EXPERIMENTAL INVESTIGATION OF WELDED BUTT JOINT REPLACED WITH RESIN WELD

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Abstract - *The main parameters that affect the performance of resin joints such as surface treatment, joint Configuration, geometric and material parameters, failure mode etc. are discussed. The environmental factors such as pre-bond moisture, moisture and temperature are also discussed in detail and how they affect the durability of adhesive joints. Lots of shortcomings were resolved during the last years by developing new materials, new methods and models. However, there is still a potential to evaluate and identify the best possible combination of parameters which would give the best performance of composite bonded joints. The selection of the manufacturing bonding method usually depends on the substrate to be bonded, service condition, area of application, etc. However, there is a lack of understanding of bonding methods on the failure behavior and the relationship between bulk adhesive strength and joint strength. Suitable manufacturing bonded joint method for a particular area of application is important, especially in case of the composite repair method, as the parent material (damaged) already contain moisture and suffered other changes during the service period. It is evident from literature survey of Resin-bonding that it has several benefits than individual one. The current use of weld-bonding in engineering applications is at aerospace and automobile industry. The excellent fatigue property and better static strength of joint makes the light-weight structure possible for assembly in automobile sector and thus this light weight structure increases the strength to weight ratio. Use in different materials like Metal , Ceramics Wood, Vulcanized Rubber, Foams, Plastics.*

***Key Words*: Process parameter, Finite Element Analysis, CFRP, Epoxy Resin Adhesive, Universal Testing Machine, ANOVA**

1. INTRODUCTION

Resin bonding offers improved joint stiffness compared to applications is that they prevent ingress of water spot welding and mechanical joining, since it produces continuous joining instead of localized, discrete joining. This also results in more uniform stress distribution over a larger surface area. A properly designed resin weld joint produces high joint strength and is capable of high energy absorption. It also provides good noise and vibration damping. Another advantage of resin joints in automotive and debris into the joint area, thus acting like a seal. However, resin bonding may require surface preparation, which may include surface cleaning and surface pretreatment. Resin bonding has the ability of joining dissimilar materials that cannot be welded, such as steel and polymer matrix composites, or steel and magnesium. For aluminum or magnesium, which are inherently more difficult to weld than steel, or for thermoset matrix composites that cannot be welded at all, adhesive bonding may be a better option than mechanical fastening. One reason for this is that mechanical fastening creates stress concentration in the material due to the presence of drilled or punched holes, which is completely avoided in resin bonding. The chemical pre-treatment is applied not only to prevent surface oxide formation, but also to improve paint adhesion and corrosion protection. The lubricant is added on the pre-coated surface to facilitate the stamping and other press forming operations needed to manufacture the parts. Resin bonding is similar to brazing and soldering, although the bonding formed is not a metallurgical bond, rather, it is chemical in nature

1.1 Need of work

Residual stresses are induced in welded components (development of tensile residual stresses adversely affects the tensile and fatigue properties of work piece). Simple shape components to be joined are partially melted. Temperature of the base metal during welding in and around the weld varies as function of time (weld thermal cycle). Chemical, metallurgical and mechanical properties of the weld are generally anisotropic. Reliability of weld joint is poor. Little amount of metal is wasted in the form of spatter, run in and run off Process capabilities of the welding in terms of dimensional accuracy, precision and finish are poor. Weld joints for critical applications generally need post weld treatment such as heat treatment or mechanical working to get desired properties or reline residual stress. So to reduce overall drawbacks of weld joint, resin weld is best for overall performance of joint.

1.2 Basic principle of resin weld joint

Resin weld create a permanent bond between two parts. The resin layer applied hardens, depending on The type of resin, either through drying or through a chemical reaction, thereby holding the materials together. Two physical factors influence the durability of the bond the adhesion of the glue to the surface of the work pieces and the internal cohesion of the adhesive itself. Adhesion refers to how the adhesive sticks to the surface of the part of the joint. Within a solid substance, the bonding forces between the molecules are balanced. But at the edges, there are a greater or fewer number of bonds free. If another material comes closes enough, it can come within the effective range of these forces. Everyone is familiar with the phenomenon of a wet sheet of paper sticking to a pane of glass, for instance. Cohesion robustness of the now permanently forged contact between the bonded materials is dependent on the cohesion, i.e. the internal strength of the adhesive after hardening. If an joint has been carefully executed, then millions of resin bridges between the hardened adhesive and the surfaces of the materials ensure a joint which is capable of handling high stresses. Where this involves pulling or shearing stresses, the stress is distributes.

1.3 Types of material used for joining process

In this joint process materials used for investigation G.I. Pipe, composi, Standard Epoxy Resin AW 106 IN, Hardener HV 953 IN and Glasswool to improve strength of materials, types of fiber etc. Resins are used to “glue” the fibers together. The resin keeps the fibers in the proper position, distributes loads, protects the filaments from abrasion, and provides inter laminar shear strength. The resin also provides a uniform external surface for bonding of external hardware to the structure. There are several classes of resins available. These resins include polyesters, epoxies, phenolics, bismaleimides , and polyimides. Epoxy resin systems have been the most widely used resin for advanced composite structures. Araldite AW 106 resin/Hardener HV 953 IN epoxy adhesive is a multi-purpose, viscous material that is suitable for bonding a variety of materials including metal, ceramic, and wood. The electrically insulating adhesive is easy to apply either manually by spatula and stiff brush or mechanically with meter/mix and coating equipment. Araldite AW 106 resin/ Hardener HV 953U epoxy adhesive cures at temperatures from 68ºF (20ºC) 356ºF (180ºC) with no release of volatile constituents.

Fig -1: Epoxy Resin and Hardener & Glasswool

1.4 Methodology

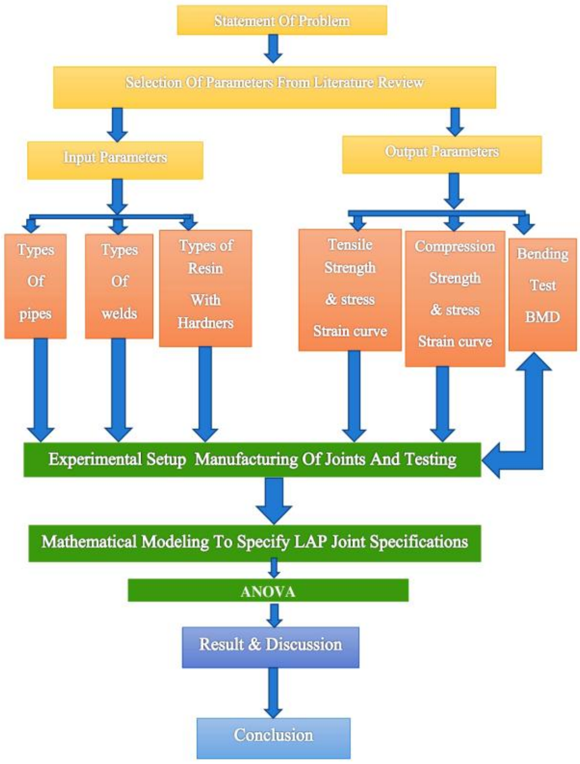


Fig -2: Flowchart of Methodology

2. EXPERIMENTAL SETUP

In the experimental setup investigation of welded butt joint replaced with resin weld following main Components are important, the stage of these are classified as:

1. Proper Mixing of resin with hardener and glasswool, to joint the hollow GI pipe.
2. Arc Welding Process is used for another hollow pipe joint for comparison of resin joint pipe.

Steps in methodology:

1. Basic bonding requirement Parts to be bonded must be clean. If the surface of the parts contains oxidations/rust, wetness, oil or dirt then the adhesive

will not be able into joint failure. Therefore contaminants and weakly bounded surface to make proper joint with required strength which results layers must be removed for strong bonding of the surfaces. Also joining surface should not be very smooth as it will not give proper grip to adhesive to hold the material. Sand paper abrasive is most commonly used to clean the surface.

2. Preparation of joint:
GI Pipe of 25.4 mm size hollow pipe with length 300 mm, weight 425 kg of are selected for the experiment. The surfaces of the plates to be joined are cleaned using abrasive sand paper. Mix the Adhesive material thoroughly and apply it properly on the surface of the plates. Control the bonding thickness as per design requirement. Apply a uniform clamping pressure on the joint for one to two hours. This clamping pressure is nearly equal to 0.2MPa to 0.3MPa. Once the adhesive is properly cured, the joint is ready for the further testing. And for Comparison purpose Arc welding Process is used for same size pipe to joint the pipe.
3. Tests on Universal Testing Machine (UTM)

2.1 Preparation of Joints

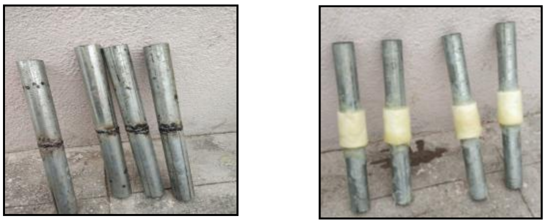


Fig 3: Welded and Resin Joint Sample

3. DESIGN OF EXPERIMENT

3.1 Tensile Strength of Welded Butt Joint

Apparatus : Universal Testing Machine, GI hollow of two types resin weld joint and welded joint, Graph Pape, Scale, Vernier Calliper.

3.2 Procedure :

1. Measure the original length and diameter of the specimen. The length may either be length of gauge section which is marked on the specimen with a preset punch or the total length of the specimen.
2. Insert the specimen into grips of the test machine and attach strain measuring device to it.
3. Begin the load application and record load versus elongation data
4. Continue till the test till Fracture occurs.

3.3 Original dimensions

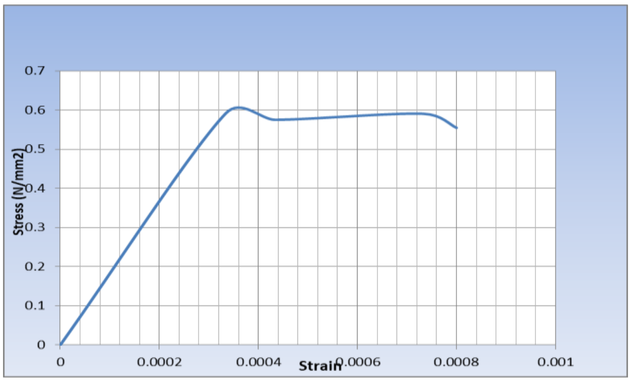
1. Specimen Type = Hollow
2. Length (mm) = 300
3. Outer Diameter (mm) = 320
4. Wall Thickness (mm) = 2
5. Area (mm^2) = 97.38

Fig 4: Tensile Test for welded Joints

Fig 5: Reading of Load for Welded Joints

Table 1: Observation Table for Four Samples

Sr. No	Load (N)	Original Gauge length	Extension (mm)	Stress= Load/Area (N/ mm^2)	Strain= Increase in length/ Original length
1.	0	300	0	0	0
2.	57600	300	300.1302	591	0.0003
3.	56000	300	300.2213	575	0.0004
4.	57500	300	300.2200	590	0.0007
5.	54000	300	300.2600	555	0.0008



Graph 1: Stress Vs Strain Curve for Welded Joint

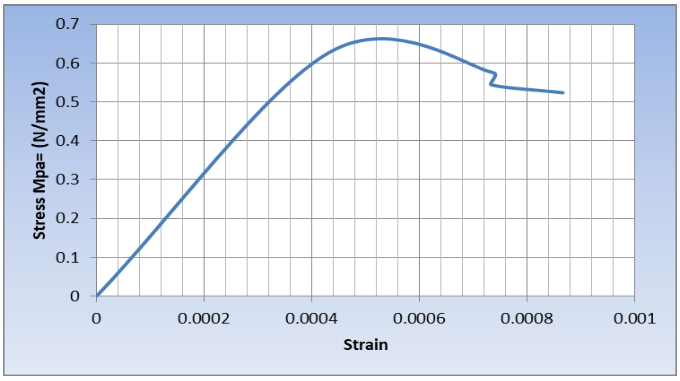
3.4 Tensile Strength Of Resin Weld Butt Joint

Fig 4: Tensile Test for Resin Joints

Fig 6: Reading of Load for Resin Joint

Table 2: Observation Table for Four Sample

Sr. No	Load (N)	Original Gauge length	Extension (mm)	Stress= Load/Area (N/ mm^2)	Strain= Increase in length/ Original length
1.	61200	300.000	300.1302	628	0.0004
2.	56000	300.000	300.2213	575	0.0007
3.	53000	300.000	300.2200	544	0.0007
4.	51000	300.000	300.2600	524	0.0009



Graph 2: Stress Vs Strain Curve for Resin Joint

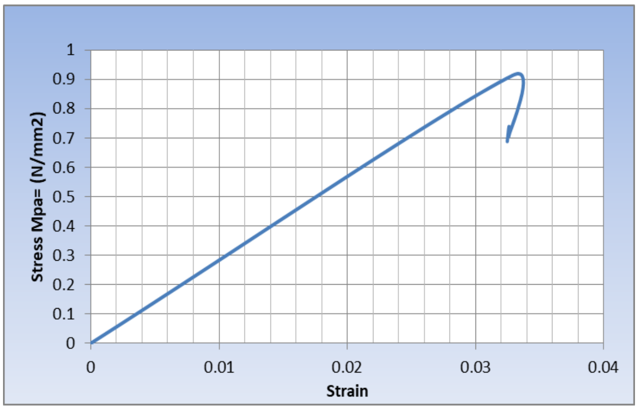
3.5 Compressive Strength Of Welded Butt Joint

Fig 4: Compressive Test for Welded Joints

Fig 6: Reading of Load For welded Joint

Table 3: Observation Table for Four Sample

Sr No.	Load (in KN)	Length (in mm)	Stress (Mpa)	Strain
1	0	300	0	0
2	89	290.1302	0.91395	0.0329
3	69	290.2213	0.70856	0.0326
4	72	290.2200	0.73937	0.0326
5	67	290.2600	0.68803	0.0325



Graph 3: Stress Vs Strain Curve for Welded Joint

3.6 Compressive Strength of Resin Welded Butt Joint

Fig 4: Compressive Test for Resin Joints

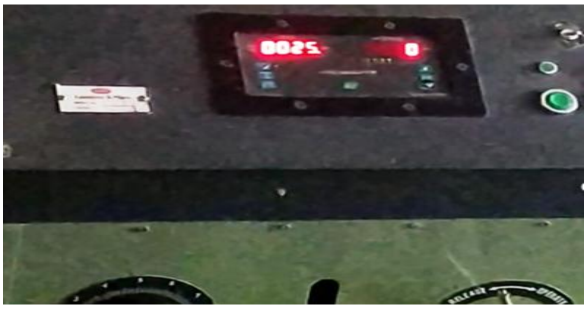
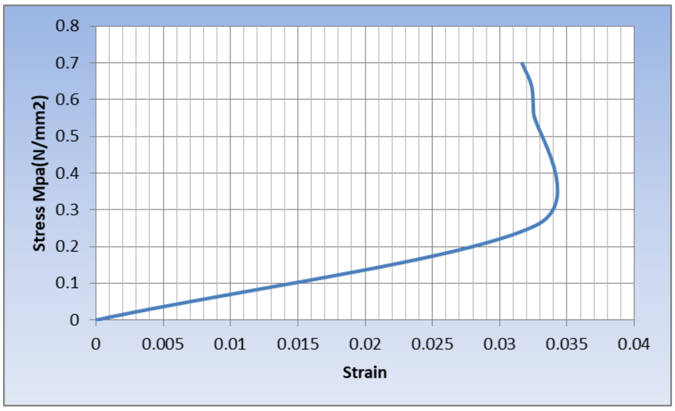


Fig 6: Reading of Load for Resin Joint

Table 4: Observation Table for Four Sample

Sr No.	Load (in KN)	Length (in mm)	Stress (M pa)	Strain
1	0	300	0	0
2	25	290.2100	0.25673	0.0326
3	55	290.2500	0.5648	0.0325
4	62	290.2900	0.63668	0.0324
5	68	290.5000	0.6983	0.0317



Graph 4: Stress Vs Strain Curve for Resin Joint

3.7 ANOVA

The main purpose of Analysis of variance is to show how the data fits for the model. The P-value of regression and Lack of fit plays an important role in determining the fitness of model. P-values (P) in the analysis of variance table are used to determine which of the effects in the model are statistically significant. P-values determine whether a factor is significant; typically compare against an alpha value of 0.05. If the p-value is lower than 0.05, then the factor is significant. ANOVA is a necessary test which is performed in most of the optimization process due to its accuracy in prediction of P-values.

3.8 One Way ANOVA:

The one way ANOVA compares the means between groups you are interested in and determines whether any of those means are statistically significantly different from each other, specifically, itb tests the null hypothesis:

H_0: $\mu_1 = \mu_2 = \mu_3$

Where ,

H_0 = the null hypothesis,

μ_1 = the mean of population 1, and

μ_2 = the mean of population 2.

Since, No difference among the means values Then alternative (H1) will be

H1= At least One difference among the values.

Notation:

SS : Sum of Square

df : Degree Of Freedom

MS : Mean Sqaure

3.9 Steps for Calculating the One Way Anova :

1. State Null and Alternative Hypothesis
2. Calculate the degree of freedom (df)
3. Calculate Sum of Square of Deviation from the mean (SS)
4. Calculate Mean Square
5. Calculate F-Statistics
6. Compare F Values
7. State the Conclusions

3.10 Analysis of Tensile Load of Welded Joint for Group A and Tensile Load of Resin Weld Joint for Group B

Table 5: Observation Table for Four Sample

A	B
57600	61200
56000	56000
57500	53000
54000	51000

Table 6: Anova: Single Factor For Compression Load

SUMMARY

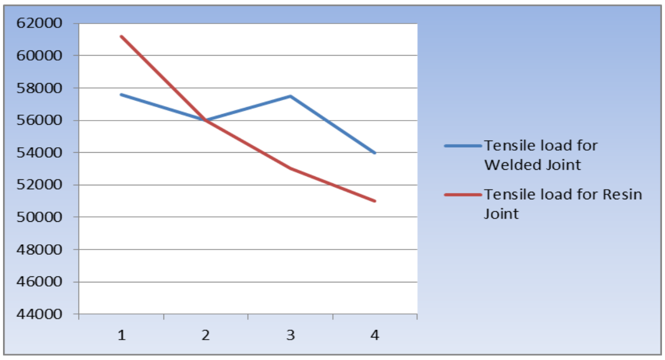
Groups	Count	Sum	Average	Variance
A (Tensile load of welded joint)	4	225100	56275.00	2835833.33
B (Tensile load of Resin Joint)	4	221200	55300.00	19693333.33

Table 7: ANOVA for Tensile Load

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1901250	1	1901250.00	0.17	0.70	5.99
Within Groups	67587500	6	11264583.33			
Total	69488750	7				

Calculated **F (0.17)** value is less than the tabulated **F (5.99)** Value Hence H0 is accepted and it means there is no difference among the two groups.



Graph 5: Main Effects and Interactions for Tensile Load

3.11 Analysis of Compressive Load of Welded Joint for Group A and Compressive Load of Resin Weld Joint for Group B

Table 5: Observation Table for Four Sample

A	B
89000	25000
69000	55000
72000	62000
67000	68000

Table 8: Anova: Single Factor For Compression Load

SUMMARY

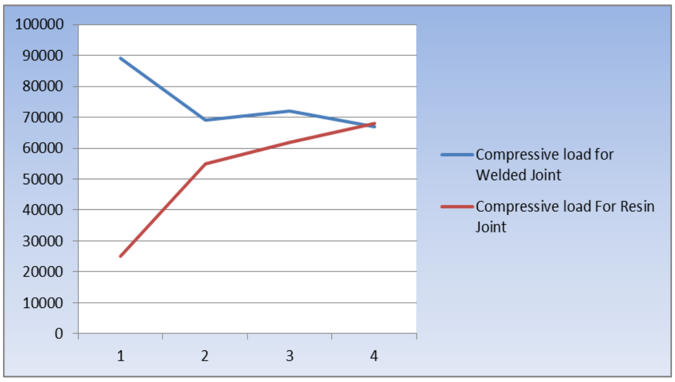
Groups	Count	Sum	Average	Variance
A (Compressive Load Of Welded Joint)	4	297000	74250.00	100916666.67
B (Compressive Load Of Resin Weld Joint)	4	210000	52500.00	364333333.33

Table 9: ANOVA for Compression Load

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	946125000	1	946125000.00	4.07	0.09	5.99
Within Groups	1395750000	6	232625000.00			
Total	2341875000	7				

Calculated **F (4.07)** value is less than the tabulated **F (5.99)** Value Hence H0 is accepted and it means there is no difference among the two groups.



Graph 5: Main Effects and Interactions for Tensile Load

4. CONCLUSION

Experimental results are obtained from the best combination of input and output process parameters. The developed experimental investigation of all the testing procedure implies that Resin weld is also important factor instead of welded joint in joining technique because of similarity of loading conditions and the advantages of resin weld over welded joints. Resin-bonding that it has several benefits than individual one. The current use of weld-bonding in engineering applications is at aerospace and automobile industry. The excellent fatigue property and better static strength of joint makes the light-weight structure possible for assembly in automobile sector and thus this light weight structure increases the strength to weight ratio. Use in different materials like Metal Ceramics, Wood, Vulcanized Rubber, Foams, Plastics. And it was found that resin weld provided better result as compared to welded joint. Thus we used resin weld as joining material

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