Analysis of Repaired Bajaj Discover 135cc Chassis Frame Joint Through Hybrid Joint

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Abstract- *A motorcycle, also known as a two-wheeler, is a common form of public transportation in many countries around the world. The Chassis is considered to be one of the significant structures of an automotive engineering usually made of a steel frame which holds the body and motor of an automotive vehicle. This paper is intended to provide a repair of a chassis for the future motorcycle 135cc discover for the Bajaj brand. Chassis parts may gets fails due to various load and fatigue parameter generally it would be repaired by metal inert gas welding (MIG).But in this work an attempt, to prepare hybrid joint using combination of ductile adhesive araldite 2015 supplied by Huntsman International India Pvt. Ltd and MIG welding. The material used for the structure is cold rolled steel IS513 having yield strength of 250 MPa. The Catia v5 R20 and Ansys 14.5 workbench play major role for modeling & analysis of chassis respectively. The structural analysis of the chassis shown the stress and displacement plots and it is limited to the rear part of the chassis keeping the same as parameters. The computed results for chassis repaired by new hybrid joint are then compared with the existing chassis where it is found that the novel repaired technique chassis is safe and stronger in strength.*

Keywords- CAD, CAE, Catia v5 R20, Ansys 14.5, Chassis, Single Lap Adhesive Joint, MIG, Finite Element Method, Structural Analysis.

I. INTRODUCTION

The chassis frame forms the backbone of a vehicle; its principle function is to safely carry the maximum load for all designed operating conditions. Automotive chassis is the main carriage system of a vehicle. The chassis serves as a skeleton upon which parts like gearbox and engine are mounted. The two-wheeler chassis consists of a frame, suspension, wheels and brakes. The chassis is what truly sets the overall style of the two wheeler. Commonly used material for two-wheeler chassis is steel which is heavy in weight or more accurately in density. There are various alternate materials like Cold rolled steel IS513 alloys, titanium, carbon fiber, magnesium, etc.

Fig.1: Bajaj Discover 135cc Chassis Frame

Properties of cold rolled steel IS513

Material: 100Cr6
Young's Modulus: 2.1 e^5 MPa
Poisson's Ratio: 0.3
Density: 7.850×10^{-6} Kg/mm^3
Yield Strength: 410MPa

In automobile chassis frame most off the joints are of lap type that's why we choose such a type of lap joint for testing. The existing Motor bicycle chassis all subparts assembled by means of MIG welding. It might have got fails due to vibration and fatigue loads come from road irregularity and change in mechanical properties of chassis due to heat developed by MIG welding. Instead of taking direct test on chassis parts and chassis, in this project same material will be selected for preparation of control sample (single lap welded/adhesive/welded adhesive joint) as per **ASTM D1002-01** standard.

Table 1. Mechanical properties of cold rolled IS513

Property	IS513	MIG Weld
Tensile strength σt MPa	410	396
Yield Stress σy MPa	280	273
Poisson's Ratio	0.29	0.3

For the testing program two different kinds of adhesives were selected. A brittle one (Huntsman AV138 +

HV998 Hardener) and a more ductile one (Huntsman Araldite 2015). These adhesives when applied on a patterned surface are expected to have different behaviors.

Fig.2: Araldite 2015 with the tube for application of the adhesive & Araldite AV138 with Hardener HV998

The mechanical properties of the adhesive can be seen on Table 1 & 2

Table 2. Properties of the Adhesives Araldite 2015

Property	Araldite 2015
Young's modulus, E [GPa]	1.850+/-0.21
Poisson's ratio	0.33
Tensile yield strength, σy [MPa]	12.630+/-0.61
Tensile failure strength, σf [MPa]	21.631+/-.61
Shear modulus, G [GPa]	0.560+/-.21
Shear yield strength, τy [MPa]	14.61+/-.3
Shear failure strength, τf [MPa]	17.91+/-.8

Table 3. Properties of the Adhesives AV138

Property	AV138
Young's modulus, E [GPa]	4.897+/-0.81
Poisson's ratio	0.35
Tensile yield strength, σy [MPa]	36.492+/-.47
Tensile failure strength, σf [MPa]	39.453+/-.18
Shear modulus, G [GPa]	1.560+/-.01
Shear yield strength, τy [MPa]	4.8970+/-0.81
Shear failure strength, τf [MPa]	30.20+/-.40

II. DESIGN & ANALYSIS OF WELDED JOINT

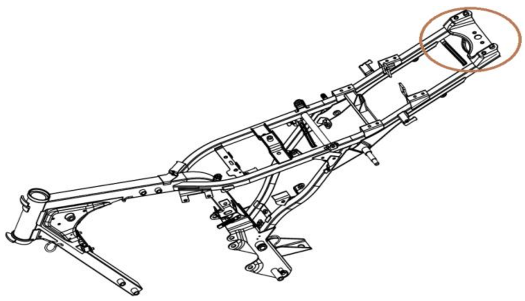


Fig.3: 2D Drawing of Discover 135cc Chassis

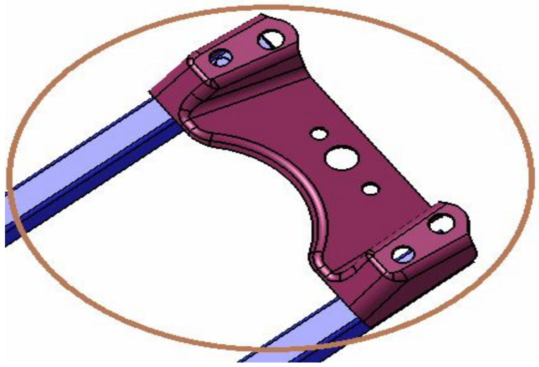


Fig.3: A- Seat mounting bracket

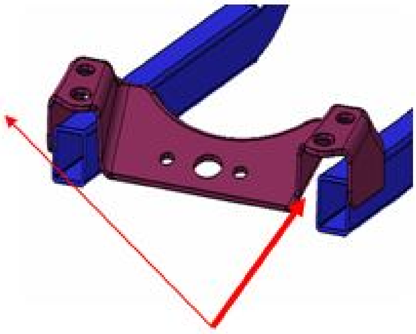


Fig.4: Bracket mounted on chassis by manse of 8 mm overlap where adhesive and MIG weld are possible and called hybrid joint

In above figure Seat mounting bracket is mounted on chassis arm by covering 8 mm contact area by means of welding. Similarly there are number of sub parts are mounted on chassis to perform their holding function. Generally thickness of chassis arm is of 1.6 mm and mounting bracket of 2mm in thickness. In this hybrid joint is proposed for all sub parts which are make contact area on chassis arm more than 5 mm, because it achieved good strength of adhesive joint. When motorcycle is in running condition all sub parts are under shear load and direct load. If this case are in repetitive nature then joint may gets fail if it purely prepared by MIG weld. Because material loss its elastic and plastic properties due to uneven heating of welding process.

But it can be recovered if joint is prepared by adhesive and MIG welding and it can be increased shear strength capacity.

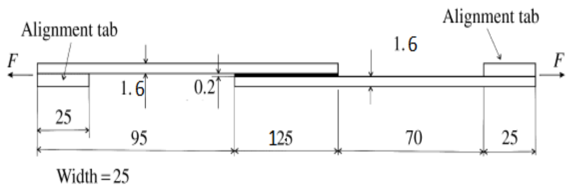


Fig.5: Single Lap Geometry (not to scale, dimensions in mm)

2.1 CAD MODELS

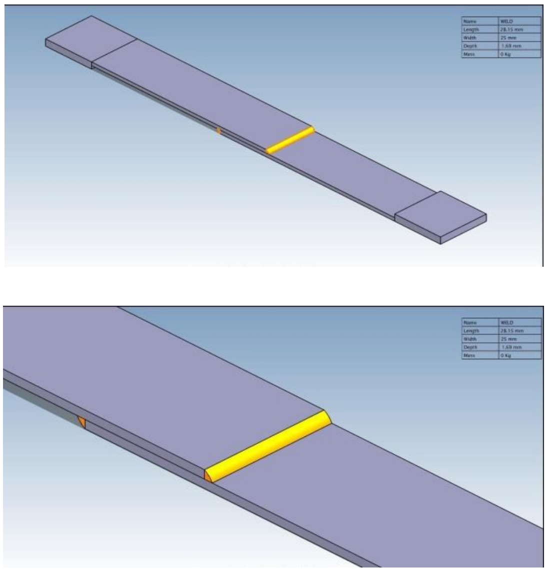


Fig.6: Purely MIG Welded Joint Model

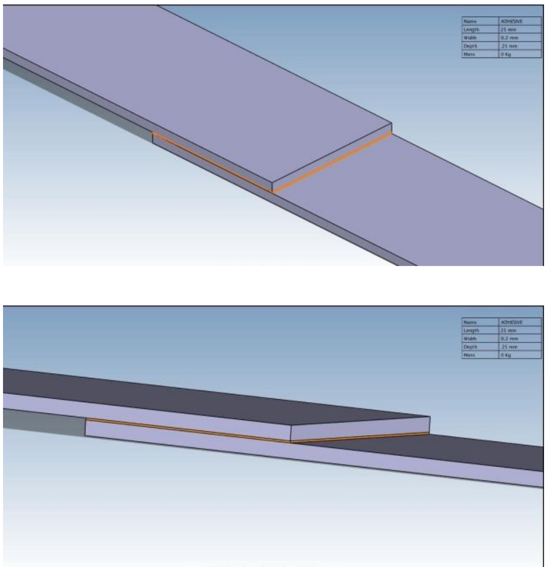
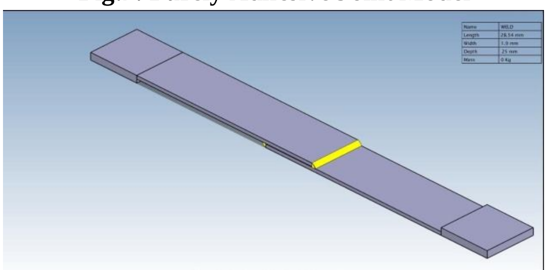


Fig.7: Purely Adhesive Joint Model



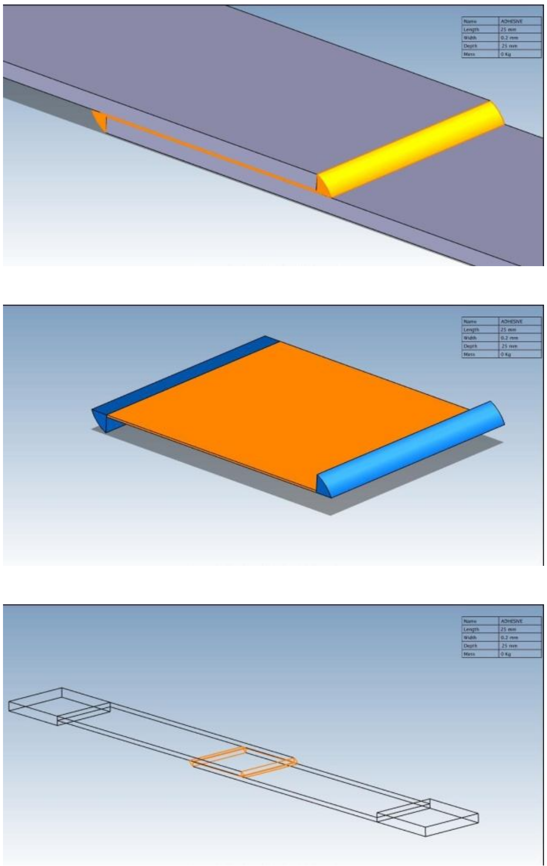
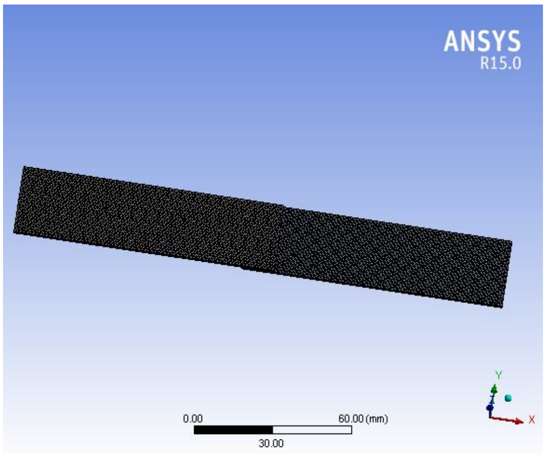


Fig.8: Hybrid Joint Model

2.2 ANALYSIS THROUGH ANSYS 14.5 WORKBENCH



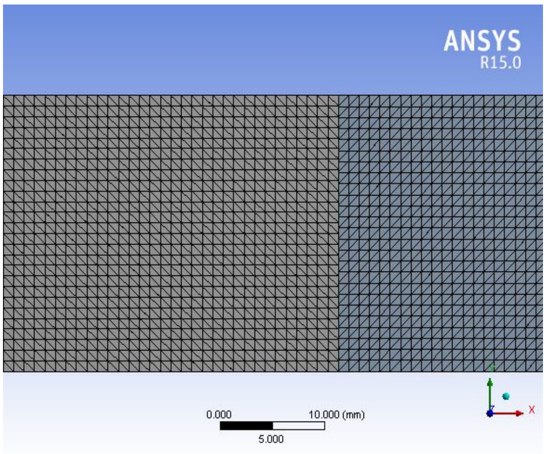


Fig.9: Tetrahedral & Map mashing & its zoom view for Adhesive Joint

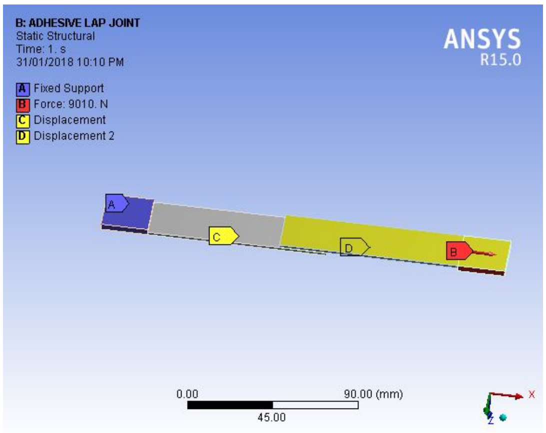


Fig.10: Applied Boundary condition

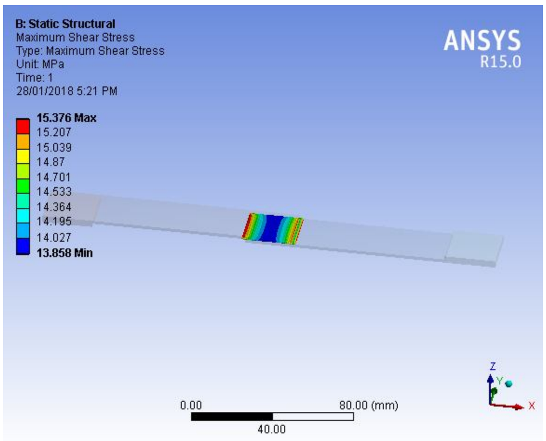


Fig.11: Max. shear stress for single lap adhesive joint

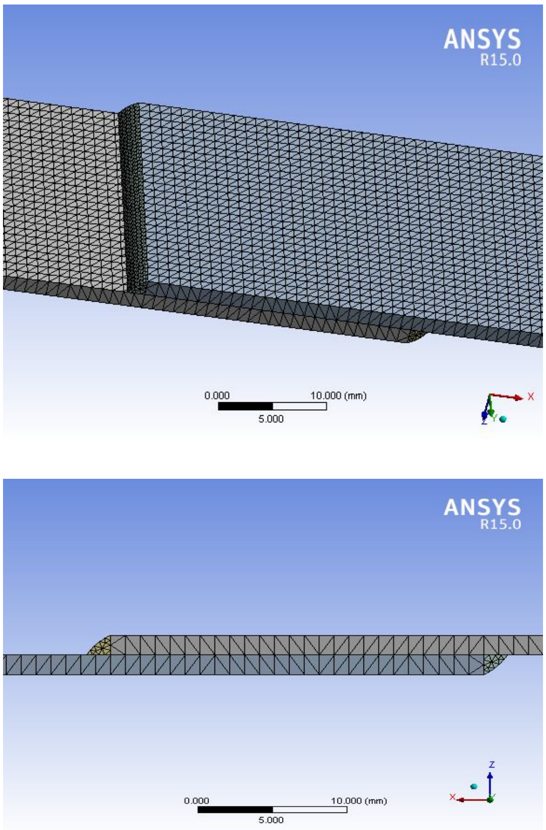


Fig.12: Tetrahedral mesh & zoom view for welded joint

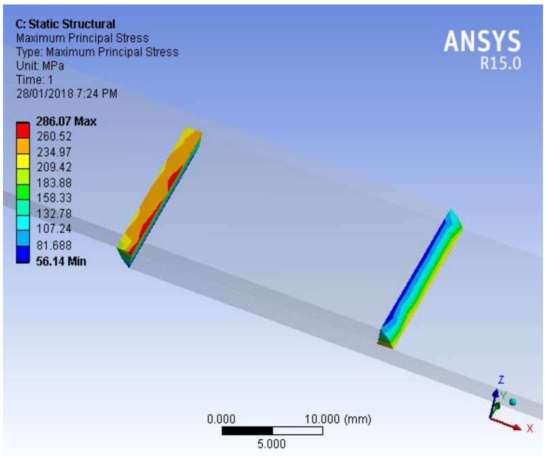


Fig.13: Max. principal stress distribution

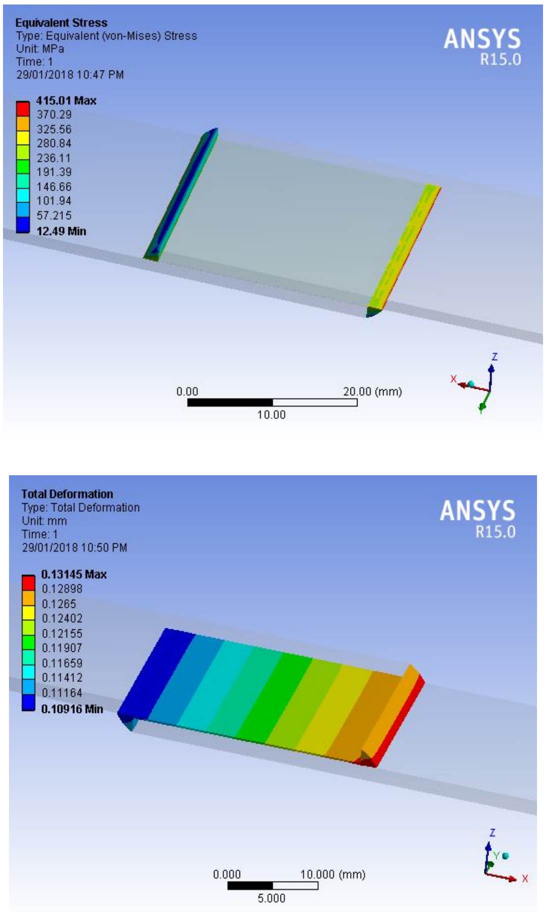


Fig.14: Stress value and total deformation of material at overlap region

III. EXPERIMENTATION

The tensile test of a single lap joint is one of the most common methods to characterize an adhesive joint. The test consists in applying forces in the longitudinal direction of the specimens until the occurrence of rupture. As can be seen by the geometry of the specimen, there is a misalignment of traction forces, even when spacers are used in the places of mooring. The test of a single lap joint can be used as a method for comparative study of adhesives, provided that the standardization of other parameters that can affect the outcome of the tests is ensured. The tests were done on a **Universal Testing Machine** with a test velocity of 2 to 5 mm/min in typical laboratory ambient conditions (approximately 25ºC and 50% relative humidity). Specimens based on **ASTM D1002-01** standard were fabricated from the produced joints (see Figure 2) and tested in series of 3 specimens.

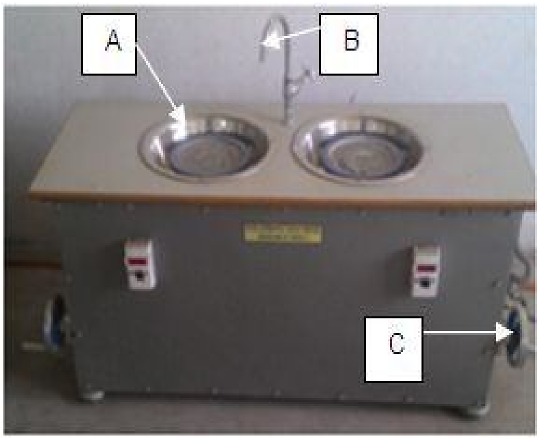


Fig.15: Double disk polishing machine (A-Emery paper, B-Running water tap, C-speed control handle)

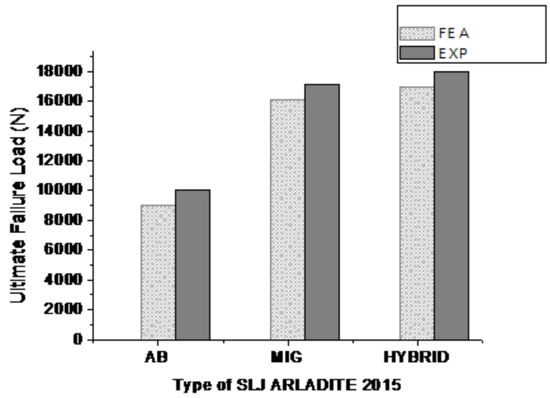
Fig.16: Experimental set up on Universal Testing Machine

IV. RESULTS & OBSERVATIONS

The load vs. displacement curves of the joints with higher ultimate loads of each joint type (AB, MIG with one pass, MIG with two passes, hybrid with one pass and hybrid with two passes) are presented in following figure.

Table 4. Result comparison of adhesive, MIG and Hybrid Joints for Ductile SLJ (Araldite 2015)

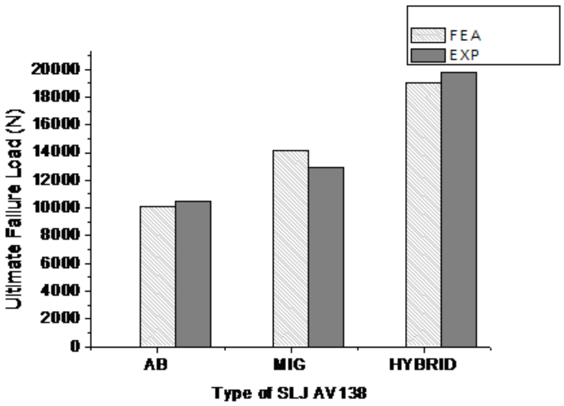
Ultimate Failure Load(N) for Ductile SLJ (Araldite 2015)			
Type of results	Ductile Adhesive (2015)	MIG	Hybrid
FEA	9010	16100	17000
EXPERIMENTAL	10000	12440	18000



Adhesive bonding joints strength is 40% LOWER than the highest strength MIG lap joint, although when combining the two techniques to form a hybrid joint, the strength is matched, this excluding AB- joint.

Table 5. Result comparison of adhesive, MIG and Hybrid Joints for Brittle SLJ (Araldite AV 138)

Ultimate Failure Load for Brittle SLJ (Araldite AV138)			
Type of results	**Brittle Adhesive (138)**	**MIG**	**Hybrid**
FEA	10100	14100	19000
EXPERIMENTAL	10500	12920	19800



Adhesive joints not only present higher ultimate loads than MIG joints, they also show higher displacement upon failure, meaning that they absorb more energy. The best hybrid joint presents a similar ultimate load than the adhesive joint , but with lower displacement upon failure. Figure 5 and 6 lead to the conclusion that hybrid joints do result in better mechanical performance in quasi-static conditions, and at best can equal the adhesive joints performance. The failure process in hybrid joints is slow and gradual.

V. CONCLUSION

Hybrid AB+MIG joints were manufactured and tested for static mechanical properties against AB and MIG only joints. FEM models of the three joint types were created in ANSYS FEM software package and related to experimental results. Adhesive bonded single lap joints achieved lower strength in static testing than MIG lap joints, with both single and two welding passes, with a 60% lower strength towards the highest strength MIG joint. Hybrid MIG+AB joints achieved similar strength level to adhesive bonded joints although with smaller displacement at failure.

An experimental and an FEM study were carried out on hybrid MIG welded/bonded single-lap joints, by comparison with the MIG-welded and adhesively bonded equivalents, for the evaluation of this technique and the capability of FEM for design purposes. The study began with an influence analysis of the welding parameters on the strength of MIG-welded joints and on the visible adhesive degradation by welding-induced heating, which allowed selecting the most suitable conditions. After proper characterization of the FEM of the adhesive and weld nugget, a FEM stress analysis provided a background for further discussion and showed, for the welded joints, the stress concentrations at the weld–nugget periphery and also a large rotation of the adherents and consequent separation at the overlap edges, the stresses for the bonded joints peaked at the overlap edges, while weld-bonded joints benefit from higher transmission of shear loads in the inner overlap region by the weld nugget, because of the stiffness differential to the bonded region. The strength comparisons between the three joint techniques showed a marked advantage of weld-bonding over the traditional equivalents.

With such a type of hybrid joint we can repair minor breakages & fill the cracks of chassis frame, also we can repair chassis frame support joints successively by importing such a hybrid joint techniques. Hence our validation is successfully accomplished.

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