Design and Analysis of Adhesive and Riveted Single lap Joint for Al Plates

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Abstract:- Adhesive bonded are already playing a significant role in the development and production of metal aircraft structures and indication are strong that such joints will be even greater importance in structures. The design is applied to analyze the parameters that influence the load transfer between the different components of the joints as well as the maximum stress in adhesive. Experimental analysis is used to investigate the shear strength behavior of aluminum alloy adhesive joint as well as rivet joints. It carried out in order to understand the effect of geometrical parameters and adhesive strength of adhesive bonding joints with the aim of optimizing shear strength. The adhered material used for the experimental tests was an aluminum alloy in the form of thin sheets, and the adhesive used was a high strength. Nine test to be studied. An experimental analysis was developed to give approximate value of load required to carry out test and shear strength of adhesive joint. Nine test specimens are testing on Universal Testing Machine. Then Compare results obtain from UTM machine. When we comparing result of adhesive joint the shear stress is observed 4.80 N/mm^2, 5.10 N/mm^2 and 3.44 N/mm^2 having lap length 12.5mm, 18mm & 25mm respectively. When we comparing result of rivet joint the shear stress is observed at rivet position is 96.66 N/mm^2 99.78 N/mm^2 and 94.32 N/mm^2 having lap length 12.5 mm, 18 mm & 25 mm respectively. When we comparing result of adhesive + rivet joint the shear stress is observed 4.19 N/mm^2, 53.4 N/mm^2 and 2.58 N/mm^2 having lap length 12.5 mm, 18 mm & 25 mm respectively.

***Keywords**:- Adhesive joint, Rivet Joints, Adhesive- Rivet joint, Shear Strength.*

I. INTRODUCTION

Materials can be joined by utilizing an assortment of strategies. Up to around 60 years back, the important joining strategies were by mechanical attaching (screws, bolts, fasteners, and so on.) or by welding, binding or brazing [1]. These techniques had points of interest and detriments. Amid the Second World War, a progression of novel cements, created by Dr Norman de Bruyne at the organization which moved toward becoming to be known as Ciba, was utilized for fundamentally holding airplane, for example, the de Havilland Mosquito [1-5]. Since that time, huge advances have been made in glue holding innovation. With the advantage of science and experience, we would now be able to utilize adhesives joints in stack bearing building circumstances which can withstand numerous times of utilization. And in addition flying machine, adhesives are broadly utilized as a part of engine autos, and almost all lightweight structures. They are being utilized to find course and outfits, and even to move stacks in gigantic structures, for example, are utilized as a part of structural building. Weights on expenses and vehicle weight (meeting Corporate Average Fuel Economy (CAFE) directions), while meeting wellbeing objectives, and further feature the test, driving the business towards new, less exorbitant materials and procedures. The pattern towards reusing the whole vehicle, as of now generally solid in Europe, has as of late influenced material and securing decisions in auto insides in Asia [6-9]. Accordingly, new materials and procedures are consistently being worked on. Some of the advantages of using adhesives include the following:

- Invisible bonding.
- Even distribution of the bond stress.
- Ability to join dissimilar substrates and surfaces.
- Ability to fill gaps
- Elimination of vibration failure.
- Corrosion protection;
- Reduced manufacturing/assembly costs.
- Bond strength;
- Potential for dual functionality; and
- Ability to fit into tight spaces.

II. OBJECTIVE PROPOSED WORK

- The major objective of the proposed research work is to enhance the shear strength of a lap joint.
- To propose a joint preparation technique, to develop a robust joint which can sustain maximum possible shear strength.
- Analyze Effect of varies adhesive joint, rivet joint and rivet –adhesive joint on strength and failure of joint.
- Analyze Effect of adhesive and rivet joint on strength and failure of adhesive and rivet joint.

III. EXPERIMENTAL WORK DATA

For performing shear strength analysis we have used Universal Testing Machine. In which one jaw is fixed and other jaw is used for the applying shear load.

A. Type of Joint – (Aluminum & Aluminum Adhesive Joint)

Geometry of Specimen-

- Adhesive Lap Length – 12.5mm, 18mm, 25mm
- Adhered plate dimensions - 100mm X 25mm
- Thinness of Plate – 3 mm

ISSN No:-2456-2165

- Adhesive use- 495 (General Purpose)
- Material – Aluminum.

Fig 1:- Universal Testing Machine with specimen.

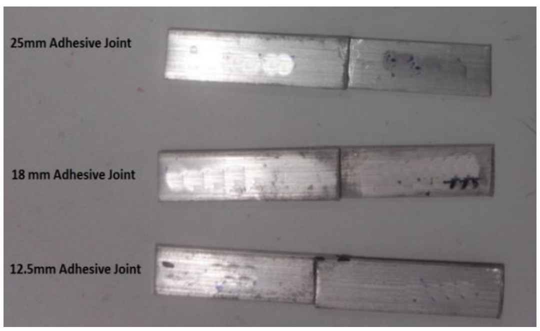

Fig 2:- Actual Specimen of adhesive joint having lap length 12.5mm, 18mm & 25mm

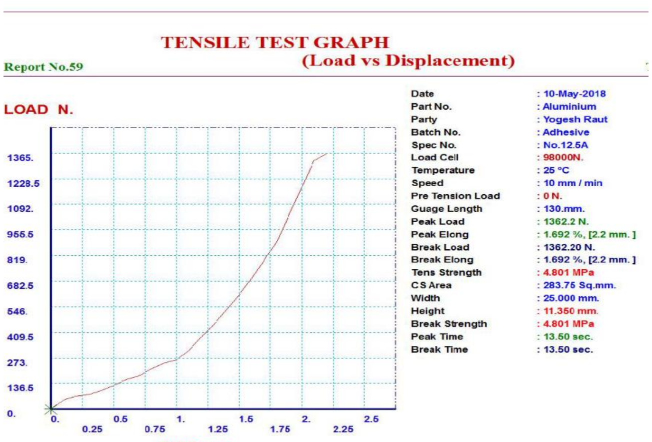

Fig 3:- Load vs. Displacement graph of adhesive joint having 12.5 mm Lap length.

For performing shear strength analysis we have used Universal Testing Machine. In which one jaw is fixed and other jaw is used for the applying shear load. It is observed that when 1362.2 N force is applied on specimen which having lap length 12.5mm the specimen get break and shear force 4.801 N/mm^2 is observed as shown in fig 3.

From the adjacent fig.4 It is observed that when 2234 N force is applied on specimen which having lap length 18 mm the specimen get break and shear force 5.107 N/mm^2 is observed.

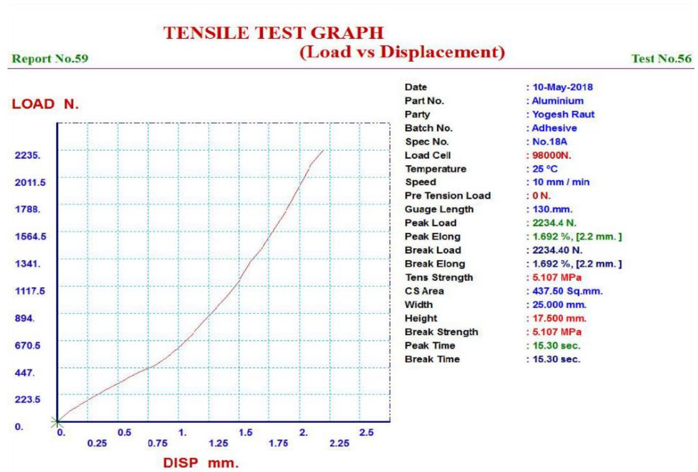

Fig 4:- Load vs. Displacement graph of adhesive joint having 18 mm Lap length.

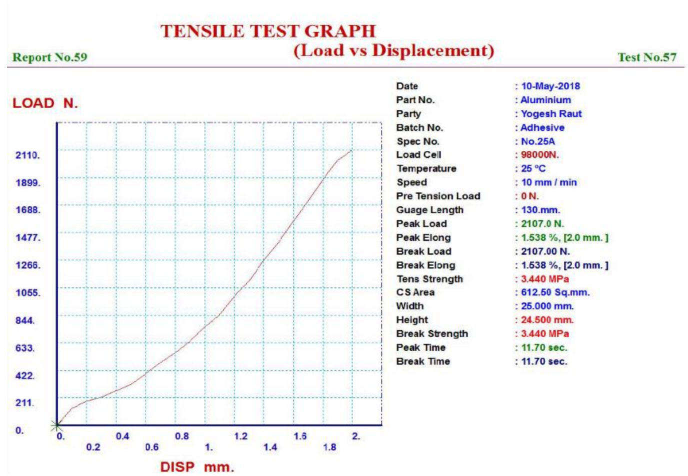

Fig 5:- Load vs. Displacement graph of adhesive joint having 25 mm Lap length.

From above fig.5 It is observed that when 2107 N force is applied on specimen which having lap length 25 mm the specimen get break and shear force 3.44 N/mm^2 is observed.

B. Type of Joint – (Aluminum & Aluminum Rivet Joint)

Geometry of Specimen-

- Adhesive Lap Length – 12.5mm, 18mm, 25mm
- Adhered plate dimensions :- 100mm x 25mm
- Thinness of Plate – 3 mm
- Adhesive use- No only jointed by Rivet 4mm Diameter.
- Material – Aluminum.

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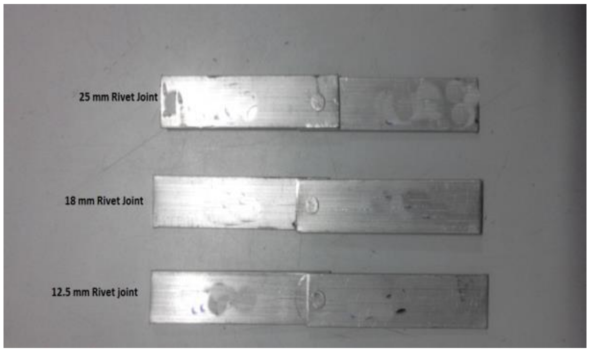

Fig 6:- Actual Specimen of Rivet joint having lap length 12.5 mm, 18 mm & 25 mm

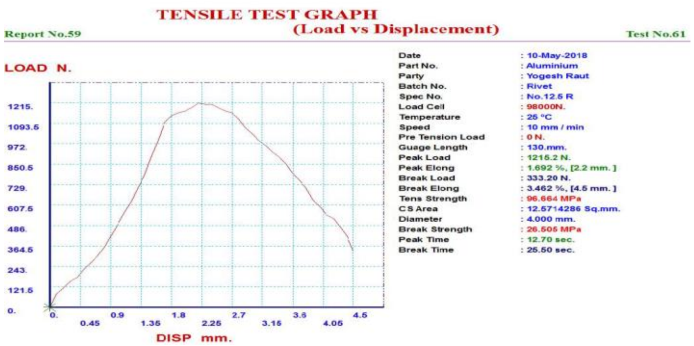

Fig 7:- Load vs. Displacement graph of Rivet joint having 12.5 mm Lap length

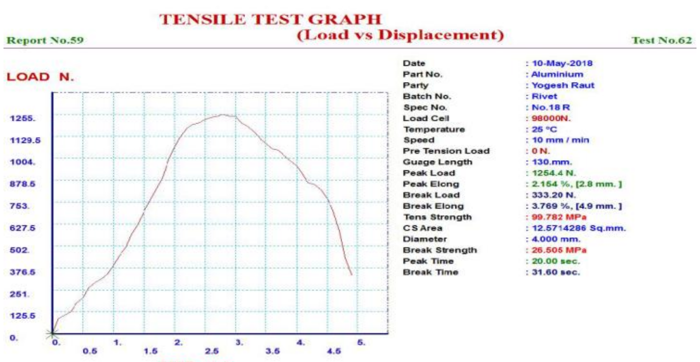

Fig 8:- Load vs. Displacement graph of Rivet joint having 18 mm Lap length.

From fig. 7 It is observed that when 1215.2 N force is applied on specimen which having lap length 12.5 mm the specimen get break and shear force 96.664 N/mm^2 at rivet section and breaking strength 26.505 N/mm^2 is observed.

From fig.8 It is observed that when 1254.4 N force is applied on specimen which having lap length 18 mm the specimen get break and shear force 99.782 N/mm^2 at rivet section and breaking strength 26.505 N/mm^2 is observed.

From fig. 9 it is observed that when 1185.8 N force is applied on specimen which having lap length 25 mm the specimen get break and shear force 94.325 N/mm^2 at rivet section and breaking strength 24.954 N/mm^2 is observed.

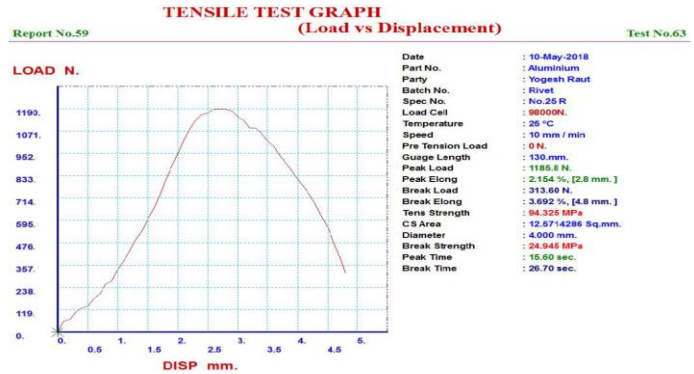

Fig 9:- Load vs. Displacement graph of Rivet joint having 25 mm Lap length.

C. Type of Joint – (Aluminum & Aluminum Rivet + Adhesive Joint)

Geometry of Specimen-

- Adhesive Lap Length – 12.5 mm, 18 mm, 25 mm
- Adhered plate dimensions :- 100 mm X 25 mm
- Thinness of Plate – 3 mm
- Adhesive use- jointed by Rivet 4 mm Diameter with adhesive
- Material – Aluminum.

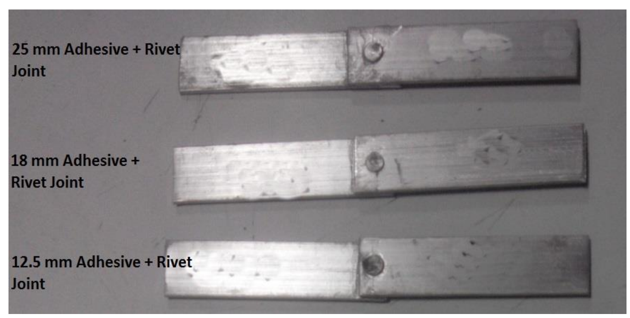

Fig 10:- Actual Specimen of Rivet + Adhesive joint having lap length 12.5mm, 18 mm & 25 mm

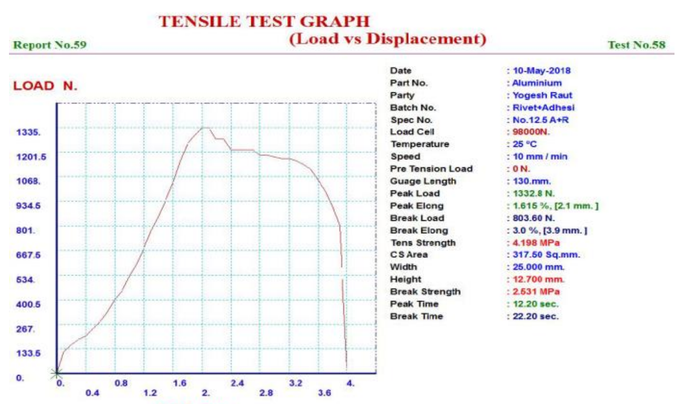

Fig 11:- Load vs. Displacement graph of Adhesive+ Rivet joint having 12.5 mm Lap length.

From fig. 11 it is observed that when 1332.8N force is applied on specimen which having lap length 12.5mm the specimen get break and shear force 4.198 N/mm^2 is observed.

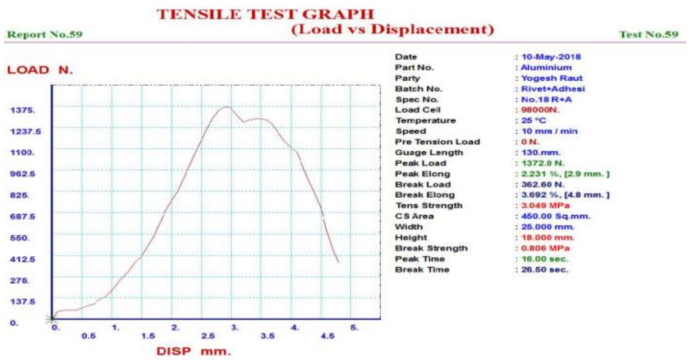

Fig 12:- Load vs. Displacement graph of Adhesive+ Rivet joint having 18 mm Lap length.

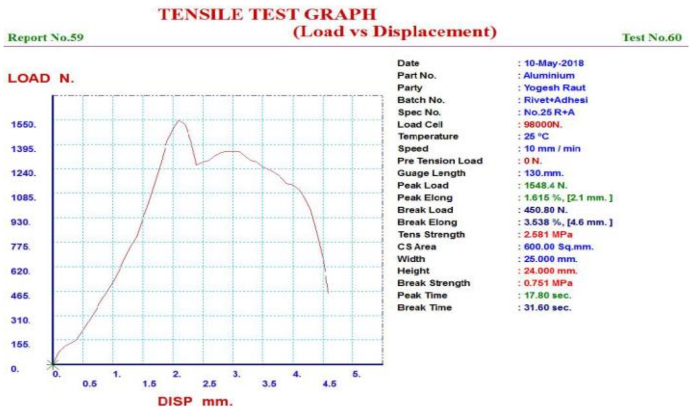

Fig 13:- Load vs. Displacement graph of Adhesive+ Rivet joint having 25 mm Lap length.

From fig. 12 It is observed that when 1372 N force is applied on specimen which having lap length 18 mm the specimen get break and shear force 3.049 N/mm^2 is observed. From fig.13 It is observed that when 1548.4 N force is applied on specimen which having lap length 25 mm the specimen get break and shear force 2.581 N/mm^2 is observed.

IV. RESULT AND DISCUSSION

After performing final experiments, analysis of experimental data is done by using universal testing machine. The effect of various input parameters on output responses will be analyzed using universal testing machine.

From fig 14 and table I it is observed that when the adhesive joining specimen has lap length 12.5 mm, then specimen is break at 1362 N and strain is 0.0169, displacement is 2.2 mm, shear stress 4.801 N/mm^2. When lap length 18mm, then specimen breaks at 2234 N and strain is 0.0169, displacement is 2.2mm, shear stress 5.107 N/mm^2. . When lap length 25mm, then specimen break at 2107 N and strain is 0.0154, displacement is 2 mm, shear stress 3.44 N/mm^2.

Sr. No.	Material	Type of Joint	Lap Length	Time (sec.)	Disp. (mm.)	Load (N.)	Stress (MPa)	Strain	% Elong. (% mm.)
1	Al + Al	Adhesive	12.5mm	13.5	2.2	1362	4.801	0.0169	1.692
2	Al + Al	Adhesive	18mm	15.3	2.2	2234	5.107	0.0169	1.692
3	Al + Al	Adhesive	25mm	11.7	2	2107	3.44	0.0154	1.538

Table 1. Specimen utm result of adhesive joint

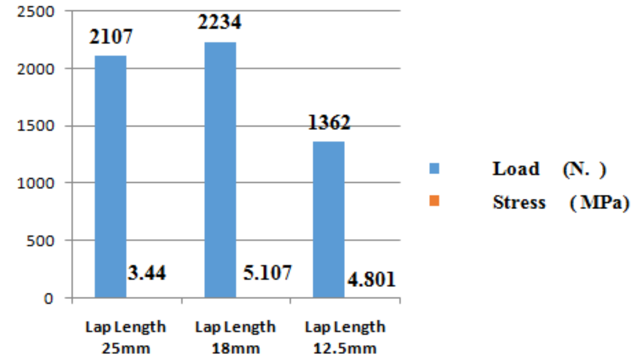

Fig 14:- Comparison value of adhesive joint

Sr. No.	Material	Type of Joint	Lap Length	Time (sec.)	Disp. (mm.)	Load (N.)	Stress (MPa)	Strain	% Elong. (% mm.)
1	Al + Al	Riveted	12.5mm	12.7	2.2	1215	96.664	0.0169	1.692
2	Al + Al	Riveted	18mm	20	2.8	1254	99.782	0.0215	2.154
3	Al + Al	Riveted	25mm	15.6	2.8	1186	94.325	0.0215	2.154

Table 2. Specimen Utm Result of Rivet Joints

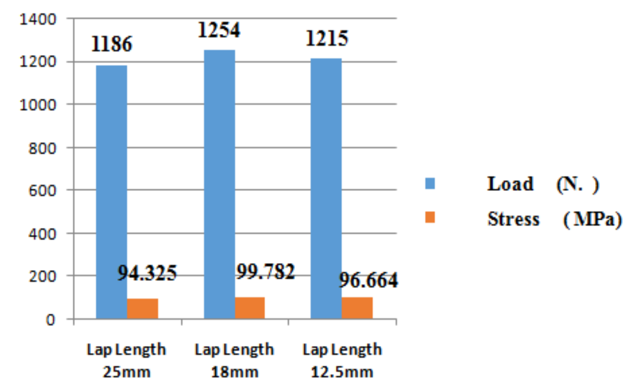

Fig 15:- Comparison value of rivet joint

From fig 15 and table II it is observed that when the riveted joint specimen has lap length 12.5mm, then specimen is break at 1215 N and strain is 0.0169, displacement is 2.2 mm, shear stress 96.664 N/mm^2. When lap length 18 mm, then specimen breaks at 1254 N and strain is 0.0215, displacement is 2.8 mm, shear stress 99.782 N/mm^2. When lap length 25mm, then specimen breaks at 1186 N and strain is 0.0215, displacement is 2.8 mm, shear stress 94.325 N/mm^2.

Sr. No.	Material	Type of Joint	Lap Length	Time (sec.)	Disp. (mm.)	Load (N.)	Stress (MPa)	Strain	% Elong. (% mm.)
1	Al + Al	Rivet + Adhesive	12.5mm	11.6	2	1333	4.198	0.0154	1.538
2	Al + Al	Rivet + Adhesive	18mm	16	2.9	1372	3.049	0.0223	2.231
3	Al + Al	Rivet + Adhesive	25mm	17.8	2.1	1548	2.581	0.0162	1.615

Table 3. Specimen Utm Result of Rivet + Adhesive Joints

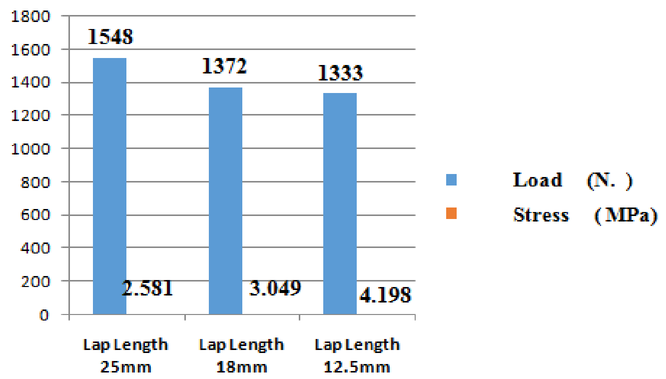

Fig 16:- Comparison value of rivet + adhesive joint

From fig 16 and table III it is observed that when the riveted + adhesive joint specimen has lap length 12.5mm, then specimen is break at 1333N and strain is 0.0154, displacement is 2 mm, shear stress 4.198 N/mm^2. When lap length 18mm, then specimen breaks at 1372 N and strain is 0.0223, displacement is 2.9mm, shear stress 3.049 N/mm^2. When lap length 25mm, then specimen breaks at 1548 N and strain is 0.0162, displacement is 2.1mm, shear stress 2.581 N/mm^2.

V. CONCLUSION

- The experimental results are found out from universal testing machine. There are nine samples test are carried out. From this testing we find out load, shear stress, percentage elongation etc.
- When we compare the load value of rivet joint having different lap length, it is observed that load required for this test is less as compare to adhesive joint and rivet + adhesive joint.
- In adhesive joint for lap length 12.5mm load required to break the specimen is increased by around 12% as compare to rivet + adhesive joint.
- In adhesive joint for lap length 18mm load required to break the specimen is Increased by around 63-78% as compare to rivet + adhesive joint.
- In adhesive joint for lap length 25mm load required to break the specimen is increased by around 36-78% as compare to rivet + adhesive joint.
- Hence It is observed that the adhesive joint having much better strength as compared to rivet joint and adhesive + Rivet joint in all parameters giving maximum possible shear strength and also increases maximum load carrying capacity.

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