

Alternative Mechanism for Peel Strength Tester

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Abstract: *The paper mainly focuses on measuring peel strength of adhesive tapes. Peel strength is average force required to separate two bonded materials from one another, is properly applicable to various industries aerospace, automotive, adhesives, packaging, biomaterials, microelectronics, and more. Peel test data is used to determine the quality of the adhesive joint and, where applicable, provides information on the effects of processes. Peel tests are constant-speed tests in the tensile direction. In material testing, peel strength is calculated after measuring and averaging the load to peel the specimen and dividing the average load by unit width of the Adhesives. Different adhesives are used for joining the different types of materials. The different types of peel tests available for investigating the adhesive strength are 90°, 135°, 180° and T-peel test. This mechanism mainly focuses on 180° peel type test.[1] Key point of this study is to get precise reading by 180-degree peel strength measurement machine. In this mechanism of peel strength measuring machine that the motor which having low rpm will drive power screw with help of coupler. rotating motion of leadscrew will then convert into linear motion of table. Supporting bars support table mounted on leadscrew and adhesive strength will tested with help of measuring gauge. 180-degree peel strength measuring machine can measure adhesiveness of tape applied on any surface with higher accuracy. It will require zero lubrication and maintenance cost is also low. Machine is cheaper in cost and faster in working.*

Keywords: Peel strength, 180° peel test, Motor having low rpm, Leadscrew, Measuring gauge.

I. INTRODUCTION

A Proposed Mechanism for Peel Strength Measuring Machine is mainly focused on measuring the Peel strength of adhesive tapes. Peel strength is very important factor for any type of adhesive. Because it plays very important role for the selection of adhesive and as per the requirement parameter. Peel strength is generally used to measure the bond strength of a material, typically an adhesive. Peel strength is the average load per unit width of bond line required to separate bonded materials where the angle of separation is 180 degrees.[1]

Peeling tests are the practice of testing adhesion properties of film bonded to substrate, usually by tensile. The peel strength determines the adhesive strength (also called the adhesive fracture toughness). Physical testing of packaging products by peeling can tell us a lot about its properties and manufacturing process such as sealing consistency, bonding strength, adherence ability, cohesive properties of the interface, bond durability and other parameters.[2]

There are two primary reasons for performing a peeling test:

1. Assessing the uniformity of the adhesion of a given type of pressure sensitive
2. Distinguishing between acceptable and unacceptable criteria, by determining the adhesive strength range which is acceptable for consumer or for the purpose of the adhesive.

Industry which deals with adhesive tapes or gums needs such peel tester in their testing laboratory to measure the peel strength. Simple mechanism, in which a motor drives a power screw due to which reciprocating action of table mounted on power screw takes place. On table we adhere adhesive tape as per ASTM D3330 norms, one end of tape is adhered on table and one end will stick on arm of measuring gauge. Due to movement of mounting table tensile forces are developed between tape and the arm of measuring gauge which will be reflected in the dial of gauge and we get the value of Peel strength of adhesive tapes. For this proposed mechanism, main requirement is raw materials like A.C motor, power screw, thin aluminium sheets, angles, L clamp, limit switches, and many more.

1.1 Objectives of the Study

- To check and ensure quality of adhesive bond using 180 Degree Peel test.
- To check effect on peel strength of different types of adhesive tapes at different temperatures.
- To design and manufacture cost effective and modular peel strength testing machine with upgradable option using relatively low cost with simplicity in construction using readily available materials in workshops.
- To Assessing the uniformity of the adhesion of a given type of pressure sensitive adhesive interface, which indicates a bad adhesion and good adhesion between the adhesives and the adherents.

1.2 Problem Statement

Currently industries are using the peel strength measuring machine which works on the mechanism of ‘90° peel test type A’ in which the complexity of the machine is very high which resulted in high cost of the machine. But as peeling angle increases the accuracy will also increases, so we are focusing on ‘180° peel test type B’ as per ASTM standard D3330. On the other side, the solution that we have proposed based on the 180° peel strength mechanism which has reduced the machine complexity and resulted in economical peel strength measuring machine.

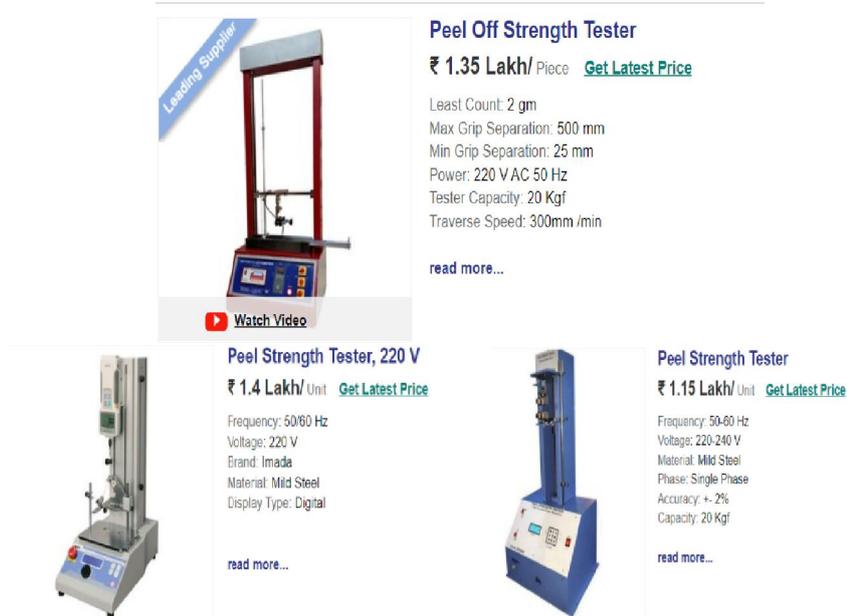


Figure: Existing Peel strength Tester[3]

1.3 Scope of Study

1.3.1. ASTM STANDARDS ASTM D3330/D3330M-04(2018) – Standard Test Method for Peel Adhesion of Pressure-Sensitive Tape.[1]

- **Peel strength** - According to ASME (American Society of Mechanical Engineering) Peel strength or Peel Adhesion is defined as “The force per unit width required to break the bond between a tape and surface when it pulled back usually at 180 at standard rate and condition”
- **Pressure Sensitive** - A term commonly used to designate a distinct category of adhesive tapes and adhesives which is dry (solvent free) form are aggressively and permanently tacky at room temperature and firmly adhere to a variety of dissimilar surfaces upon mere contact without the need of more than finger or hand pressure. they require no activation by water, solvent, or heat in order to exert a strong adhesive holding force towards such materials as paper, plastic, glass, wood, cement and metals.

They have sufficiently cohesive holding and elastic nature so that, despite their aggressive tackiness, they can be handled with the finger and removed from smooth surfaces without leaving a residue. General trade by leading tape manufacturer does not sanction extension of the term “pressure sensitive” to embrace tapes and adhesives merely because they adhere.

Common Peel Tests: The most common types of peel tests for the measuring of adhesive strength are the T-peel, 90° peel, and the 180 degree peel. The T-peel test is a type of tensile test performed upon two flexible substrates that have been bonded together and placed into peel test grips such that one substrate sticks up and the other sticks down while the bonded area sticks out horizontally so that the entire setup forms a “T” shape.[1] The 90° test requires a 90° peel test fixture to determine the adhesive strength between a flexible (tape) and rigid substrate (plate), where the plate lies horizontally with the gripped end of the tape sticking up perpendicular while the rest is bonded to the plate so that it forms an “L” shape.[1] The 180 degree test is similar to the 90° peel test except that the bonded area between the tape and plate is placed vertically between the peel test grips while the free end of the of plate is gripped by the bottom and the free end of the tape is gripped by the top so that it forms a tight “U” shape.[1]

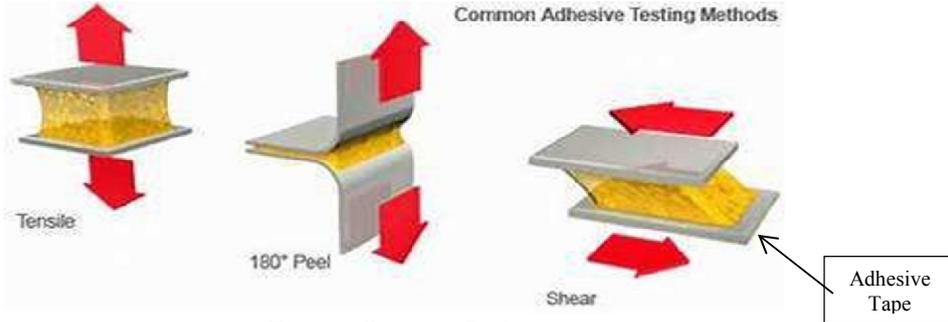


Figure: Common Peel

II. LITERATURE REVIEW

Peel strength is applicable to various industries including aerospace, automotive, adhesives, packaging, biomaterials, microelectronics, and more. Peel test data is used to determine the quality of the adhesive joint and, where applicable, provides information on the effects of processes.

Peel tests are constant-speed tests in the tensile direction. In material testing, peel strength is calculated after measuring and averaging the load to peel the specimen and dividing the average load by unit width of the bond line.

We had studied different research papers, Blogs, Textbooks for studying different aspects of peel test, different methods and ASTM Standards use for test. Following information gives idea about different aspects which we had studied:

2.1 Evolution

A. By, Y. wang et al., Awlekar et al, G C Kolleman et al,[4] I got information about different effects of peeling angle on peel strength. I got information about different type of test available like T-type peel test. dead weight peel test, 180-degree peel test 90-degree peel test etc. Peel angle shows the peel force in peeling test. As peel angle increases peeling force decreases to some extent. Paper gives idea about different pattern different pattern formed during testing of specimen while fracture at different angle condition from referring to this 180° is best suitable method as it gives gradual shear resistance.

B. By, M V Borse et al, M D Toughness [5] I got to know Adhesive strength refers to the ability of an adhesive to stick to a surface and bond two surfaces together. It is measured by assessing the maximum tensile stress needed to detach or unstick the adhesive perpendicular to the substrate. To measure this adhesiveness there is a device called Adhesive Peel Tester. Peeling tests are the practice of testing adhesion properties of film bonded to substrate, usually by tensile. The peel strength determines the adhesive strength also called the adhesive fracture toughness. Physical testing of packaging products by peeling can tell us a lot about its properties and manufacturing process such as sealing consistency, bonding strength, adherence ability, cohesive properties of the interface, bond durability and other parameters. This device covers the measurement of the peel adhesion of pressure sensitive tapes. Peel adhesion is the force required to remove a pressure sensitive tape from a test panel or its own backing at a controlled angle and at a standard rate and condition. A peel test is performed between two substances bonded together with an adhesive. The substrates may be both flexible or one may be flexible while other is rigid.

C. By, 180 Degree peel for Method B of ASTM D3330

ASTM D3330 Test Method B is very similar to Method A, but Method B measures the adherence of two layers of single-coated tapes to each other. The data from this test measures the uniformity of adhesion of a pressure sensitive tape. In this test a strip of tape is applied to a rigid substrate and then another strip of tape is applied to the backing of the first strip, then tested for peel adhesion.[1]

C.1. Method B Testing Procedure

For Method B, measure out several strips of the tape according to the standard. Now apply a strip of the tape to a rigid panel, such as the standard stainless-steel panel. Use a Test Resources Sample Roller to firmly apply the tape to avoid bubbles. Apply a second strip of the tape to the backing of the first strip on the test panel, taking care to align the edges of the second specimen with those of the strip in the test panel. Fold a tab of the tape and double back at an angle of 180 degrees. Next, clamp the substrate panel into the moveable jaw of testing machine and free end of tape into other jaw.

C.1.1. Procedure

According to ASTM, DESIGNATION D 3330/3330D-04 Around six Methodologies are given for the peel adhesion tests namely Type A, B, C, D, E, & F. From that we worked on Type A Method. Which is for single-coated tapes and assesses the peel adhesion at a 180 angle.

C.1.2. Definition:

Peel adhesion or peel strength can be defined as the force required to remove pressure sensitive tape form a test panel or its own backing.

C.1.3. Significance:

In many applications the use of pressure sensitive adhesive tape depends upon adhesion strength or peel strength to give satisfactory performance. This property is also important in determining the uniformity of quality.

Equipment:

1. Peel strength measuring machine
2. Measuring gauge
3. Roller (4.5 lb.)

C.1.4. Test method.

1. Adhesion to Steel:

Touch the one end of specimen or sample to the Steel plate. hold the other end of sample so that it does not make contact with other parts but is positioned is loosely above it. Roll the tape mechanically once each lengthwise direction using the roller to apply the tape to the steel plate. This prevents entrapment of air, between the adhesive and the steel plate should this occur, discard the sample. Where the width of sample is less than 1 in. prior to applying test sample, apply a strip or strips of the tape to give the equivalent width of 1 in. for rolling purpose. Prepare each sample individually and test immediately within one minute. (Longer dwell time will give the different result). Pass Roller over the tape around 5 times. [17]

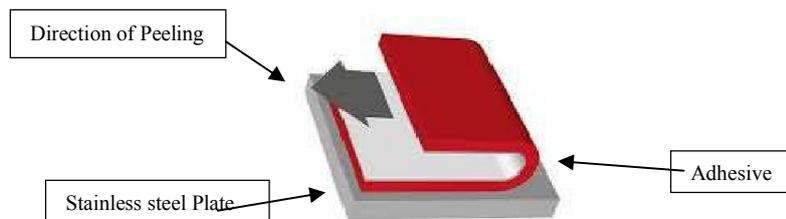


Figure: Peel Adhesion at 180 angle.



2. Adhesion to Backing:

Conduct the test for adhesion of a tape to its own backing. strips of the test under test to the lengthwise surface of cleaned surface. do not touch the backside of the strips. The sample on these strips taking care to align the edges, proceed the Steps as mentioned.

III. EXPECTED WORKING OF MECHANISM

3.1 Working of Mechanism

1. For this setup we require Low speed Bi-Directional AC motor. And we will design Power screw for suitable load application.
2. When we put the toggle switch on ON position the anti-clockwise motion of shaft of motor will take place.
3. This motion will transmit to power screw through coupler.
4. Due to this,reciprocating motion of table is take place and table slides over the supporting bar.
5. When table reach at left most position, it actuates the limit switch and due to this motor will stop and toggle switch gets in OFF position.
6. When we put the toggle position at second on position the clockwise motion of motor take place and due to this table mounting slides back.
7. On table, we will mount stainless steel plate on which we have to adhere adhesive tape of which we have to measure peel strength.
8. We are going to adhere adhesive tape as per ASTM standards. One end of adhesive tape is connected to peel measuring gauge.
9. As table will move leftward, resistance will offer by adhesive tape, this resistance will indicate by measuring gauge and we will get reading for that one.

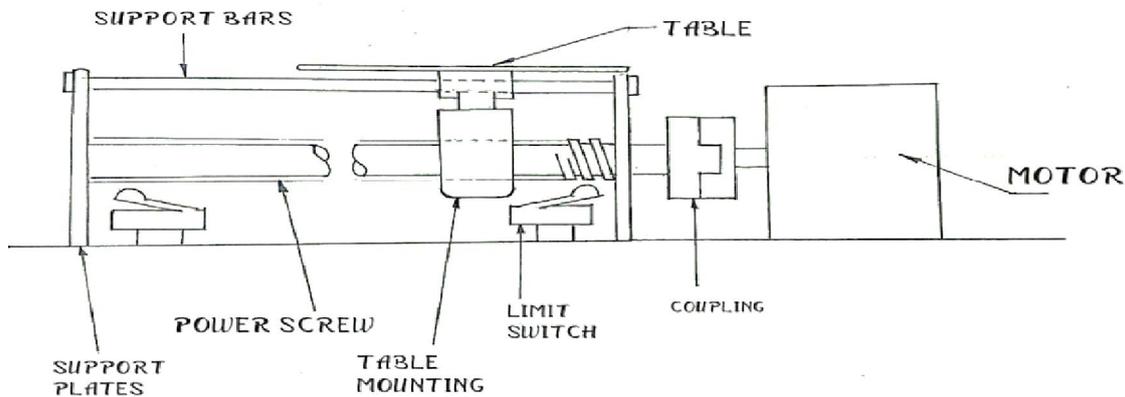


Figure: Layout for Purposed mechanism.

IV. CONCLUSION

Peel Strength Tester is widely used testing machine which is used in different packaging products manufacturing industries to test the bond or adhesive strength of self-adhesive products such as tapes, labels and many more. The adhesive products are tested to measure the maximum amount of force that an adhesive material requires to leave another substrate on which it is applied. Peel Strength Test is one of the best testing machines which are used to measure the bonding strength of the packaging materials. The test is performed to ascertain the bond strength of the adhesives even in tough working conditions. These tests are tools for quality assurance control and use, the benefit of performing objective, accurate and repeatable peeling testing can improve product consistency and assess interface adhesion. If it works as promised, the Peel strength measuring machine would improve peel adhesion by far more than other options, some of which can improve efficiency on the order of 20 percent. It is expected to cost of other systems currently on the market is high. Bottom line is it help not only to just reduce the price of that machine but it can give alterative mechanism to perform peel strength test.

REFERENCES

- [1]. ASTM D3330/D3330M-04(2018)“Standard Test Method for Peel Adhesion of Pressure-Sensitive Tape”(https://www.testresources.net/applications/standards/astm/astm-d3330-peel-adhesion-pressure-sensitive-adhesive-tapes/)
- [2]. SteavenAbott Textbook of Adhesion science and Engineering, Effect of atmospheric temperature.
- [3]. Technical specifications for peel tester: (https://www.prestogroup.com/articles/significance-of-peel-strength-tester-in-the-packaging-industry)
- [4]. Yuvraj J. Awalekar, Atul S. Takalkar, Sachin S. Shinde “Proceedings of Engineering and Technology Innovation”, vol. 10, 2018, pp. 19 - 28 Investigation of Peel Resistance of Adhesives Materials.
- [5]. G C Knollman and J Hartog, “Experimental determination of the variation in shear modulus through the interfacial zone of an adhesive”, J Adhesion vol 17 pp251-272, 1985.