COMPARITIVE STUDY ON COMPRESSION STRENGTH OF GLASS FIBRE STRENGTHENED CIRCULAR HALLOW STEEL SECTIONS

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***Abstract*: Increased urbanisation creates a need for speedy construction. Thus conventional construction concrete can be replaced by steel construction. Steel can resist heavy loads and they are of different shapes. In specific cirular hallow steel section mostly used as coloum. To make it more load bearing, glass fiber sheet is wrapped around using epoxy resin. As expected the composite material (steel+fiber) resist heavy compression load than empty steel(without glass fiber). Based on the results on experiment conducted on various sections graphs are plotted.**

***Keywords*: OD-outer diameter, t-wall thickness, woven roving, breaking load.**

1. Introduction

1.1. General Today Construction industries are facing problems of Cracking and Tensile strength problems, for that we have to add something in concrete to improve concrete in tensile way. For that Fiber is most commonly used in construction industries. Use of steel is speedy in construction

2. Literature review

Chaurasia Raj ,N. Jeevan Kumar(2018) discussed that Mechanical behavior of bidirectional carbon epoxy, bidirectional glass epoxy composite material and aluminum under static loading at room temperature was experimentally investigated as per standards. The failure of composite materials and aluminum specimens under tensile, 3-point bending, were investigated. Based on the test results, the following conclusion are drawn: Fabrication of carbon woven reinforcement sheet and glass woven reinforcement sheet with isophthalic epoxy is done by hand lay-up technique.

Santhif Kumar. R,Arumugam.C(2016)experimental and numerical investigation on strengthening cold formed steel channel members using externally bonded high modulus carbon fibre-reinforced polymer (CFRP) plate. The CFRP plate strengthening is only applied to a small localize area subjected to concentrated load. A series of tests on CFRP strengthened cold formed steel channel members sections subjected to web crippling was conducted. The load carrying capacity has been increased by 29.43% by providing CFRP sheet wrapping in comparison to the normal beam

Pratik Gayakwad[1] A. C. Mattikalli[2] 2015 This article shows the investigation details of the glass fiber and carbon fiber it mainly deals moderate strength. the properties of these composites are tested by conducting experiments on tensile and Izod test The composite which was planned to form by utilising the carbon-glass fiber toughened epoxy was done successfully. And in result it was found that the characteristics and the behaviour properties of the merged product is influenced by the loads of fiber and also due to the orientation.

Ashvini,Swaminathan Subramaniyan 2015 study on the performance of circular hallow steel section . The paper conclude that in order to improve the compressive strength the gfrp helps in great way, it withhold high compressive strength

3. IDEOLOGY:-Hallow circular steel section wrapped by glass fiber sheet**,**In addition ,extra layer of glass fiber sheet is also analysed

4. Grade of steel: ASTM (American society for testing and material) or ASME(American society of mechanical engineer)

5. Test specimen details:-

5.1 Grade:-All test were conducted on grade b tubes**.**It is an average which lies between a and c, that is the maximum and minimum carbon content**.** Therefore choosing GRADE B can obtain valuable result analysis Testing grade: B

Table no. 5.1 chemical composition of steel

CHEMICAL COMPOSITION			
	% OF CHEMICALS		
CHEMICALS	**GRADE A**	**GRADE B**	**GRADE C**
Carbon, max	0.25	0.3	0.35
Manganese,max	0.27–0.93	0.29–1.06	0.29–1.06
Phosphorus, max	0.035	0.035	0.035
Sulfur, max	0.035	0.035	0.035
Silicon, min	0.1	0.1	0.1
Chrome, max	0.4	0.4	0.4
Copper, max	0.4	0.4	0.4
Molybdenum, max	0.15	0.15	0.15
Nickel, max	0.4	0.4	0.4
Vanadium, max	0.08	0.08	0.08

5.2:-Mechanical properties:-
Tensile strength, min, psi (MPa)= 60000 (415)
Yield strength, min, psi (MPa)= 35,000 (240)

5.3:-Dimension specification:-As per ASTM(American society for testing and material) or ASME(American society of Mechanical engineer) 106

Table no. 5.3 dimension of steel pipes

Outer diameter		Pipe wall thickness - Pipe weight							
mm	**Inch**	**mm**	**kg/m**	**mm**	**kg/m**	**mm**	**kg/m**	**mm**	**kg/m**
10.3	0.405			1.25	0.28	1.73	0.37	2.42	0.47
13.7	0.54			1.66	0.49	2.24	0.63	3.03	0.8
17.2	0.675			1.66	0.63	2.32	0.85	3.2	1.1
21.3	0.84	1.65	0.81	2.11	1	2.77	1.27	3.7	1.62
26.7	1.05	1.65	1.02	2.11	1.28	2.87	1.68	3.92	2.2
33.4	1.315	1.65	1.3	2.77	2.09	3.38	2.5	4.55	3.24
42.2	1.66	1.65	1.66	2.77	2.69	3.56	3.39	4.86	4.47
48.3	1.9	1.65	1.91	2.77	3.11	3.69	1.06	5.08	5.41
60.3	2.375	1.65	2.4	2.77	3.93	3.92	5.45	5.54	7.49
73	2.875	2.11	3.69	3.05	5.26	5.16	8.64	7.01	11.4
88.9	3.5	2.11	4.52	3.05	6.46	5.49	11.3	7.62	15.3
101.6	4	2.11	5.18	3.05	7.41	5.74	13.6	8.08	18.6
114.3	4.5	2.11	5.84	3.05	8.37	6.02	16.1	8.56	22.3
141.3	5.563	2.77	9.46	3.41	11.6	6.56	21.8	9.53	31
168.3	6.625	2.77	11.3	3.41	13.9	7.12	28.3	10.9	42.6
219.1	8.625	2.77	14.8	3.76	20	8.18	42.5	12.7	64.6
273.1	10.75	3.41	22.7	4.2	27.8	9.28	60.4	12.7	81.5
323.9	12.75	3.97	31.3	4.58	36.1	9.53	73.9	12.7	97.4

6. Epoxy resin: Epoxy is either any of the basic components or the cured end products of epoxy resins, as well as a colloquial name for the epoxide functional group.[1] Epoxy resins, also known as polyepoxides, are a class of reactive prepolymers and polymers which contain epoxide groups. Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols (usually called mercaptans). These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing. Reaction of polyepoxides with themselves or with polyfunctional hardeners forms a thermosetting polymer, often with favorable mechanical properties and high thermal and chemical resistance. Epoxy has a wide range of applications, including metal coatings, use in electronics/electrical components/LEDs, high tension electrical insulators, paint brush manufacturing, fiber-reinforced plastic materials and structural adhesives. Epoxy is sometimes used as a glue (two part one is resin and the other is harder)

Fig no. 6 epoxy resin.

6.1 structure of epoxy: Structure of the epoxide group, a reactive functional group present in all epoxy resins.
(R – represents alkyl group)

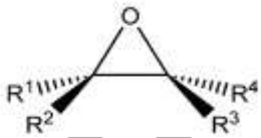

Fig no 6.1 epoxy resin chemical structure.

7. Glass fiber:

7.1Production of glass fiber: Both, continuous and staple forms of glass fibers are produced by partially similar method. Process of producing continuous fibers:– Raw materials (sand, limestone, alumina) are mixed and melted in a furnace at approximately 1260 C.– Molten glass then : Either flows directly into a fiber-drawing facility. This process is known as “direct melt” process. Most of fiber glass in the world is produced this way Or gets formed into marbles. These marbles are later fused, and drawn into fibers. For producing continuous fibers, molten glass passes through multiple holes to form fibers. These fibers are quenched through a light spray of water. Subsequently, fibers are coated with protective and lubricat ingagents. Next fibers are collected in bundles known as “strands”. Each strand may have typically 204 individual fibers.Next, strands wound on spools. Fibers in these spools are subsequently processed further to produce textiles.Staple fibers are produced by pushing high pressure air-jet across fibers, as they emanate from holes during the drawing process. These fibers, are subsequently collected, sprayed with a binder, and collected into bundles known as “slivers”. These slivers may subsequently be drawn and twisted into yarns.

7.2 woven roving fiber Fiber is made as a mat , fiber is oriented perpendicular to each other.

Fig no 7.3 and 7.2 production of woven roving fiber

8. Testing Lenth is kept constant (300mm),only the diameter and the thickness is varied

Fig no. 8 UTM testing machine

Table no.8.1 testing of material

OUTER DIAMETER -48.3mm					
THICKNESS-1.65mm					
EMPTY TUBE		1 LAYER		2 LAYER	
LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)
10	0.5	10	0.5	10	0.4
20	0.7	20	0.6	20	0.5
30	1.2	30	1.1	30	1
40	3.4	40	3.2	40	3.1
50	4.5	50	4.3	50	4.2
60	5.7	60	5.4	60	5.2
70	6.3	70	6	70	5.8
80	7.1	80	6.9	80	6.6
90	8	90	7.6	90	7.9
		94	9	95	8.7
				97.5	10

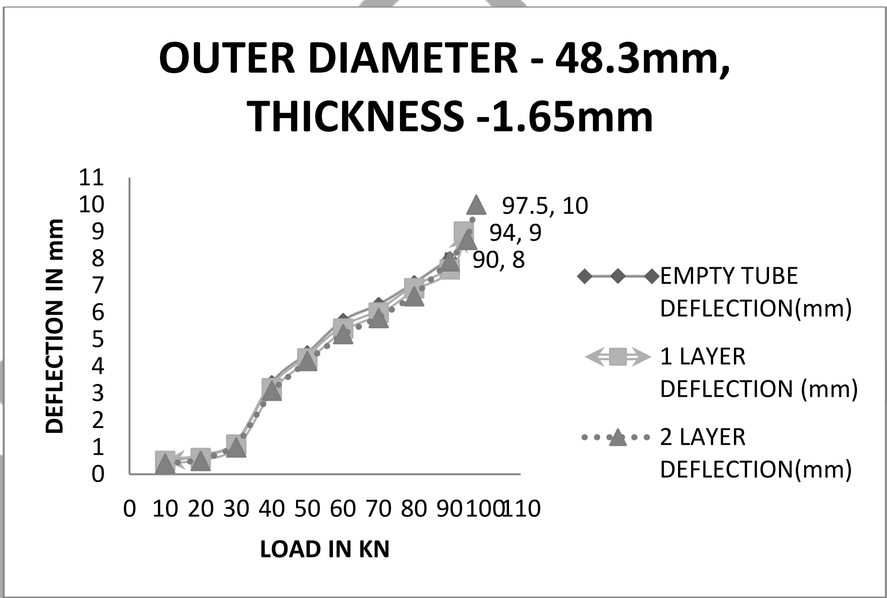

Fig no. 8.1Graphical representation

Table no.8.2 testing of material

OUTER DIAMETER -48.3mm					
THICKNESS-2.77mm					
EMPTY TUBE		1 LAYER		2 LAYER	
LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)
10	0.5	10	0.5	10	0.4
20	0.7	20	0.6	20	0.5
30	1.2	30	1.1	30	1
40	3.4	40	3.2	40	3.1
50	4.5	50	4.3	50	4.2
60	5.7	60	5.4	60	5.2
70	6.3	70	6	70	5.8
80	7.1	80	6.9	80	6.6
90	8	90	7.6	90	7.9
95	8.5	95	8.5	95	8.7
97.5		98.5	9.2	98.5	9.6
				101.5	10.5

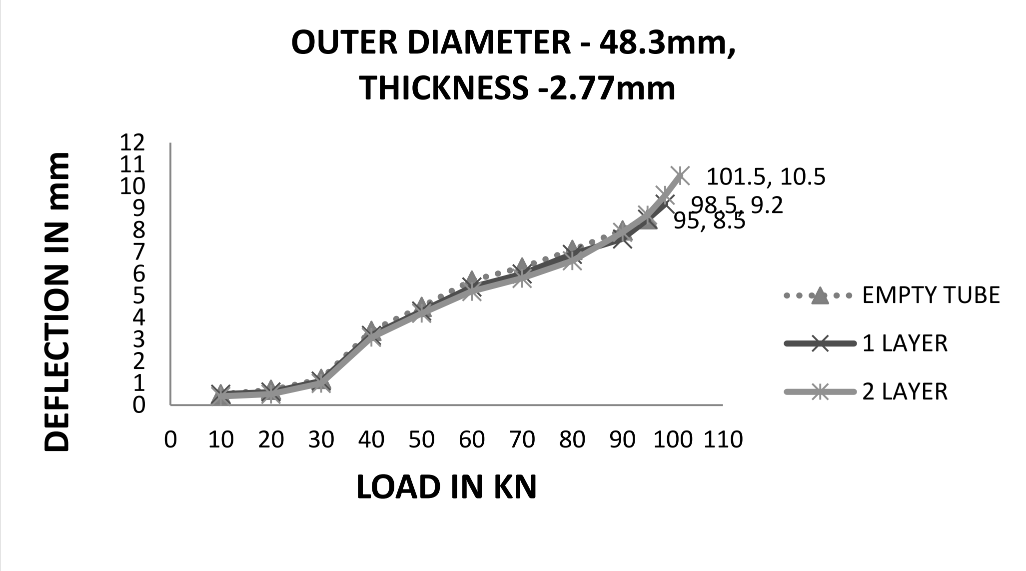

Fig no. 8.2 Graphical representation

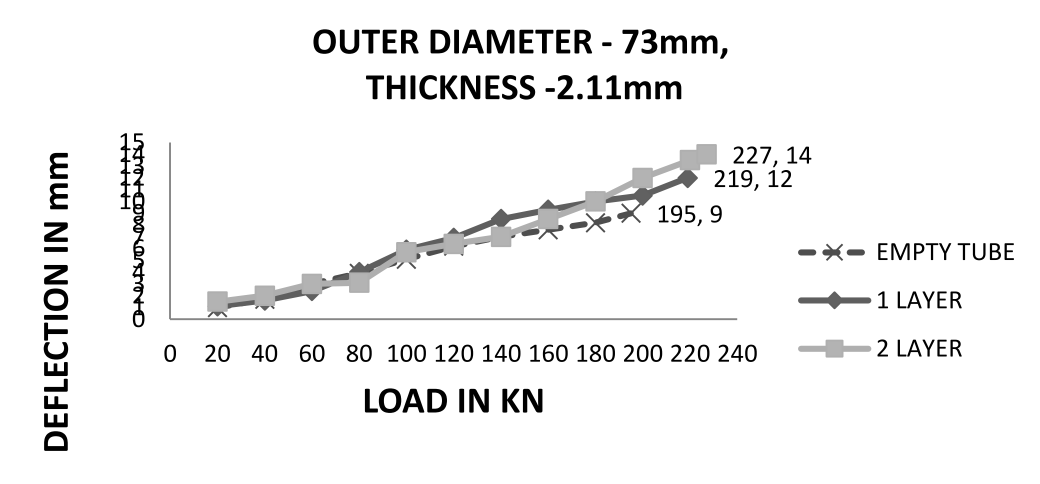

Fig no. 8.3Graphical representation

Table no.8.3 testing of material

OUTER DIAMETER -73mm					
THICKNESS-2.11mm					
EMPTY TUBE		1 LAYER		2 LAYER	
LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)
20	1	20	1.1	20	1.5
40	1.7	40	1.6	40	2
60	3	60	2.4	60	3
80	3.9	80	4	80	3.1
100	5.1	100	5.9	100	5.7
120	6.2	120	6.9	120	6.4
140	7	140	8.5	140	7
160	7.6	160	9.3	160	8.5
180	8.2	180	10	180	10
195	9	200	10.5	200	12
		219	12	220	13.5
				227	14

Table no.8.4 testing of material

OUTER DIAMETER -73mm					
THICKNESS-3.05mm					
EMPTY TUBE		1 LAYER		2 LAYER	
LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)
20	0.9	20	0.5	20	0.5
40	1.5	40	1.6	40	2
60	3	60	2.2	60	3
80	3.7	80	4.2	80	3.1
100	5.1	100	5.9	100	5.7
120	6.2	120	7	120	6.4
140	7.2	140	8.5	140	7
160	7.6	160	9.4	160	8.5
180	8.2	180	10	180	10
200	8.9	200	11.5	200	12
213	9.6	220	13	220	13.5
		230	13.7	240	14
				248	15

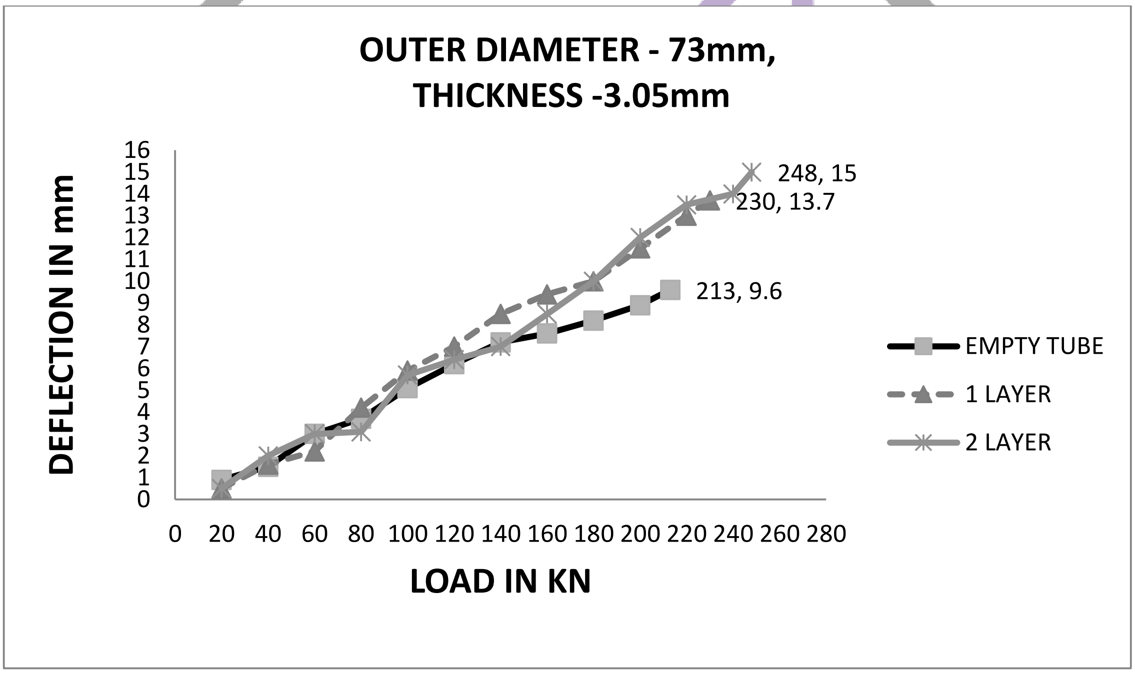

Fig no. 8.4Graphical representation

Table no.8.5 testing of material

OUTER DIAMETER -114.3mm					
THICKNESS-2.11mm					
EMPTY TUBE		1 LAYER		2 LAYER	
LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)
40	0.5	40	0.4	40	0.5
80	1.5	80	1.4	80	1.3
120	2.5	120	2.2	120	2
160	4.5	160	4.2	160	3.1
200	6	200	5.7	200	4
210	7.9	240	7.3	240	6.4
		254	8.5	279	10.7

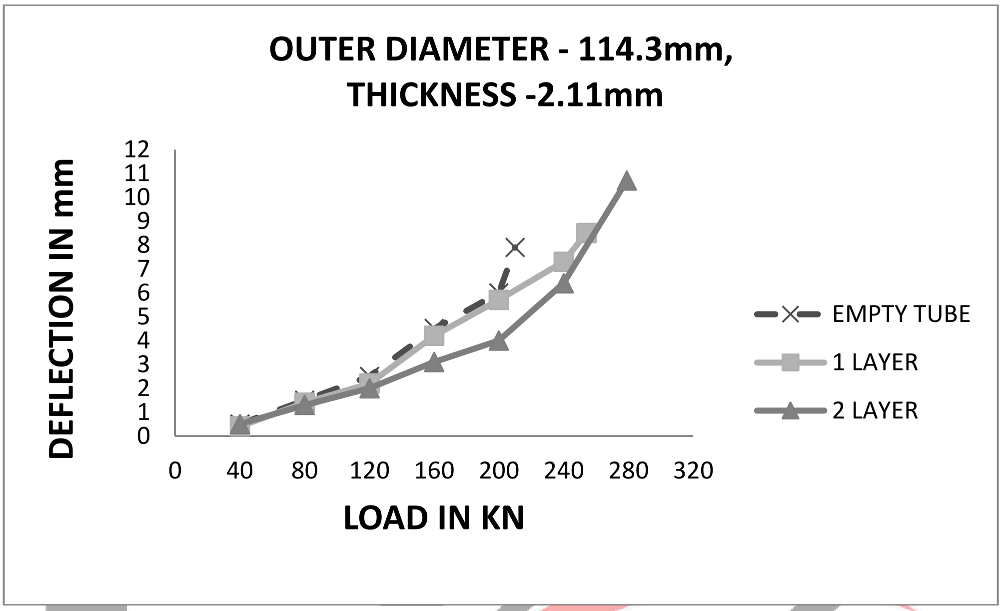

Fig no. 8.5.Graphical representation

Table no.8.6 testing of material

OUTER DIAMETER -114.3mm					
THICKNESS-3.05mm					
EMPTY TUBE		1 LAYER		2 LAYER	
LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)
40	1.3	40	1.2	40	1
80	3	80	2.7	80	2.5
120	4	120	3	120	3.3
160	6.3	160	5.3	160	5
200	7.1	200	6.9	200	6.5
240	8	240	7.9	240	8
		276	9.9	280	10.7
				291	11

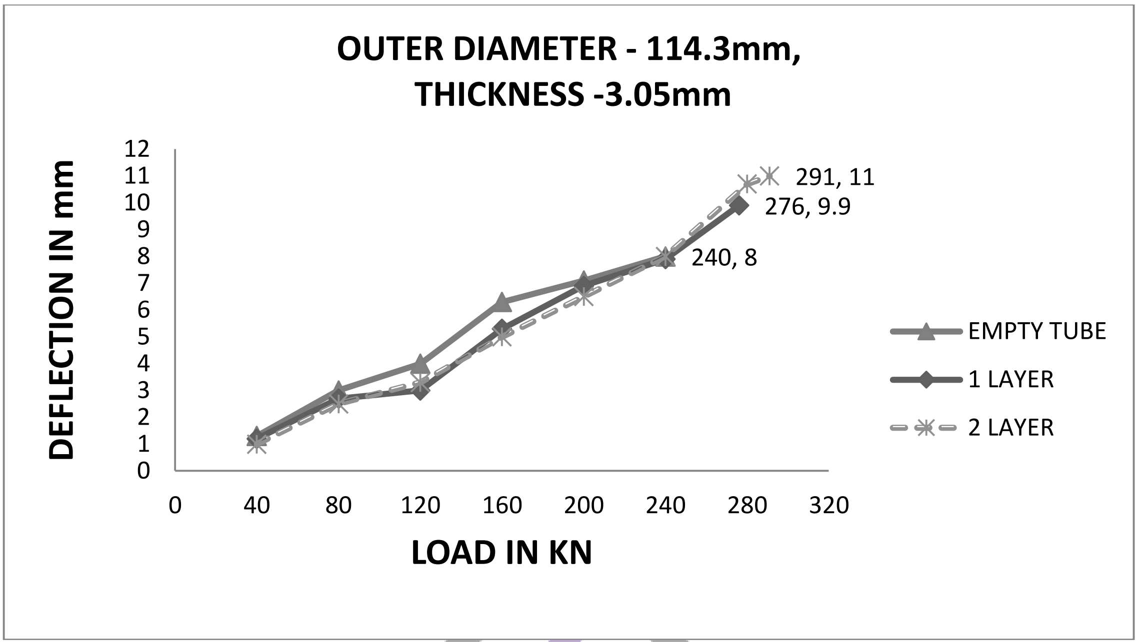

Fig no. 8.6.Graphical representation

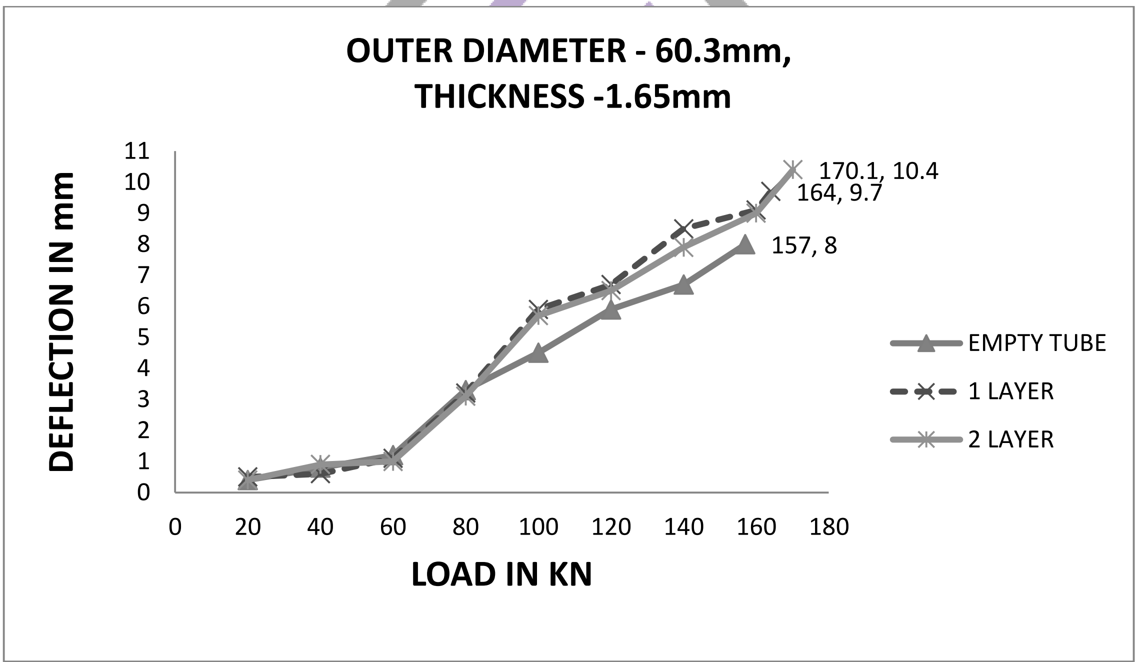

Fig no. 8.7.Graphical representation

Table no.8.7 testing of material

OUTER DIAMETER -60.3mm					
THICKNESS-1.65mm					
EMPTY TUBE		1 LAYER		2 LAYER	
LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)
20	0.4	20	0.5	20	0.4
40	0.8	40	0.6	40	0.9
60	1.2	60	1.1	60	1
80	3.3	80	3.2	80	3.1
100	4.5	100	5.9	100	5.7
120	5.9	120	6.7	120	6.5
140	6.7	140	8.5	140	7.9
157	8	160	9.1	160	9
		164	9.7	170.1	10.4

Table no.8.8 testing of material

OUTER DIAMETER -60.3mm					
THICKNESS-2.77mm					
EMPTY TUBE		1 LAYER		2 LAYER	
LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)	LOAD(KN)	DEFLECTION(mm)
20	1	20	1.1	20	1
40	1.7	40	1.3	40	2.5
60	3	60	2.8	60	3
80	3.9	80	4	80	3.1
100	5	100	5.9	100	5.7
120	5.9	120	6	120	6.5
140	6.7	140	8.5	140	7.9
160	8.8	160	9.1	160	9
162	9	168	9.5	172	10.2

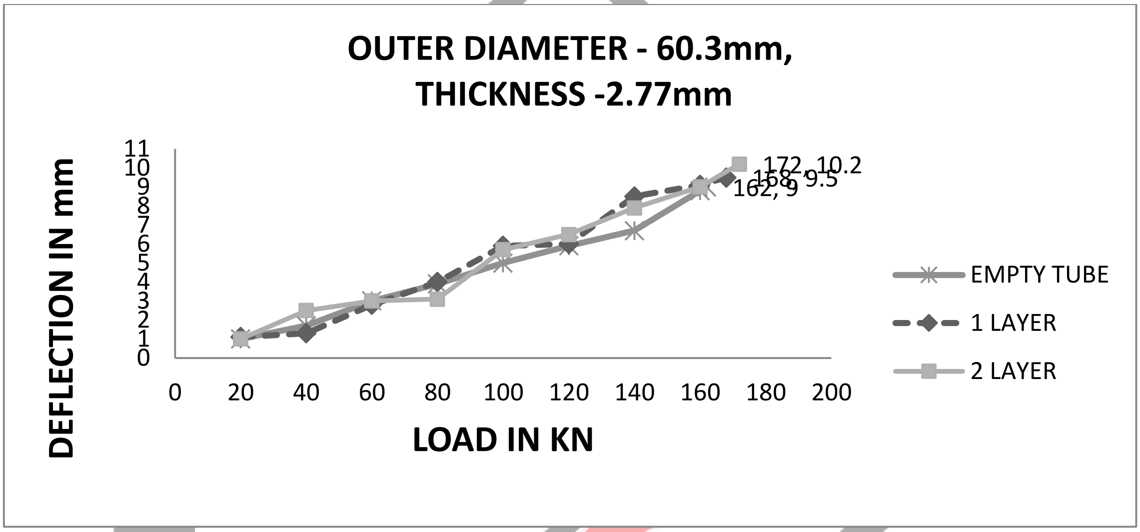

Fig no. 8.8.Graphical representation

8.1 Failure OF Specimen

Fig no. 8.7 failed specimen

9 Result analysis:-The result obtained expresses that the tube wrapped with woven glass fiber sheet take bear more compressive strength. The epoxy resin binds both the glass fiber sheet and steel strongly and also there in increase in deflection also

9.1 Graphical analysis:

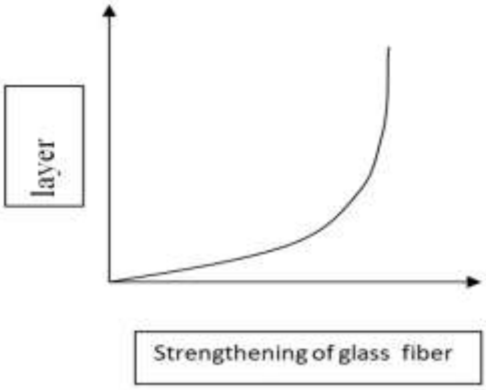

Fig no .9.1 layer vs strengthening of glass fiber

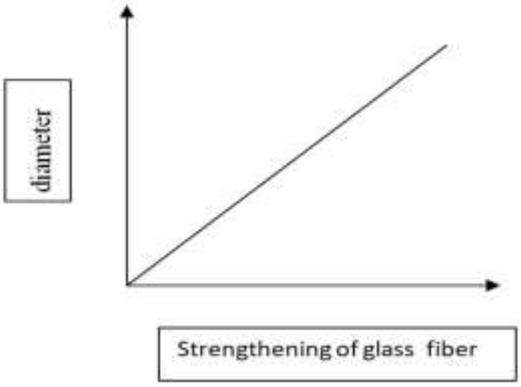

fig. No. 9.1diameter vs strengthening of glass fiber

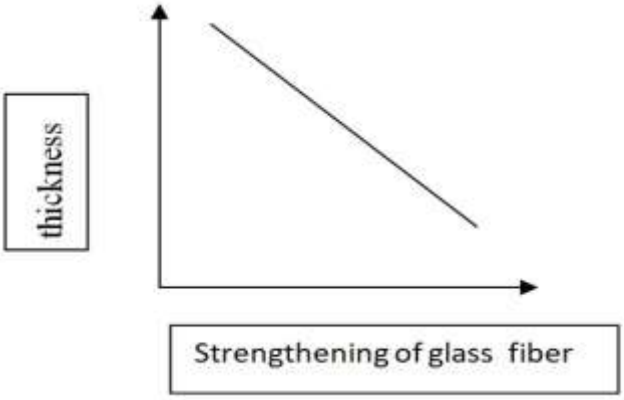

Fig no.9.2 thickness vs strengthening of glass fiber

Conclusion: Use of glass fiber sheet give additional compressive strength. Less thick tube can be us. Use of glass fiber sheet saves the material cost

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