What is a Tension Test？

Tension testing is a method used to quantify the strength of an object by applying a tension load or essentially pulling it. It can be employed to evaluate the functionality of the object, including its mechanical safety and comfort. Tension testing is one of the means to improve and stabilize the quality of manufactured products. It is used to evaluate weather the strength is sufficient and the object is operated with the appropriate amount of force. It is utilized not only to ensure product safety but also to enhance brand image.

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1. Overview of Tension Testing

- Tension testing is a type of force measurement where force is applied in the direction of pulling the test specimen.（Tests such as breaking, joining, tearing, and drawing are also classified as Tension tests）
- The purpose of Tension testing can be broadly categorized into "strength testing," which defines the material's physical properties themselves, and "functionality assessment" which evaluates factors, such as safety, by adding specific criteria to the strength test
- Tension testing uses force measurement devices such as force gauges or universal testing machines
- The unit of tension force value is N (Newton)

Force Measurement

Force measurement refers to the measurement of force, which includes such forces applied in compression, tension, peeling, and friction, among others. These forces can be measured using instruments and sensors like force gauges or universal testing machines. Understanding the strength of an object and then using that knowledge to ensure safety and comfort in manufactured products through specific indicators is one of the means of force measurement.

Tension Test

Tension Testing is a type of force measurement where a Tension force, directed towards pulling the test specimen, is applied to assess the strength and functionality of the specimen. Tension tests are conducted by pressing the test specimen on the sensor part of a force gauge or universal testing machine equipped with tension testing fixtures. It is important to note that tension testing encompasses various types, including tension, tearing, pulling, opening, shearing, and tension, depending on the method of force application.（Rerer to page 6 for more details）.

Strength Test

Strength testing is a type of test where a tension force, directed towards pulling the test specimen, is applied to determine how much tension force the test specimen can withstand. This test defines the physical properties themselves and comes in two main categories; Material Strength Testing (Assesses the strength of the material itself) and “Structural Strength Testing (Evaluates the strength of a fully assembled and completed product).（Refer to page 4 for more details）.

Functionality Assessment

Functional evaluation is a type of test where, in addition to strength testing, other indicators are included to assess aspects such as safety, comfort, protection, etc. These evaluations are crucial for determining product quality and, consequently, customer satisfaction. From a branding perspective, they are also essential as they directly impact the perception of the product's quality and performance in the market.（Refer to page 4 for more details）

2. Why is Tension Testing Necessary in the First Place?

For example, you are inquiring with manufacturers about the dimensions of a product considered for purchase. If you receive a vague answer like, "It's slightly shorter than the width of a 5-euro bill," you would likely think, "Can you please measure it precisely and tell me the exact dimensions?" It's unlikely that manufacturers would provide vague answers when it comes to dimensions. However, when it comes to mechanical strength and functionality, it is often the case that they are not quantified and measured.

Let's say you work for a clothing manufacturer and are looking for a type of zipper with a smooth sliding motion to make a pair of pants. You contacted two manufacturers, and they presented you with their recommended zippers. You asked, "How smooth are they?" , and the two companies provide the following answers: How would you compare the two companies?

Company A's response	Company B's response
The Force of our zipper is defined at 2-2.5N and inspected to ensure that the Tension Forces of all the zippers manufactured are stable enough for smooth motions. We graph the fluctuation of the measured values and check for any issues, such as snagging	Our zippers open and close smoothly
✓ **It is reliable**	The lack of evidence causes anxiety

Company A is reliable, isn't it?　Numerical evidence is a decisive and persuasive factor for users.

As in the case of Company B, there are cases where quality is not measured but checked by human senses. However, relying on the human sense would result in significant individual differences with unstable results. Also, verification productivity inevitably declines in product development because numerical values cannot be used as a basis.

If the zipper is easy to open and close smoothly, usability is preserved, but if it is beyond smooth and if slides to open unintentionally, it is also a problem. In pursuing proper opening and closing conditions, it is essential to quantify and analyze the results of tension tests.

The advantages of conducting tension testing lie in the quantification and analysis of strength and operability, which leads to stable quality and accelerates the speed of product development verification.

	Quality Control	R & D
Conduct Tension Test	Quality stabilizes through numerical evidence and management.	High productivity in verification is achieved due analysis is based on numbers.
Tension Test Not conducted	Unstable Quality	It is difficult to create evidence, and the verification Low productivity

3. What is the Difference Between Strength Testing and Functionality Assessment?

Strength Testing: Strength testing is to clarify the physical characteristics by saying, "The Tension strength of this packaging film is 10N." It focuses on quantifying how much force an object can withstand and is mainly concerned with determining the strength of the material or the object itself.

Functional Assessment: Functional assessment, on the other hand, goes beyond just defining strength and involves assessing how well a product meets specific functional criteria or requirements such as safety, protection, comfort etc. For example, if a packaging film is subjected to tension force of 10N (approx. 0.9kgf) at maximum when it is used to wrap something, assessing whether the packaging film can withstand a tension force of 10N would be a functionality assessment.

Strength testing solely defines how much strength is present, while the functionality assessment involves the creation of anticipated indicators and their comparative assessment particularly aimed at achieving the purpose of protecting contents within the packaging film from tearing even when subjected to a force of 10N. This differs from strength testing. The criteria for functional assessment vary depending on how we define this protectiveness. In the case of packaging film, the evaluation criteria depend on the contents being packaged.

For instance, when it comes to packaging films intended for holding heavy items like gardening soil, it is necessary to set higher standards than 10N to ensure they do not tear when subjected to the gravitational pull of the heavy contents. Conversely, if it were a packaging film for powdered medicine, the powder itself is very lightweight, so it should be acceptable to lower the strength requirements below 10N.

It's worth noting that evaluation criteria can differ among companies and individuals, so there is no uniform value. Standards like ASTM, IEC, JIS, TAPPI, and other various international standards aim to reduce variation in safety, quality, and other areas. It is essential to consider and adopt them where relevant and applicable to ensure product quality and safety.

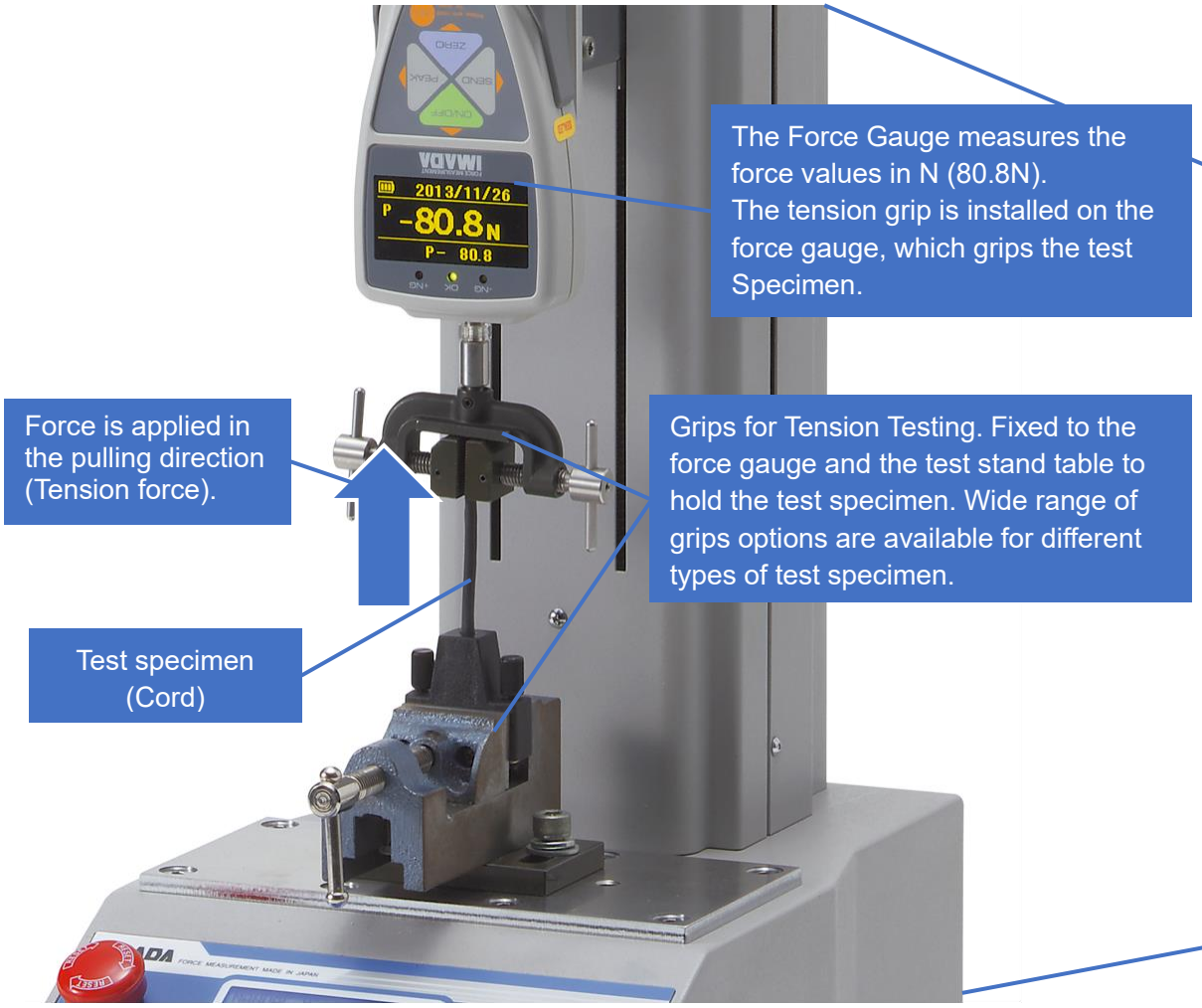
4. The Differences between "Tension force", "Tension load", and "Tension stress"

The force applied in the Tension direction is described as Tension Force, Tension Load, Tension Stress, etc. What is the difference?

*Note that **Tension Stress** is similar to **Tension Force,** but they differ: -

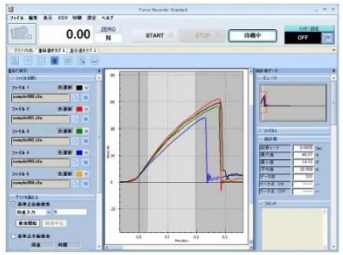
	Tension (Tensile) Force / Tension Load	Tension Stress
Definition	Refer to the actual physical force or pull applied to an object or material in the direction of tension.	Refer to the tensile resistance. Tension stress = Tension force / Cross-sectional area of the specimen
Unit	N（Newton）	Pa (Pascal) or N/m^2 (Newton per square meter) 1Pa = 1N/ m^2 (1MPa =1N/mm^2)
Measuring Instruments	Force gauges, etc	Universal Testing Machines, etc

5. Overview of Tension Testing Methods and Tension Tester
(Example of Tension Strength Test for a Cord with a Force Gauge)



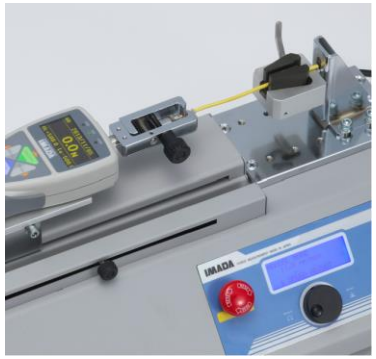
Tension Tester Overall Image

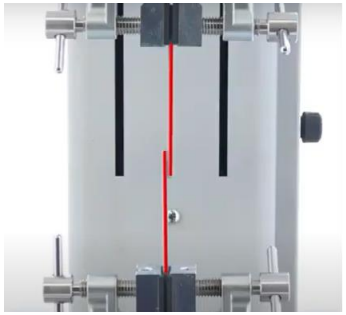
A force gauge is mounted on a test stand head, and the head moves the force gauge to tension direction (pull the sample specimen upwards)



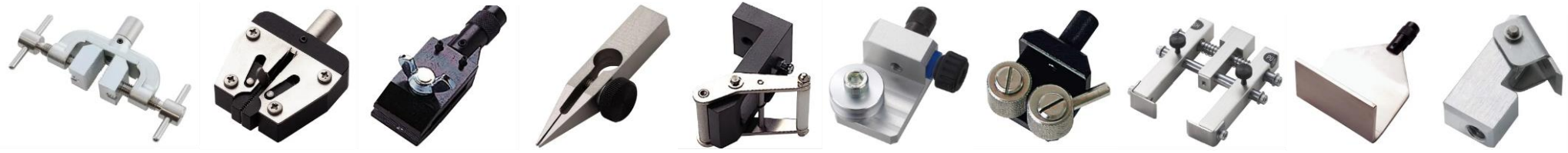
The use of software to graph measurement data allows for evaluation and analysis. Graph analysis is particularly crucial for assessing functionality.
For example, when it comes to the functionality of a zipper on a pair of pants, a smooth zipper closure results in a smooth graph waveform when measuring the closing force. On the other hand, if there are snags and the zipper cannot be closed smoothly, the waveform appears jagged. Graphing the data reveals trends that cannot be fully analyzed with a single point of load value.

6. Types of Tension Force

Tensile	Bonding Strength	Tearing	Pulling Out	Openability
				

Shear	Tenson
	

In this way, even though we refer to it as tension force, there are various types, leading to a wide range of tension testing fixtures.



7. Contact for Tension Testing

The optimum shape and type of tension test attachments and fixtures vary depending on the test specimen. Please get in touch with IMADA for consultation on tension testing and fixture options. We can offer the best tension testing solutions as a force measurement specialist.
（We specialize in measuring instruments for force strength tests and mechanical functionality evaluation, up to 5000N.　For the large-capacity force measurements over 5000N, please refer to the manufacturers specialized in universal testers.)

- Contact us：https://www.forcegauge.net/en/contact/consultation （Go to a contact form on IMADA's website）
- Tension test cases (vides)：https://www.forcegauge.net/en/solution/force/tension_test（Go to "Tension" on IMADA's website）
- About IMADA：https://www.forcegauge.net/en/company/profile （Go to "About us" on IMADA's website）