A REVIEW ON EXPERIMENTAL INVESTIGATION OF WELDED BUTT JOINT REPLACED WITH RESIN WELD

Dhananjay P. Kale [1], Prof. R.L.Karwande[2], Prof. Md. Javed[3].

[1]*PG Student, Department of mechanical engineering, MSS'S CET, JALNA, MH India.*

[2, 3,] *Assistant professor, department of mechanical engineering, MSS'S CET, JALNA, MH India.*

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 behaviour 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.

Keyword:- *Process parameter, Finite Element Analysis, CFRP, Epoxy Resin Adhesive, Universal Testing Machine*

1. INRODUCTION

Resin bonding offers improved joint stiffness compared to 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 applications is that they prevent ingress of water 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

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. These resins are highly tailorable to structural and thermal requirements and may even be formulated to fit specific needs. Resins have been formulated to achieve increased fracture toughness, adjust moisture absorption characteristics, provide high-temperature capabilities, and tailor pot life, viscosity, and strength. For example, structures that undergo in-plane bending at joints require the resin to carry a substantial inter laminar shear in the joint transition region. Epoxy resins have been widely used as a model matrix for research into natural fibre composites, they are unlikely to see widespread use in commercial natural fibre composites because of their relatively high cost. Cheaper resins, such as polyester and vinyl ester, are more commonly used. Phenolic resins have good fire resistance but are more difficult to process. Epoxy resin is most often used because it is almost totally transparent when cured. In the aerospace industry, epoxy is used as a structural matrix material or as structural glue.

2. LITERATURE REVIEW

Agustn Chiminelli et al. [2017] in this paper study was done on ‘Analysis of mixed adhesive joints considering the compaction process. Main objective of this paper is that take analysis on a mixed adhesive joints by compaction process to get improvements in the work, the potential of the techniques based in a grading of properties is analysed for a single lap joint using the mixing adhesive approach (banded shape). In addition, the compaction process effect in the structural response of the joint was analysed too, i.e. how the resin distribution after the joint assembly affects to the load bearing capacity. This methodology has been experimentally validated through joint tests that exhibit an ultimate load increased upto 70% respect to the base adhesives assemblies .[1]

Hitoshi Nakamura et al. [2009] has studied on ‘Experimental study on repair of fatigue cracks at welded web gusset joint using CFRP strips’ This paper presents repair methods of fatigue cracks using CFRP strips. In particular, the subject of repair is fatigue cracks initiated at welded web gusset joints, which are the typical details in steel bridges. Several repair methods were investigated experimentally focusing on weld details. In addition, more effective repair methods were also investigated using combination of CFRP strips and drill-holes. As a result, it was found that fatigue life after repair was significantly improved. Therefore, the authors confirmed the feasibility of the proposed technique as a useful repair method to improve fatigue life of steel structures. And concludes that for fatigue cracks initiated at the weld toe of web gusset joints, the repairs were performed using CFRP strips and epoxy resin adhesive, and the effects of repair on the bond strength and the fatigue durability were examined experimentally and analytically as increase of bond strength and reduction of opening displacement of joint , the proposed method was positioned as a first aid repair to prolong the fatigue life , since no crack recurrence was prevented. [2]

Xiaocong He et al. [2011] studied on finite element analysis of adhesively bonded joints. The main objective was used to the increasing demand for energy-efficient vehicles, there was an increasing need to design lightweight structures such as aircraft and vehicle body frames. Because of this factor and due to the increased use of lightweight materials, sheet material joining techniques have been developed rapidly in recent years for joining advanced lightweight materials that were dissimilar, coated and hard to weld. He concluded that, differences in the basic mechanical properties, hygrothermal behavior, occurrence of high stress gradients in certain regions of the joints. And also FEA model of adhesive bonded joint must be able to predict failure in the adhesive and at the adhesive – adherend interfaces.[3]

E.M.Sampaio et al. [2017] studied on Static failure analysis of adhesive corner joints. The main objective was concerned with the failure analysis of a special type of adhesive corner joint, which was essentially a rectangular cantilever bonded to a support. The purpose of this work was to provide a method to easily perform the static failure analysis of a class of corner-joints with arbitrary glued area. [4]

El-Sabbagh et al. [2008] studied the properties and performances of various hybris glass/natural fibres composites for curved pipes. The objectives of this paper is that use of natural fibres for application in the piping industries. And he concluded that the material selected were fully characterized in terms of their mechanical properties.[5]

Md. Shamsuddoha et al. [2013] studied on Effectiveness of using fibre reinforced polymer composites for underwater steel pipeline repairs. The main objective of project was repair of corroded and gouged pipes incorporating with fibre-reinforced composite wraps. This paper provides a comprehensive review on the use of fibre-reinforced polymer composites for in-air, underground and underwater pipeline repairs. They concluded that, the advancement in this new material opens up great opportunities to expand the options for pipeline industry to rehabilitate and reinstate their pipeline systems using a lightweight, high-strength, fast and easy to handle, and cost effective material system. [6]

Heraldo S. et al. [2012] in this paper suggested a simple methodology for the design of lap joint bonded with epoxy/ceramic composites. And proposed a shape factor that allows correlating the static strength of two single lap joints with different geometries. The formula was valid for epoxy/ceramic composites used as adhesive in special applications in oil and gas industry and highly resistant metallic adherends. The experimental results performed in the present study indicates that the proposed methodology can be a simple but effective auxiliary tool in joint design. The shape factor may be used to obtain a preliminary estimate of the adhesive area before a more adequate (but complex) analysis.[7]

Garbiñe Fernandez et al. [2017] In this paper studied Experimental identification of static and dynamic strength of epoxy based adhesives in high thickness joints. The main objective of this paper study Epoxy based adhesives already have a long history in structural joining. Commonly with this type of adhesive, the bond layer is thin. However, as the thickness of a joint increases (e.g. over 10 mm), its structural properties may alter very much. In such a case, both the interfacial strength and the intrinsic adhesive strength need to be verified in static and dynamic conditions. This research work identifies joint strength using a mainly experimental procedure. They concluded that an experimental campaign for the identification of the static and cyclic strength of adhesively bonded joints on glass fibre reinforced composite materials. This campaign focuses on joint thicknesses up to 10 mm and on multi-axial stress states, with one component of normal stress and one component of shear stress. [8]

Asuka Suzukia et al. [2018] In this paper studied Structural design and bonding strength evaluation of Al/epoxy resin joint via interpenetrating phase layer. In this paper their main objective is that, the effect of the volume fraction of resin on the bonding strength of Al/epoxy resin joints via interpenetrating phase layer. In this project they concluded that, the tensile strength and the fracture points can be understood by the strength of each interface estimated from rule of mixture. [9]

M. Satyanarayan Gupta et al. [2016] In this paper studied the Fabrication and Analysis of Adhesive joints Used in Aircraft Structures. In This paper studied that, Fabrication, Analysis and Testing of adhesive joints used in the aircraft structures. An adhesive was any substance applied to the surfaces of materials that binds them together and resists separation. Some of the more common adhesives that have been used in aircraft construction and repair include casein glue, plastic resin glue, resorcinol glue, and epoxy. The joints made with the help of adhesive materials are called adhesive bonded joints. The fabrication, Analysis and testing of adhesive bonded Joints are performed in this work. And the shear strength of the double lap joint is more than the single lap joint. The double lap joint is recommended to the structure where the structural components subjected/tends to fail due to shear. It can be demonstrated empirically, that when used properly structural adhesives can meet or exceed the performance of traditional joining methods such as welding, rivets and bolts.[10]

Salih Akpinar et al. [2013] Studied on the Effects of laminate carbon/epoxy composite patches on the strength of double-strap adhesive joints: Experimental and numerical analysis. The main objective of the project was mechanical properties of double-strap joints with aluminum or composite patches of different orientation angles at their overlap area were investigated under tensile loading. In this study concluded that, six different double-strap joint (DSJ) types, one with aluminum and the rest five with composite patches with different orientation angles, were subjected to tensile loading and their mechanical behaviors were investigated numerically and experimentally.[11]

P.S. Sreejith et al. [2016] In this paper studied the updated the review of adhesively bonded joints in composite materials. This paper reports on the main parameters that affect the performance of bonded joints such as surface treatment, joint configuration, geometric and material parameters, failure mode etc. were 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 was still a potential to evaluate and identify the best possible combination of parameters which would give the best performance of composite bonded joints. In this paper it conclude that, the selection of the manufacturing bonding method usually depends on the substrate to be bonded, service condition, area of application, etc. However, there was 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 was 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.[12]

Jianfeng Li. et al. [2014] had taken the Experimental study of adhesively bonded CFRP joints subjected to tensile loads. The main objective of this paper to investigate the influence of different lap parameters on the bond strength and failure mode of the adhesively bonded CFRP joints. They found that, the tensile performance of adhesively bonded CFRP joints has been investigated experimentally.[13]

Avinash Parashar et al. [2015] In this paper they studied on adhesively bonded composite tubular joints. The main objective of this paper was to examine solutions and challenges associated with adhesively bonded fibre reinforced polymer (FRP) pipe sections. FRP materials have been used in piping systems for more than 40 years. Higher specific mechanical properties and corrosion resistance of FRP makes it a potential candidate for replacing metallic piping structures. In this way they concluded that, with the cited advancement in joining techniques, bonding of composite pipes is becoming relatively simple and less cumbersome in terms of time and alignment. Semi-automation and field-friendliness are reported as a key aspect in achieving consistently high joint quality, long- term performance, and cost-effectiveness of composite piping as a whole.[14]

Lucas F.M. et al. [2006] I studied that, adhesive joints at high and low temperatures using similar and dissimilar adherents and dual adhesives. This paper presented for titanium and titanium composite double lap joints. It is shown that, for a joint with dissimilar adherents, the combination of two adhesives gives a better performance (increased load capacity) over the temperature range than a high temperature adhesive alone. Mixed adhesive joints were also cycled thermally to prove that they can be used at low temperatures after a stage at high temperatures, and vice versa. A mixed adhesive joint might be also advantageous depending on the relative importance of the thermal effects and the stiffness unbalance. If the CTEs are such that the thermal loads decrease the load capacity, then the mixed adhesive joint is beneficial.[15]

Bruce L. Taia et al. [2016] In this paper designed a self-contained breathing apparatus (SCBA) using a carbon fibre reinforced polymer and filament winding. This paper summarizes the work developed and here in presented sought to verify the feasibility and the benefits that pressure vessel designers can obtain from using

CFRP filament winding technique in a specific type of pressure vessel design application. In this paper it concluded that the filament winding has been developed along the years and is considered the most efficient and appropriate process to manufacture SCBA made of composite materials. In addition, filament winding provides not only efficient ply deposition.[16]

J.A.B.P. Neto et al. [2012] studied the Parametric study of adhesive joints with composites. The objective was to presents a study of the experimental tests carried with single lap joints with composite adherents and different adhesives, brittle and ductile, with several overlap lengths. A Cohesive Zone Model (CZM) was taken into consideration to predict the results observed during the experimental tests. The experimental results were also compared with simple analytical models and the suitability of each model was evaluated for each bonded system. They found that the characterisation of the failure process and strength of adhesive joints with composites, bonded with different adhesives and from short to long overlaps, and the validation of different predicting methods.[17]

3. REASEARCH FINDINGS AND GAP

In the recent research survey observed some research gap and some literature finding which will be full feel by our present and future work so there are various literature findings which is describe in details as follows, there has been an increased use of adhesive bonding in all industries, as it is more suitable in many aspects, such as high strength to weight ratio, design flexibility, damage tolerance, fatigue resistance etc. over conventional joining methods. In fact, the adhesive bonding has found application in various sectors such as aeronautics, electronics, automobile, sports, marine, oil and even construction industries, etc. The application of adhesively bonded joints for the composite repair of a damaged structure has been also increased in all sectors mentioned above. Hence investigation of resin weld butt joint is important.

4.EXPERIMENTAL METHOD

In this experimental approaches we will used arc welding process for butt joint and epoxy resin for the analysis of various properties . In this model we will used various type of design and experimental approaches for various result. And we will used UNIVERSAL TESTING MACHINE to determine various results effecting on welded joint and resin weld joint by considering various input parameter.

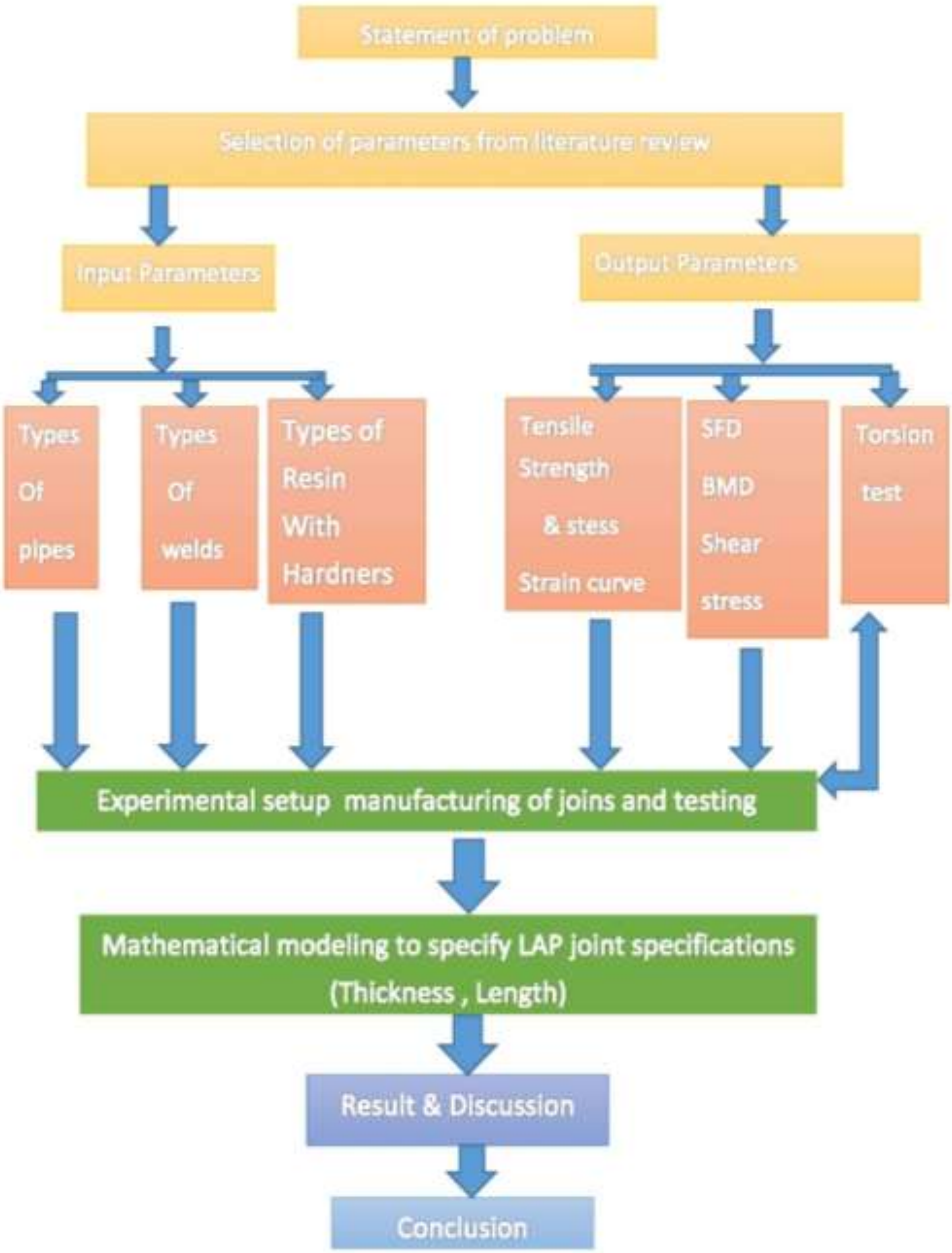

Fig. Flow Chart of Methodology

5. CONCLUSION

This paper summarizes the change in various parameters like tensile strength ,stress ,shear stress and surface roughness of resin weld as compared to weld joint. The input and output temperature difference will be reduced. Adhesive thickness will change load bearing capacity, strength to weight ratio of resin weld butt joint. Based on the literature review, 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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