |
| 4 | Epoxy + MS powder | 48.00 | 28.53 |
| 5 | Al (Epoxy + MS lathe scrap as flakes) | 187.86 | 96.136 |

**RANKINE'S COLUMNAR THEORY**

By using RANKINES columnar theory we found the ultimate compressive load of all the test specimens and the results tabulated below.

Rankines columnar theory formula

$$P = \frac{F_c A}{1 + \frac{F_c}{\Pi^2 E}\{L|K\}^2}$$

**Experimental Vs Theoritical Results**

| SPECIMEN | ULTIMATE COMPRESSIVE LOAD (EXPERIMENTAL IN KN) | ULITMANTE LOAD (RANKINE'S COLUMNAR THEORY IN KN) |
|---|---|---|
| Al (EP+Graphite powder) | 162.6 | 151.11 |
| Ep+Graphite Powder | 28.02 | 25.28 |
| Al (EP+MS Powder) | 177.96 | 172.26 |
| Ep+MS Powder | 48 | 47.51 |
| Al (Ep+Lathe Scrap) | 187.86 | 182.19 |

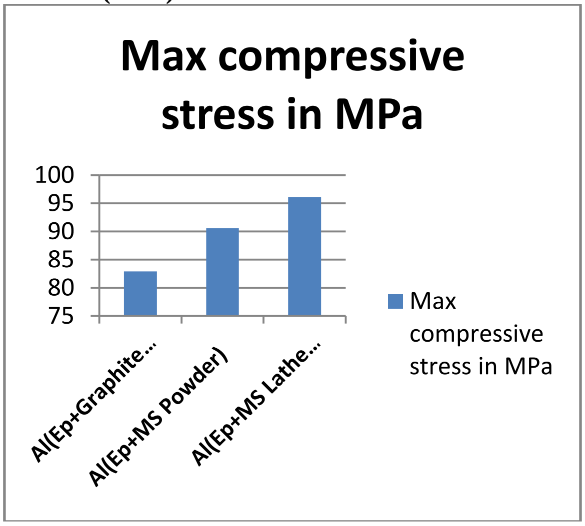
Finite Element Analysis is a mathematical representation of a physical system comprising of part, material properties, boundary conditions. Mainly three basic steps in the Ansys are

ANSYS Preprocessor
ANSYS Solution Processor
ANSYS Post Processor

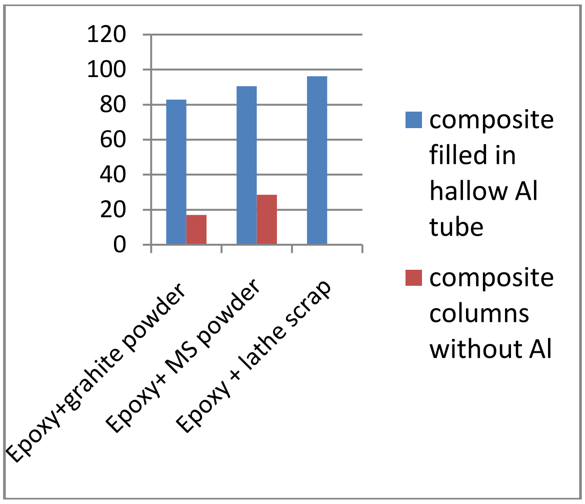
**Compressive stress Experimental VS Ansys**

| SPECIMEN | MAX COMPRESSIVE STRESS (EXP) IN MPa | MAX COMPRESSIVE SRESS (ANSYS) IN MPa |
|---|---|---|
| EP+Graphite column without Al | 17 | 18.0339 |
| EP+MS Powder without Al | 28.53 | 30.2651 |
| EP+Lathe scrap in Al | 96.136 | 103.855 |

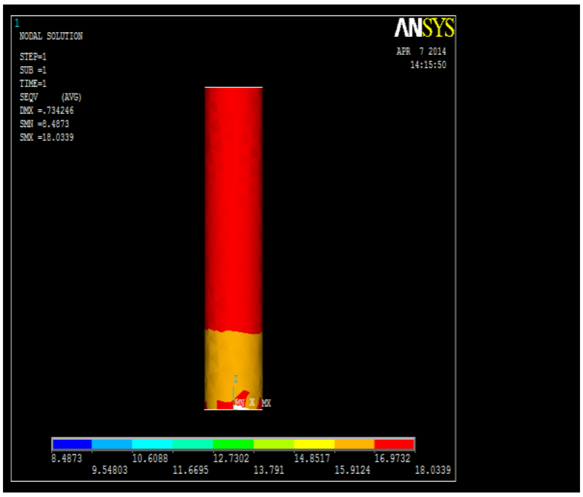
**Max compressive stress of composite filled Al columns.(MPa)**



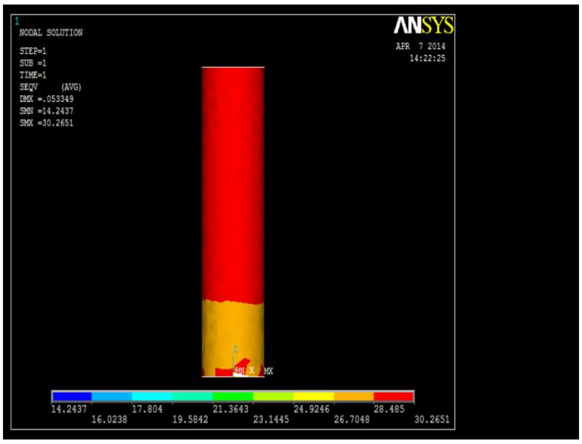

**Comparision between the compressive strengths of composite columns with and without hallow Al tube(MPa)**



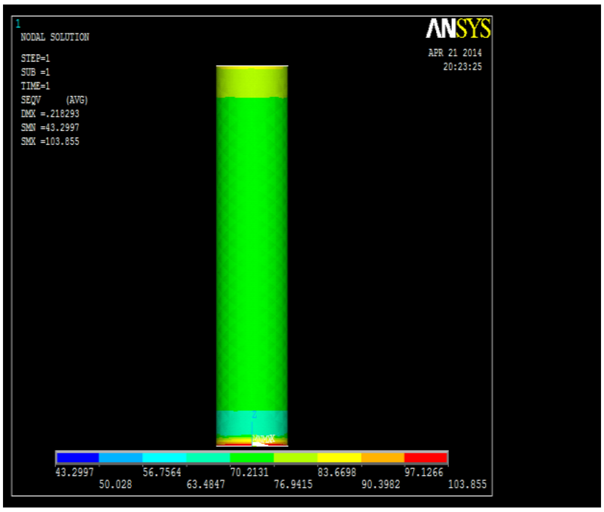

**Ansys Image for Ep+Graphite Powder without Al**




**Ansys Image for EP+MS Powder without Al**




**Ansys Image for EP+Lathe scrap filled in Hallow Al tube**




## IV. COCLUSION:

In our Project we obtained better compressive strengths for the composites filled in Al column. Both (Epoxy + Graphite powder) and (Epoxy + MS powder) without Al tube failed at 17 MPa and 28.53 MPa respectively. But however, (Epoxy+graphite powder), (Epoxy + MS lathe scrap ) and (Epoxy + MS powder) filled in an Al tube gave better compressive strengths.

But cost is the major issue for using these materials because both graphite powder and MS powder are costlier. However Lathe scrap being available cheaply is the material which gave higher compressive stress of 96.136 MPa. Many Reasearch works are in progess by many scientists on the use of lathe scrap in structural engineering.

The applications are these composite filled Al columns can be used as columns in the primary lateral resistance systems of both braced and unbraced building structures. There exist applications of composite filled hallow tubes as bridge piers. Moreover, Composite filled hallow tubes may be utilized for retrofitting purposes for strengthening earthquake zones.

Railway bridges are subjected to vibrations when a train passes by it. When Columns are fitted inside a hollow metal they can withstand greater compressive strengths. Also hollow columns filled with concrete is already used in earthquake zones.

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