Automobile Interior Testing Machine - A Review

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Abstract

This paper represents the materials used in automobile interior parts, testing of automobile interior parts, study of selection of automobile interior testing machine parts & Study of development of machine. To test the stiffness of interior parts of automobile at different point's universal testing machine is required. Now days automobile aesthetic is become the key factor to attract the customers. Automobile interior aesthetic is improved by using different parts having curvature surfaces. In this case the special universal testing machine is required to test the stiffness of parts having curvature surfaces.

1. Introduction

An automobile consist of interior trim & ornamentation subsystem which consist of cup holder, ashtray, overhead console, engine cover, visor, door trim, cowl trim, scuff plate, luggage compartment trim, load floor, roof trim, grab handle, insulator etc. The automobile interior parts generally made with plastic. In research & development dept. for the automobile interior systems, first design is to prepare & according to that part is made with help of injection molding. After molding the part is come to testing department. In testing department part have to go through different tests, such as abrasion test, scratch test, impact test, rigidity test etc. In rigidity test the testing engineer checks the strength of parts with the help of universal testing machine. In rigidity test the testing engineer thinks over the maximum forces to which the part is withstand during its life cycle. They will find out the deflection of part in 'mm' for particular force, this is calculated with help of universal testing machine which shows graph of force Vs deflection, where force is in Newton & deflection is in 'mm'. Universal testing machine also known as universal tester, which is used to test tensile stress & compressive strength of materials. It is named after the fact that it can perform many standard tensile & compression tests on materials, components & structures. Once the machine is started it begins to apply an increasing load on specimen. Throughout the test the control system & its associated software record the load & extension or compression of the specimen.

Now days in the market many manufacturers of vertical universal testing machines are available. In vertical universal testing machine, it applies load on the specimen vertically which is perpendicular to specimen. But in case of automobile interior parts such as door panel, instrument panel has chamfers & curves for the enhancement in aesthetics. So due to this chamfers it is difficult to measure the strength with vertical universal testing machine. So for this it is necessary to think over other alternatives.

2. Materials of automotive interior parts

The automotive industry is on the brink of a revolution, and the plastics industry poised to play a major role. The real plastics revolution in automotive industry began in 1950 when thermoplastics made their debut, starting with ABS and going on to polyamide, polyacetal and polycarbonate together with introduction of alloys and blends of various polymers. Originally plastics were specified because they offered good mechanical properties combined with excellent appearance, including the possibility of self-colouring. The application of plastic components in the automotive industry has been increasing over the last decades. Nowadays, the plastics are used mainly to make cars more energy efficient by reducing weight, together with providing durability, corrosion resistance, toughness, design flexibility, resiliency and high performance at low cost. [1]

2.1 Plastics in automotive-

The average vehicle uses about 150 kg of plastics and plastic composites versus 1163 kg of iron and steel – currently it is moving around 10-15 % of total weight of the car. Although up to 13 different polymers may be used in a single car model (Fig. 3), just three types of plastics make up some 66 % of the total plastics used in a car: polypropylene (32 %), polyurethane (17 %) and PVC (16 %).[1]

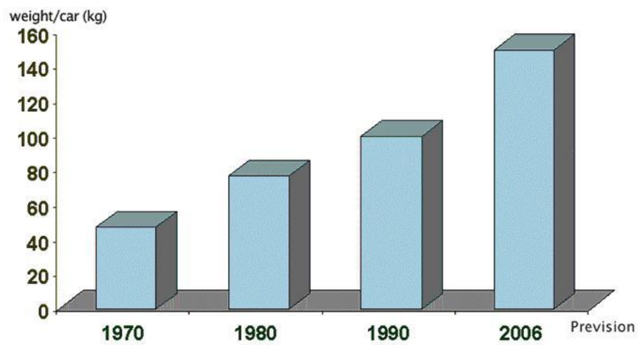

Fig.1 increasing use of plastics in automobiles [1]

2.1.1 Commonly used plastics in automobile interiors

2.1.1.1 Polypropylene (PP)-

It is extremely chemically resistant and almost completely impervious to water. Black has the best UV resistance and is increasingly used in the construction industry. Application: automotive bumpers, indoor and outdoor carpets, carpet fibers. [1]

2.1.1.2 Polyurethane (PUR)-

materials are widely used in high resiliency flexible foam seating, rigid foam insulation panels, microcellular foam seals and gaskets, durable elastomeric wheels and tires, automotive suspension bushings, electrical potting compounds, hard plastic parts (such as for electronic instruments), cushions.[1]

2.1.1.3 poly-vinyl-chloride (PVC)-

Has good resistance to chemical and solvent attack. Its vinyl content gives it good tensile strength and some grades are flexible. Colored or clear material is available. Application: automobile instruments panels, sheathing of electrical cables, pipes, doors, waterproof clothing, and chemical tanks. [1]

3. Strength & Stiffness of automobile plastics

Plastics can fall into all of the various categories of strength and stiffness, i.e. stiff and weak, stiff and strong, flexible and weak, or flexible and strong, depending on the plastic and the test or application conditions. The response of any plastic to an applied load is dependent not only on the size of the applied load, but also on the rate and temperature at which the load is applied. This is known as time temperature superposition.

Time-temperature superposition shows that time and temperature of loading can have the same (but inverse) effect on plastics – the strength and Young’s Modulus of a plastic under rapid loading and low temperatures can be effectively the same as the strength and Young’s Modulus of the same plastic under slow loading and higher temperatures. As a general rule increasing the load application rate will increase the strength and stiffness of plastics, and increasing the temperature will decrease their strength and stiffness. In assessing the suitability of a plastic for a particular application it is therefore essential to know not only about the range of mechanical loads that will be applied to the product (as with conventional mechanical design procedures), but also to know something about the rate and temperatures at which they will be applied.

4. Main parts required to be selected for automobile interior testing machine

4.1 Linear actuator-

The function of linear actuator is to convert rotary motion in to linear motion. In recent years a range of linear electric actuators have been developed to perform functions similar to hydraulic & pneumatic cylinders. These are based on a motor driven lead screw.

4.1.1 Linear actuator requirements-

4.1.1.1 Capacity-

The weight or force reqd. to move and hold the load.

4.1.1.2 Travel-

The distance or range of motion.

4.1.1.3 Speed-

The rate at which the linear actuator moves the load.

4.1.1.4 Environment-

The surrounding conditions in which the system will operate.

4.2 Load cell-

Load cells are sensors that convert force into electrical signals. In order to convert force in to electrical signals, we bond a sensor called a ‘strain gauge’ to the load cell.

4.2.1 Strain gauge-

The electrical resistance of metallic objects changes due to pressure or tension. The electrical resistance of many metals changes when the metals are mechanically elongated or contracted. A load cell is made by bonding strain gauges to a spring material.

4.2.2 Spring material-

The spring material generates a strain when external force is applied. When force is exerted to a spring material, it causes a strain, & the resistance value of the strain gauge bonded to the spring material will change. The spring material converts force in to an electrical output by utilizing the same principle. In order to enhance the performance of a load cell, the characteristics of the spring material are very important.

4.2.3 Adhesive-

The Adhesive used to bond strain gauges to a spring material has to accurately transmit the strain of the spring material to the gauge.

4.2.4 General specifications of load cell-

4.2.4.1 Rated Capacity-

Rated capacity is defined as the maximum load that a load cell can measure while meeting its specifications. It is also called the rated load. Weighing instruments should be designed so that the load to be measured will be less than the rated capacity.

4.2.4.2 Rated Output-

Rated output is the difference when there is no load and when there is a load of rated capacity. It is generally expressed in output per excitation voltage (mV/V); alternatively called "span."

4.2.4.3 Maximum Deadweight-

Maximum deadweight is the maximum tare load that can be applied onto a load cell in addition to the load to be measured.

4.2.4.4 Safe load limit-

Safe load limit is the maximum load that can be applied beyond the rated capacity without causing any permanent damage. The safe load limit is expressed as a percentage of rated capacity.

4.2.4.5 Compensated temperature range-

Compensated temperature range is the temperature range within which the rated output and the zero balance are compensated to meet load cell specifications.

4.2.4.6 Temperature effect on zero balance-

Drifting of the zero balance caused by changes in the ambient temperature. This value is expressed as a percentage of rated output.

4.2.4.7 Temperature effect on Rated output-

Drifting of the rated output caused by changes in the ambient temperature.

4.2.4.8 Zero Balance-

Zero balance is the electrical output generated when a rated excitation voltage is applied without any load on the cell. It is generally expressed as a percentage of rated output.

5. Study of Selection of parts & development of machine

E. Huerta, J.E. Corona, and A.I. Oliva have discussed the design, construction, and calibration and compliance measurement of a universal testing machine for tensile tests on thin and soft materials. The design has the capability to obtain displacement as small as 0.001 mm and maximum loads of 220 N. [2]

Paul P.L.Regtien has studied about sensor selection. Sensor selection means meeting requirements. Unfortunately, these requirements are often not known precisely or in detail, the designer has to choose the optimal sensor type out of a vast collection of sensors offered by numerous sensor manufactures. [3]

Paul Mumford & Juan R. sevila have discussed about Universal testing machine. So many UTM options are available in a competitive global environment; a buyer should optimize the evaluation process to ensure that the system meets all his application requirements before purchasing. [4]

Elwaleed Awad Khidir, Nik Abdullah Mohamed this paper discusses the utilization of deflected flexible beams to amplify the displacement of a nickel titanium shape memory alloy actuator & to provide linear motion. [5]

Tolomatic has discussed the guidelines required to select the right linear actuator. The performance ratings may take into consideration maximum allowable force, speed, load, acceleration, deceleration, loading due to impact, temperature, or in the case of off-set loading, bending moments. In many cases, all of these ratings can be applied to the actuator. The published ratings should be used as guidelines to ensure the actuator is used safely and can achieve maximum service life for its application. [6]

V. R .Singh has discussed the evolution & technology development of smart sensors for various applications in different fields. Fabrication aspect of smart sensors has also been discussed. [7]

J. Shih, J. E. Huber, N. A. Fleck, M. F. Ashby have developed a schematic method to select the most appropriate sensor for a particular application. The selection of appropriate sensor is based on matching the operating characteristics of sensors to the requirements of an application. The final selection is aided by additional considerations such as cost & impedance matching. [8]

6. Future Development

Now days in market vertical universal testing machines are available & difficulty with these testing machines is we can't measure the stiffness of automobile interior parts such as dashboard, door panel, central console at the curvature surfaces so we can make the special machine which can apply force on interior parts with an angle of 0^0 to 180^0 with speed ranging from 0.1mm/min to 1000mm/min & measure the stiffness of parts at curvature surface. The output is graph of force vs. deflection.

7. Conclusion

The automotive industry is on the brink of a revolution, and the plastics industry poised to play a major role. The automobile interiors are mainly made by plastic. Today along with the strength the part should have good appearance to attract the customers, for good aesthetic shape the part should have different designs along with curvature shapes, so in this case the special type universal testing machine play an important role.

Goal of the test stand are stiffness test for interior components (dash board, centre console and door panel). The stiffness of the components has to be measured at real configuration. So a variable positioning from the arm has to measure the stiffness in any position normal to the surface of the test part.

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