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Determination of Overlap Length and Overlap Thickness of SS304 by Using Ansys

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ABSTRACT

An adhesive is a material used for holding two surfaces together. An adhesive must wet the surfaces, hold fast to the surfaces, develop strength after it has been applied, and remain Stable. In this work we work on aerospace application, for that application we used material as SS304 and used Adhesive as EA-E30HV.We used specimen size as 130*30*1.95mm. We used different overlap length and overlap thickness. We Select that overlap length and thickness by using different criteria. We used Ansys software to calculate appropriate overlap length and overlap thickness, for that we used Von-misses stress and Deformation, and select one combination which having maximum von-misses stress and maximum deformation.

Keyword : SS304, Adhesive, EA-E30HV, Ansys.

I. INTRODUCTION

Adhesive holding is a material joining process in which an adhesive, set between the adherent surfaces, sets to deliver an adhesive bond. When we bond components then adhesive first wets the surface and then fills the gap between adhesive, then it solidifies. When solidification it becomes the bond that can withstand the stresses. The strongest adhesive is always solidifying through chemical reaction and has an affirmed liking for the joint surfaces. Adhesives come in several forms thin liquids, pre-applied on tapes, thick pastes, films, powders or solids that must be liquefied. Adhesive can be designed with a wide range of strengths, for weak temporary adhesives for holding papers in place to high strength structural systems that bond four whalers and airplanes. This day's adhesive competes with mechanical fasteners such as nuts, rivets, bolts, and welding and soldering. Torsional or angular velocity vibrations which diminish system accuracy.

In the present work, the impact of bonded lap thickness area on the tensile strength of single lap joint is examined experimentally and by using software. Adhesive composite joints these days assume a critical part in aviation, wind turbine and ship designs. Precise failure predictions are required for productive joint designing and it is useful and it having advantages of adhesive bonding, is there will be uniform stress distribution or we can joint less weight materials when compared to mechanical latches. A lot of influencing factors affects the load carrying capacity of an adhesive joint. The geometrical configuration of bonded parts is essential to obtain enough structural strength. Even joints having same adhesively bonded area, they might have different joint strength according to the bonded configuration. The following conditions are additionally essential to accomplish the joint strength (e.g. the surface roughness of adhering surface, the thickness of the adhesive layer, the pressure applied to adhesive resin and its holding time, and curing conditions of adhesive resin are substantial factors affecting the joint strength). Adhesive strength is influenced by the numerous physical and chemical factors. Here in this paper, geometrical configuration of the joint is kept constant. Two adhering parameter has been varied which is adhesive layer thickness and overlap length while other parameters are also kept constant. Mechanical testing is done on the specimen to find out the strength of the joint, after the tensile testing we will find ideal material from that both material for that adhesive.

1. Literature Review

Hans Nordberg includes the important parameter for fatigue failure of spot welded joints, autonomous of

Specimen type (stacking mode) and sheet thickness, is the stress concentration in the weld described by the stress intensity factor range.

Using adhesive bonding the surface condition of the adherent is important. However, the contributions to bond strength afforded by physical and/or chemical induced modifications are considered negligible. Simple alkaline degreasing or for special joints, shot blasting, are often sufficient. The understanding of overlap joining of stainless steel sheets is very different for different types of joining techniques. Spot welding is well understood and design techniques and rules are developed. Adhesive bonding and weld bonding is still in a developing phase but showing promising properties. Overlap laser welding and clinching are promising but are all but understood for stainless steel.

Gene Zak and Wendy Xu Wang There exists a noteworthy collection of work on metal laminate tooling built by the “cut-stack-bond” approach; however, computerization with this strategy is difficult. Building laminations by "stack-bond-cut “sequence, on the other hand, is more agreeable to mechanization. Two principle difficulties of "stack-bond-cut" sequence are blind contour cutting and bonding of the sheet. An enclosing chamber kept at elevated temperature would help to maintain the laminate at a higher temperature for a longer time. Further significant heating of the adhesive was found to occur for several subsequent laminations, which implies that process parameters may have to be adjusted for the upper part layer to assure the adhesive receives similar heat input as on the lower layers.

Rohan chumble states that Adhesive bonding is widely used to join sheet metal. Single lap joints are considered as a good class to joint for sheet metals. Here, examination on single lap glue joint is to be finished. Adherend used is aluminium 99.5% with the specimen size of 130*30*1.95mm.here overlap length is kept as constant which is equal to 40mm. Adhesive layer thickness has varied as 0.05mm, 0.1 mm, 0.15mm, 0.2 mm, 0,3mm and 0.6mm. Tensile load of 400N, 1600N, 3200N etc are applied and stress-strain nature is obtained. It is observed that deformation at small adhesive layer thickness is lesser than that of high adhesive layer thickness at same load. Shear stress value is maximum for 0.05mm ALT while it is minimum for 0.6 mm ALT. More accurate results can be found out by using higher versions of analysis software and by performing more effective meshing of the model.

P. Raos , M. Lucić and F. Matejiček, states that bonding of disciple adherent materials using the same adhesive leads to the different behaviour of adhesive. Specifically, two-component structural epoxy adhesives (Loctite 3421) and aluminium (Al99.5) as adherent materials have been tested experimentally and numerically. Simulation of stretching of joints with programming of FEM (Finite Element Method) is based on all lap length as performed in trial examination. Material model of adhesive and adherent was utilized as multi-linear isotropic (MISO). Utilized material model in numerical analysis was fulfilled, and results obtained with them were in proper relationship with trial for all lap length except for 60 mm of lap length. For given geometry of plates to be fortified, there has been an ideal lap length reached, and its value is 40 mm. adhesive joint could transmit higher values of strength than stresses which adherent could withstand, is leading parameter which initiates that MISO material model in FEA is not adequate any longer. The suitable versatile of elastic-plastic material or creep models should be utilized.

II. METHODS AND MATERIAL

The ANSYS computer program is a vast scale multipurpose finite element program, which might be utilized for fathoming a few classes of designing investigations. As ANSYS has produced, other uncommon abilities, for example sub structuring, sub modeling, irregular vibration, free convection liquid examination, acoustics, magnetic, piezoelectric, couple field analysis and design configuration improvement have been added to the program. Examination of any issue in ANSYS needs to experience three principle steps. They are,

- Pre-processor
- Solution
- Postprocessor

The ANSYS software has numerous limited component investigation abilities running from straightforward, static analysis to a complex, nonlinear, transient dynamic analysis any issue in ANSYS needs to experience the three principle steps

- Build the model
- Apply loads and obtain solution
- Review the results.

The present work manages the examination of adhesively bonded single lap joint. This is quite normally utilized technique for finding the strength various applications such as pressure vessels, aviation, marine and most part for sealed joints like oil tanks, boilers etc. In this, we are using for Aerospace purpose hence material used in that purpose is SS304.In this, plates of SS304 material are used with dimension 30x130x1.95mm is used with overlap length as 15mm,30mm,60mm and overlap thickness as 1mm,1.5mm,2mm. One end of the joint is fixed while tensile load is applied on the other end. Load applied are 500N, 1000N, 2000N for all joints and 4000N, 5000N, 7000N for some cases. Results are obtained for each load and adhesive layer thickness. These results are compared to get some significant information.

Models are prepared by using CATIA software and saved in 'igs' form and then import in ANSYS 11.0 for further processes. New project simulation is carried out for each model.

Material Properties used in Ansys

Table I. Properties of Adhesive and adherent

Properties	**Adhesive**	**Adherent**
Young's Modulus,E_0	193 Gpa	7960N/mm^2
Poisson's ratio ν	0.35	0.29

Boundary Conditions:-

By using boundary conditions we can define forces on specimens, which are as shown in table.

Table I. Boundary conditions

Spe. no.	Dimensions(mm)	1stend Condi.	End condition(2ndend)
1	T=1 & L=30	Fixed	500,1000,2500N
2	T=1 & L=60	Fixed	500,1000,2000,4500N
3	T=1.5 &L=30	Fixed	500,1000,2000,4000,5000N
4	T=1.5 &L=60	Fixed	500,1000,2000,4000,7000N
5	T=2 & L=30	Fixed	500,1000,2000N
6	T=2 & L=60	Fixed	500,1000,2000N
7	T=1.5 &L=15	Fixed	500,1000,2500N
8	T=2 & L=15	Fixed	500,1000,2000,4000N
9	T=1 & L=15	Fixed	500,1000, 3000N

We apply all these boundary conditions to the Adhesive joint and we calculate Von-misses stress and deformation. By giving this end condition we are getting Ansys results follows.

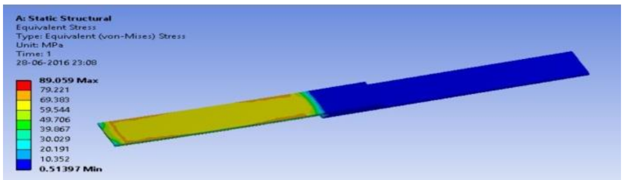

Figure 1. Von-misses for T=1mm, L=30mm at 2500N

As shown in the fig.1 at T=1,L=30mm for the loading condition 2500N max von misses stresses are 89.059mpa and it is as shown in the dig .

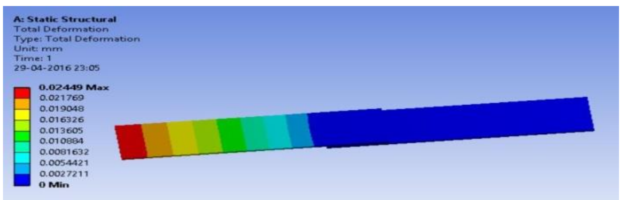

Figure 2. Deformation for T=1mm, L=30 at 2500N

As shown in the fig.2 at T=1, L=30mm for the loading condition 2500N max. Deformation is 0.02449mm and it is at the starting point of the strip.

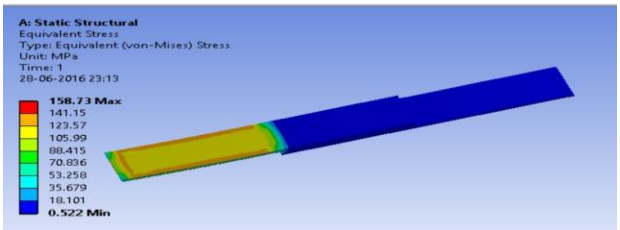

Figure 3. Von-misses for T=1mm, L=60mm at 4500N.

As shown in the fig.3 at T=1,L=60mm for the loading condition 4500N max von misses stresses are 158.73mpa and it is as shown in dig.

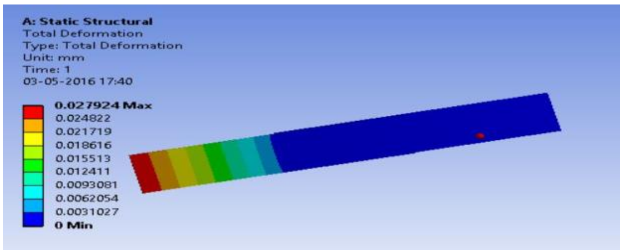

Figure 4. Deformation for T=1mm, L=60 at 4500N

As shown in the fig.4 at T=1, L=60mm for the loading condition 4500N max. Deformation is 0.027924mm and it is at the starting point of the strip.

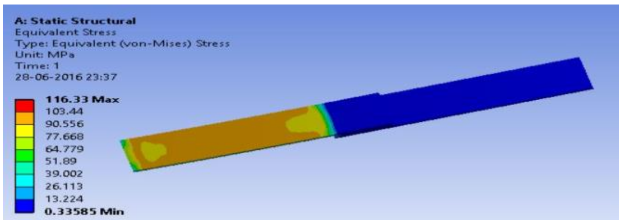

Figure 5. Von-misses for T=1.5mm, L=30mm at 5000N

As shown in the fig.5 at T=1.5,L=30mm for the loading condition 5000N max von misses stresses are 116.33mpa and it is as shown in fig .

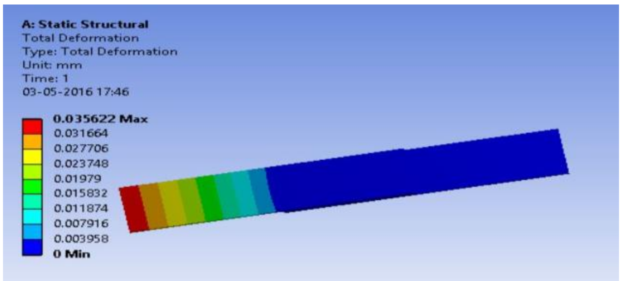

Figure 6. Deformation for T=1.5mm, L=30 at 5000N

As shown in the fig.6 at T=1.5, L=30mm for the loading condition 5000N, max. Deformation is 0.035622mm and it is at the starting point of the strip.

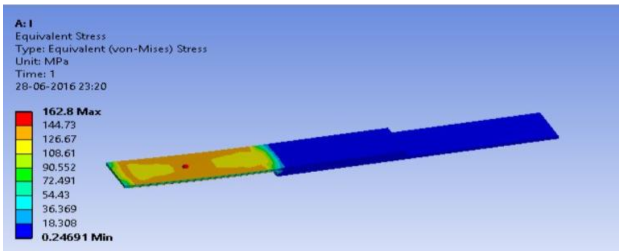

Figure 7. Von-misses for T=1.5mm, L=60mm at 7000N

As shown in the fig.7 at T=1.5,L=60mm for the loading condition 7000N max von misses stresses are 162.8mpa and it is as shown in fig.

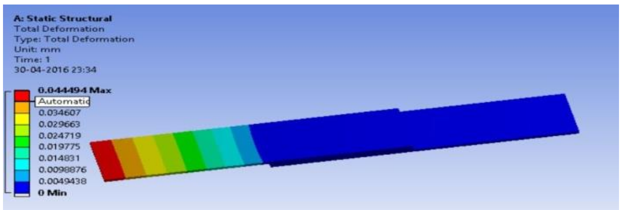

Figure 8. Deformation for T=1.5mm, L=60 at 7000N

As shown in the fig.8 at T=1.5, L=60mm for the loading condition 7000N, max. Deformation is 0.044494mm and it is at the starting point of the strip.

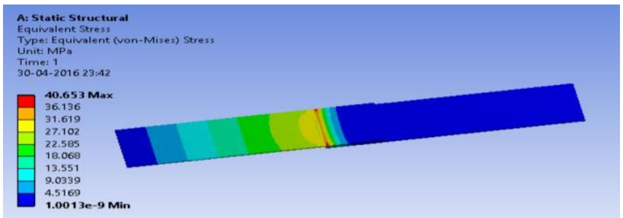

Figure 9. Von-misses for T=2mm, L=30mm at 2000N

As shown in the fig.9 at T=2,L=30mm for the loading condition 2000N max von misses stresses are 40.653mpa and it is at the starting point of the joint.

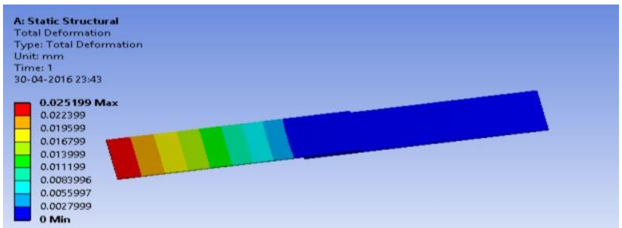

Figure 10. Deformation for T=2mm, L=30 at 2000N

As shown in the fig.10 at T=2, L=30mm for the loading condition 2000N, max. Deformation is 0.025199mm and it is at the starting point of the strip.

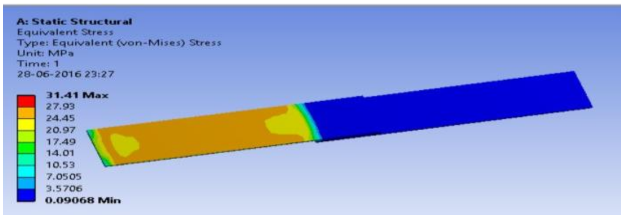

Figure 11. Von-misses for T=2mm, L=60mm at 2000N

As shown in the fig.11 at T=2,L=60mm for the loading condition 2000N max von misses stresses are 31.41mpa and it is as shown in fig

.

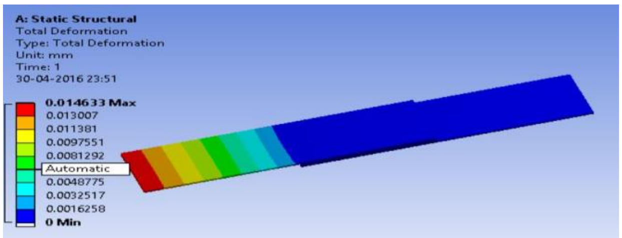

Figure 12. Deformation for T=2mm, L=60 at 2000N

As shown in the fig.12 at T=2, L=60mm for the loading condition 2000N, max. Deformation is 0.014633mm and it is at the starting point of the strip.

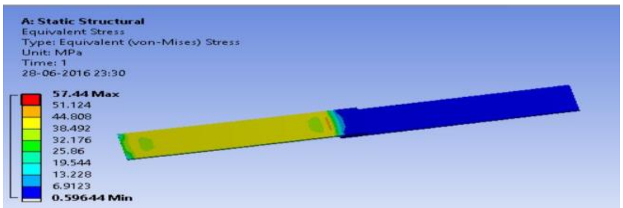

Figure 13. Von-misses for T=1.5mm, L=15mm at 2500N

As shown in the fig.13 at T=1.5,L=15mm for the loading condition 2500N max von misses stresses are 57.44mpa and it is at the starting point of the joint.

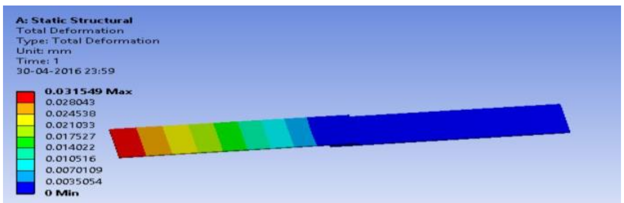

Figure 14. Deformation for T=1.5mm, L=15 at 2500N

As shown in the fig.14 at T=1.5, L=15mm for the loading condition 2500N, max. Deformation is 0.031549mm and it is at the starting point of the strip.

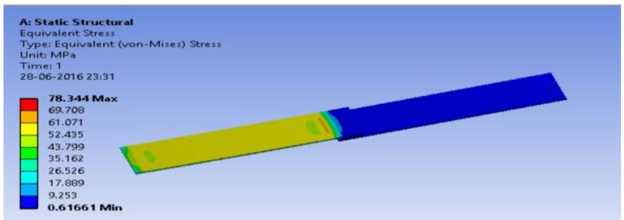

Figure 15. Von-misses for T=2mm, L=15mm at 4000N

As shown in the fig.15 at T=2,L=15mm for the loading condition 4000N max von misses stresses are 78.344mpa and it is at the starting point of the joint .

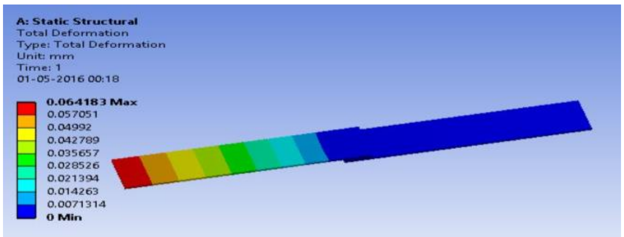

Figure 16. Deformation for T=2mm, L=15 at 4000N

As shown in the fig.16 at T=2, L=15mm for the loading condition 4000N, max. Deformation is 0.064183mm and it is at the starting point of the strip.

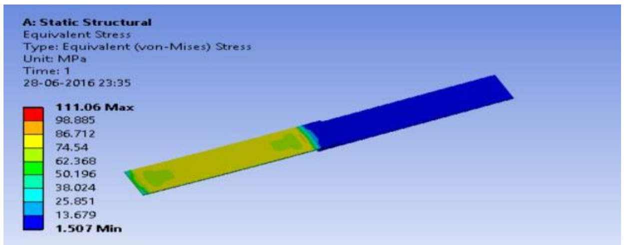

Figure 17. Von-misses for T=1mm, L=15mm at 3000N

As shown in the fig.17 at T=1,L=15mm for the loading condition 3000N max von misses stresses are 111.06mpa and it is at the starting point of the joint .

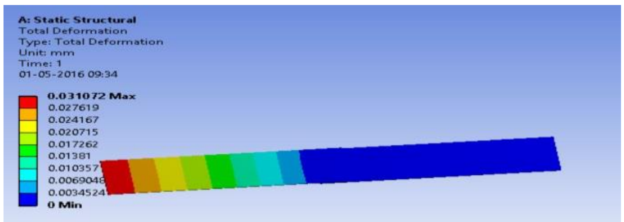

Figure 18. Deformation for T=1mm, L=15 at 3000N

As shown in the fig.18 at T=1, L=15mm for the loading condition 3000N, max. Deformation is 0.031072mm and it is at the starting point of the strip.

The goal of experimental work is to find the optimum overlap length and optimum overlap thickness for the joint in which adherent is SS304 and adhesive is Loctite EA E-30HV.

III. RESULTS AND DISCUSSION

Table I. Results By Using Ansys

Spe. No	Dimensions	Force(N)	Stress (mpa)	Deformatn (mm)
1	T=1 & L=30	500	10.624	0.0061
		1000	42.494	0.012245
		2500	89.059	0.02449
2	T=1 & L=60	500	7.6728	0.0036415
		1000	15.346	0.007283
		2000	56.421	0.014566
		4500	158.73	0.027924
3	T=1.5 & L=30	500	7.6006	0.003768
		1000	15.201	0.007536
		2000	30.402	0.015074
		4000	70.71	0.030147
		5000	116.33	0.035622
4	T=1.5 & L=60	500	7.6628	0.003707
		1000	15.326	0.0074157
		2000	30.651	0.014831
		4000	91.953	0.029663
		7000	**162.8**	**0.04449**
5	T=2 & L=30	500	10.163	0.00629
		1000	20.326	0.012599
		2000	40.653	0.025195
6	T=2 & L=60	500	6.9636	0.003658
		1000	13.927	0.0073163
		2000	31.41	0.014633
7	T=1.5 & L=15	500	10.842	0.00788
		1000	43.37	0.01577
		2500	57.44	0.031549
8	T=2 & L=15	500	10.424	0.00802
		1000	20.848	0.01604
		2000	41.696	0.032091
		4000	78.344	0.064183
9	T=1 & L=15	500	10.943	0.0077679
		1000	61.302	0.015536
		3000	111.06	0.031072

If we observe all that results we can say that for specimen no four we are getting best results i.e. we are getting maximum von misses stress as 162.8mpa and maximum deformation as 0.04449mm so we can say that for SS304 and for Epoxy EA-E30HV it will give us best results if we use overlap length as 60mm and overlap thickness as 1.5mm.

IV. CONCLUSION

As showing in the Table no.3, in that table we got all the results by using ANSYS. In that results for specimen no four i.e. for overlap thickness 1.5mm and for overlap length 60mm we are getting maximum Von misses stress as 162.8mpa and deformation as 0.04449mm.can say that when we have to join two plates (130*30*1.95) of SS304 by using Adhesive EA-E30HV for overlap length 60mm and overlap thickness 1.5 we are getting best results. We can test that by using ANSYS.

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