Review for Design of Gripper in Universal Testing Machine

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Abstract— Mechanical tensile testing plays an important role in evaluating fundamental properties of engineering materials as well as in developing new materials and in controlling the quality of materials for use in design and construction. If a material is to be used as part of an engineering structure that will be subjected to a load, it is important to know that the material is strong enough and rigid enough to withstand the loads that it will experience in service. Most common type of test used to measure the mechanical properties of a material is the tension test with the help of Universal Testing Machine (UTM). Tension test is widely used to provide basic design information on the strength of materials and is an acceptance test for the specification of materials. In tensile test, a specimen is prepared suitable for gripping into the jaws of the testing machine type that will be used. The specimen used is approximately uniform over a gauge length.UTM have fixtures for holding the test specimen called gripper in which the both ends of the test specimen fitted. Gripper cannot hold the test specimen of larger size which limits to test such specimen. UTM has less floor space so the vertical daylight and diameter of the test specimen cannot exceed than the pre-defined values. To increase the vertical daylight and test specimen size, the change should be made in the gripper design. This work provides valuable intuition of gripper a design.

Key words: Universal Testing Machine, Gripper, Tensile Testing, Friction, Mechanical Jaw, Gripping System

I. INTRODUCTION

Universal tensile test is known as a basic and universal engineering test to achieve material parameters such as ultimate strength, yield strength, % elongation, % area of reduction and Young's modulus. These important parameters obtained from the standard tensile testing are useful for the selection of engineering materials for any applications required. The tensile testing is carried out by applying longitudinal or axial load at a specific extension. A range of universal standards provided by Professional societies such as American Society of Testing and Materials (ASTM), British standard, Japanese Industrial Standards (JIS) provides testing are selected based on preferential uses. ASTM E8: is a standard test method for tension testing of metallic materials

A gripper is a device which enables the holding of an object to be manipulated. The easier way to describe a gripper is to think of the human hand. Just like a hand, a gripper enables holding, tightening, handling and releasing of an object. A gripper is just one component of an automated system. A gripper can be attached to a testing machine and perform useful tensile testing system. Many styles and sizes of grippers exist so that the correct model can be selected for the application.

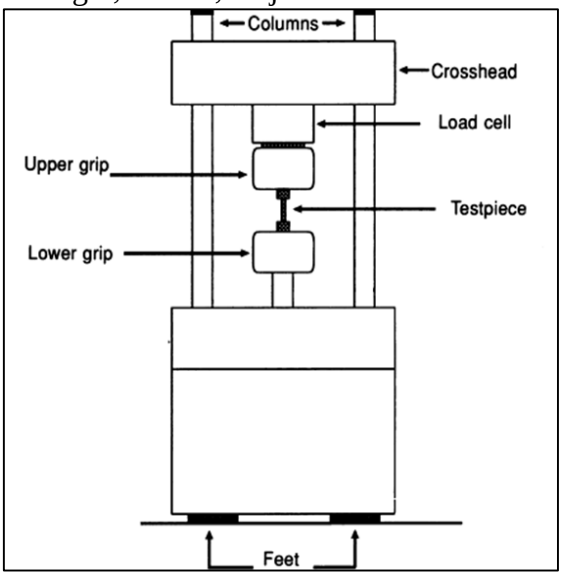

Fig. 1: Schematic diagram of Universal Testing Machine

A. *Parameters of Gripper:*

1) Size and Function:

Size and function of gripper is related to dimensional size, material and weight of components to be grip.

First parameter that defines gripper design is static load

1) The component weight in terms of capacity of gripper, determines ability to carry component.
2) Gripper's ability to restrain the components weight and shear forces determines the weight can be held without slippage under static conditions.
3) The attitude of the gripper jaws during particular controls the weight that can be moved.

If the jaws are always at the right angle to the gravitational forces then the component's weight is withstand by frictional forces and shear forces.

The frictional forces are those which act between gripper jaw and component surface.

Shear forces come into effect when the component rests on the top of the jaws, so that shear strength of both component and jaws resist the weight of the component.

If the jaws are at other attitude then both frictional and shear forces apply but each to lesser degree.

4) Its also necessary that limiting force that can be applied to the component is one that will cause damage.
5) Its also necessary that loading is uniform across clamped surface otherwise load acting at particular point cause localized damage to the component.

B. *Movement of Gripper within Space:*

This movement generates dynamic forces on the component gripper interface as gripper accelerates and decelerates during its task performance.

Dynamic forces on the gripper can be consider as

- Centrifugal force
- Momentum

C. Component Geometry:

Geometry of the component is used to define operational envelope.

It refers to maximum component dimensions that can be accommodated without affecting desired performance of the gripper.

There are same aspects that cause instability of gripper performance due to component geometry.

1) When the component dimensions are such that gripper cannot satisfactory hold it.
2) Whether one or more of the components dimensions are such that the centre of gravity of the component causes large tilting movement, either on gripper or component within it.
3) Whenever one or more component dimensions are such that component cannot move without collision.
4) When component is so small then gripper cannot function satisfactorily.

D. Construction Material:

Gripper is normally constructed of steel, which is tough and easily obtainable material that is suitable with majority of manufacturing processes.

Aluminum can be also used for gripper material when a nonmagnetic yet tough material is required.

Like Steel and Aluminum are easily available and can be processed easily.

Plastics can also use for constructing gripper to handle delicate components or when its necessary to ensure electrical isolation.

The use of soft materials is restricted to expansion or contraction for gripper contact surfaces are manufactured from robust materials.

Ceramics are used to construct grippers in hostile environment.

II. LITERATURE REVIEW

A. I. De Bearer, W.Van Paepegem, and J.Degrieck, "Design of mechanical clamps with extra-long wedge grips for static and fatigue testing of composite materials in tension and compression", Experimental Techniques, May/June 2008,Society for Experimental Mechanics.[1]

This paper relates to the gripping of the specimen with standard clamps. The end of the specimen should not touch the clamps because the specimen should be isolated from the tensile machine.

If a set of mechanical wedge grips is used, it is usually only suited for either tension or compression testing but rarely for both. For the gripping, the principle of a wedge is used; it is obvious that this only works in one direction.

If the wedges are pulled down (tensile test), the grips move inwards, increasing contact pressure. However, if the wedges are pushed up (compressive test), the wedges open and the contact pressure decreases.

It is possible to have mechanical grips for compressive tests, simply by putting the wedges upside down, but then they will no longer function in tensile conditions.

For testing in tension, the more the specimen is pulled, the higher the contact pressure becomes and the better the specimen is gripped.

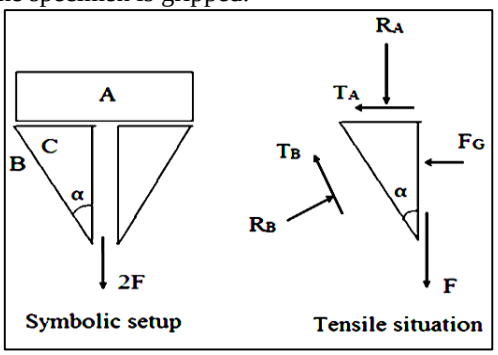

Fig. 2: Schematic representation of mechanical wedge grip[1]

B. "Grip assembly apparatus for tensile testing", By D.H.Pham, World Applied Sciences Journal 11 (7): 840-846, 2010 ISSN 1818-4952. [2]

This paper relates to Grip apparatus for use with tensile stress testing apparatus includes a housing having connecting means on the of the housing for connecting the grip apparatus to the tensile stress testing apparatus.

The grip apparatus of claim wherein the said release means comprises:

- First release elements mounted on the upper end of each said grip bar above the said top surface, second release elements mounted on said housing and constructed, arranged to engage said first release elements for selective release of said grip bars by movement of said grip bars upwardly above the said top surface.

The grip apparatus housing is constructed of aluminum.

C. "Test specimen grip apparatus", By John M Curtis , International Journal of Engineering Research and General Science Volume 2, Issue 2, Feb-Mar 2014 ISSN 2091-2730. [3]

This paper relates to Improvements in test specimen grip apparatus for tensile stress testing machines includes replaceable grip inserts that are able to accommodate wider than usual test specimens.

The specimen grip means or grip inserts are threadedly retained on and may be wider than their supporting jaw members.

The grip housing, moreover, is provided with apertures for access to the threaded retainers for ease of grip insert removal and replacement.

According with current situation, there is provision of improved grip apparatus for tensile stress testing machines that includes replaceable grip inserts that are able to accommodate wider than usual test specimens.

D. "Grip for use in Tension Testing Machine", By F.C.Huyserf 24th CIRP Design Conference Procedia CIRP 21(2014)183 – 188. [4]

This paper relates to an improvement in grips or wedges used in universal testing machines to hold the ends of a specimen during a tension test. Quite generally the specimen is held between wedges whose inner faces are parallel and whose outer faces slide on the inclined surfaces of openings in the stationary and movable heads of the testing machine.

In order to get sufficient pressure against the specimen to prevent it from slipping in the grips, a powerful wedging action is needed.

The invention provides wedges of simple form which can be made of a quality of steel that can be readily hardened and these wedge grips are moved by separate rack plates that are not brittle.

One object of this study is to provide wedge grips interchangeably supported, on a rack operated device which simultaneously moves the wedge grips apart and upward.

E. "Grip for tensile test of steel wire", By Luc Hugelier and devlaminck, the 14th IFToMM World Congress, Taipei, Taiwan, October 25-30, 2015, DOI Number: 10.6567/ IFToMM.14T[5]

This paper relates to grip for performance of tensile test on elongated specimens such as steel wires, wherein at least the face of the grip which has an engagement with the elongated specimen is provided with roughness.

These roughnesses are virtual pyramids in shape, which at no point show an angle which is smaller than 100°. For preference the roughness have the form of truncated pyramids with an upper surface area of at least 2.5 mm^2.

Wear and breakages in the grip are considerably reduced.

According to this paper each of said gripping projections has a height which is less than 0.3 mm.

F. United States Patent on "Tensile grip", By Frederick W Wanzenberg, Patent no.2537322, Date-Jan9, 1951. [6]

This paper relates to grips for tensile testing and for test of any kind where a good mechanical holding is desired between the grip and a specimen.

One object of the invention is to provide a grip structure that is comparatively simple in construction and of light weight which is so designed that it effectively grips a specimen so as to apply a heavy tensile load there to without the necessity of the grip-being excessively large.

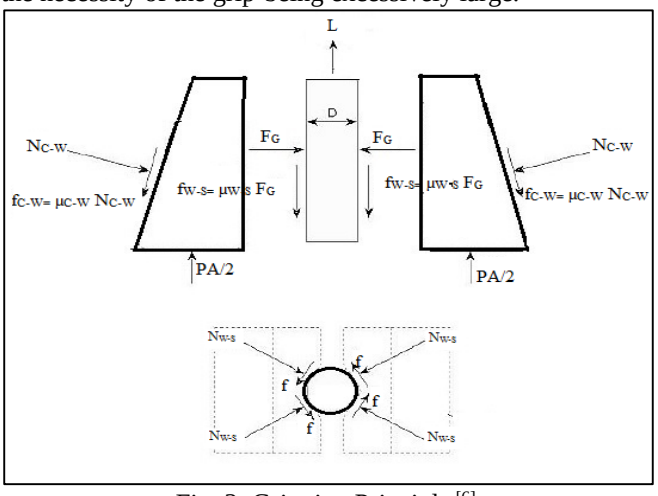

Fig. 3: Gripping Principle [6]

Another v object is to provide grips that can be made small due to the design of a pair of jaws that are supported by a lifting member and are movable toward each other under the action of a clamping- head, the grip including an adjusting means for moving the head in one direction which results in tapered faces there of contacting with similar tapered faces of the gripping jaws to move the jaws against the specimen , with an increase in pull of the specimen on the jaws resulting in the jaws gripping the specimen more tightly.

Still another object is to provide a grip for tensile test and to provide an arrangement in which a shank supports a lifting member which in turn supports the gripping jaws the clamp being movable with respect to the lifting member to effect movement of the jaws toward each other by means of a clamp nut threaded on the shank and operable-to move the shank in a clamp applying direction.

G. "Test piece gripping device in tensile test", By Alvin G Griffin, International Journal of Applied Engineering and Technology, Date-Oct. 2014, ISSN 0973-4562. [7]

This paper relates to Improvements in the construction of test piece gripping devices and physical testing apparatus for gripping the opposite ends of test specimens undergoing pull tests.

According to the present invention seeks to provide a gripping device of improved construction whereby the gripping device is capable of withstand maximum stresses in excess of the maximum stresses to which prior art gripping devices of comparable size could be subjected.

A further object of the invention is to provide springs for urging the jaw members toward a gripping condition and arranged so that they do not interfere with the operation of the cam means which moves the jaw member.

H. "Tensile sample holding and alignment means for tensile testing machine ",By B.B.Scott Etal , American Society for Metals International ,Date-March 21,2010, ISSN 0097-3912[8]

This paper relates to machines for testing the tensile strength of materials and is more particularly concerned with an improved specimen holder including grips for the opposite ends of a test sample and so constructed as to maintain the grips.

Well-known forms of universal testing machines comprise vertically spaced grips for the two ends of a test sample and applying a tensile force to the sample during the testing.

These inaccuracies have been largely due to bending forces on the samples due to misalignment of the jaws or grips during the testing operation. In the testing of resin misalignment of the two grips may result in subjecting one edge of the sample to a tensile force almost equal to its tensile strength.

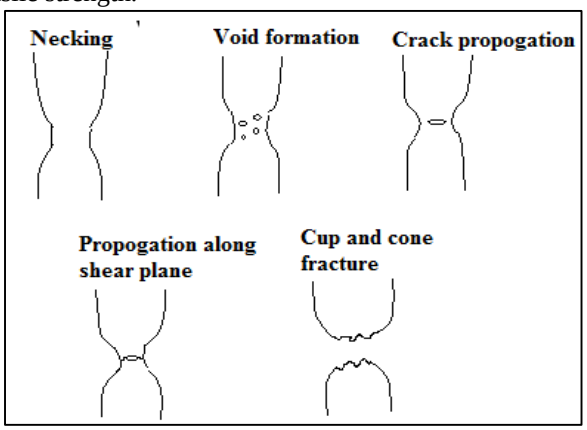

Fig. 4: Cup and cone fracture [8]

Another object of the invention is to provide a specimen holder for use with available tensile testing

machines designed to maintain alignment of the test sample centroidal axis with the tensile loading axis and thus uniformly distribute the tensile load throughout the sample cross-section during the testing.

I. "Tensile machine having grip mechanism", By W.T.Gloor IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684 (Mar. - Apr. 2013) [9]

This paper relates to apply continuously to each grip a pressure proportional to the main cylinder pressure which can develop a clamping load on the specimen of the order of 20% or more greater than the axial specimen load as developed by the main cylinder pressure.

In a testing machine, relatively movable heads, hydraulic means for relatively moving said heads for applying either tension or compression to a specimen, including a main tension hydraulic system grip means operatively connected to the heads, each grip means including relatively movable grips and hydraulic means for relatively moving the grips, in combination with hydraulic means responsive to the highest pressure attained in said main tension hydraulic system and hydraulic system for energizing said hydraulic means for relatively moving the grips at a pressure which is proportional to the highest pressure in said main tension hydraulic system.

J. "Tensile Testing machine", By W.C.Moram, American Society for Metals International, Date-Nov.1, 1932, ISSN 0097-3912[10]

This paper relates to method been adopted for securely holding the test specimens in the heads of the testing machine involves the use of pairs of wedges located in wedge shaped openings in the heads of the machine which are to be drawn or forced apart.

When a test is to be made the specimen to be tested is placed between the roughened straight faces of the wedges of the upper and lower-heads of the machine and the wedges initially tightened there against. Then the load =n applied to separate the heads the wedge grips slip inwardly within the openings in the heads, and the inclined edges of the grips cooperating with the inclined edges of the openings in the heads cause the specimen to be gripped between the grips.

If the best results are to be obtained when wedge grips are used the Wedge grips should bear for their full length against the inclined edges in the openings of the heads and the specimen should bear against the wedge grips for the full length thereof for otherwise there is a tendency, when the load is applied, for the specimen to be crushed and a force applied to the head which may split it.

The present invention overcomes the existing disadvantages accompanying the use of wedge grips and provides a compact arrangement whereby the use of all liners is eliminated and the grips in each head are absolutely centralized at the beginning of a test.

III. CONCLUSIONS

From the literature review,

- In tensile testing, the gripping of the specimen with standard clamps with help of mechanical wedge gripper higher the contact pressure becomes and the better the specimen can grip.
- Advanced design and manufacturing tools were suggested to develop the jaw grip by using stainless steel.
- It also indicates replacement of worn-out accessories has been carried out in specific time, which eventually saves idle time of equipment.
- Inaccuracies have been large due to bending forces on the samples due to misalignment of the jaws or grips during the testing operation.
- Design to maintain alignment of the test sample centroidal axis with the tensile loading axis and thus uniformly distribute the tensile load throughout the sample cross-section during the testing.
- Gripping device is capable of withstand maximum stresses.

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