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Abstract: *The goal of this research is to build a prototype to perform the resistance increased test of sunglasses, which is part of the requirements of the standard for sunglasses. This test is performed to guarantee the consumer a minimum resistance to the sunglasses rods, so that the user can put on and remove the sunglasses from the face without breaking or loosening the rod. In this research, the mechanical project was designed in SOLIDWORKS®, for the first version to the prototype. The system consists of a control panel, a cycle counter, a sample support bridge, a step motor, rod fastening points, quick tightening screws, switch, rod clamp adjustment, rotating disk, a scale of displacement of the frame and universal ball joint. The parts are being made in the mechanical workshop of the Department of Electrical Engineering of EESC-USP and preliminary tests are being performed.*
Keywords*: frame resistance test; sunglasses; NBR ISO 12311.*

Introduction

Sunglasses are very popular all over the world and when it comes to sunglasses standards, the concern is primarily about ultraviolet protection. However there are other items to be tested that are part of the standards, and this paper deals with one of these items. Sun protection goggles must comply with the requirements of international safety standards, and must follow rules in the manufacture of frames, such as the test that is cited in the standard NBR ISO 12311-2018 [1] item 9.7, which is a test of mechanical resistance that serves to guarantee the quality of the process of thermofusion of the hinges and also the characteristics of the molecular memory used in the manufacture of the frames.

When talking about the requirements of the standards of sunglasses, the first item that comes to mind is the protection that lenses must have against ultraviolet radiation, and the frames, although important enough for the proper functioning of the glasses, are forgotten. When choosing a pair of sunglasses, one should analyze how they fit the face, if the rods of these sunglasses do not have good molecular memory, to avoid that over time they will no longer have the perfect fit, and may even break. The frames guarantee the ideal position of the protective lenses on the eyes, and if they become lighter clearances or present ruptures overtime, this protection no longer exist.

When we talk about glasses for sun protection, we must remember that many people have ocular ametropias, and need lenses that can not only protect against ultraviolet radiation, but also have an amout ofdegree for visual correction. According to ROEHE [4], "If the optical center of the lens does not focus on the visual axis, a prismatic effect will be induced, which will increase the dioptric power of the lens and may result in visual discomfort or asthenia. Also, on progressive lenses, if the intrapuppilary distance is incorrect, the eyes will not be adjusted to the progressive corridor, causing image distortion. “With this information, we can conclude how important the frames are, especially in multifocal cases, because if the frame is deformed the visual axis will no longer be adjusted with the face, and the glasses are o longer functional. When the specialist prescribes the diameter of the lenses for correction of ametropias, one of the parameters to be considered are the frames. If the frames do not maintain the same measures or become lighter over time, this calculation will no longer be within the initial parameter. It may lead to a centralization error that according to ALLPROT [7] "can cause prismatic effects or even in the case of multifocal lenses problems in the user's posture, you need to turn your face constantly to see clearly."

Frames that are maintained to the same extent, even after efforts, are made with materials that have molecular memory, if the glasses are not made with these materials this can affect the lenses, as this change can abrade or release the lenses.

Sunglasses have become a style item and the most sought-after models vary by fashion. However, the choice must take more into account than the appearance. Thus, in 2015 the standards for certification came into force in Brazil, so that the glasses meet the requirements of the Brazilian Technical Standards Association (ABNT) [9]. These standards have been mirrored in international standards. However, these regulations are not compulsory, that is, it is not necessary for sunglasses to meet the requirements for entering the national market.

Taking into account the requirements of the standards, sun protection goggles must be designed and manufactured in such a way that, when used in the conditions and for the intended purpose, they will not compromise the safety and health of the user.

In this context, this project aims to develop the prototype of a test equipment for increased resistance of sunglasses, testing sunglasses sold in Brazil and evauating if they meet the requirements of the standards.

Materials and methods

The principle of the standard refers to the "test to simulate the applied forces on the frame of glasses for sun protection, especially the joints, when putting the glasses in the open or closed condition. The end of one rod is fixed to restrict lateral movement, but not the rotational movement, while the end of the other rod is rotated through a circle of 60 millimeters in diameter. The bridge is supported but not secured by an artificial nose to restrict the movement of the frame. "

When tested, sunglasses can not: fracture at any point, have cracks or have permanent deformations, ie the original distance between the sides at the measurement fixation point can not be altered by more than 5 mm after 500 cycles,ensuring that these glasses do not suffer from long-term deformation.

The standard specifies all parameters for the construction of the test equipment. Among the mentioned parameters, it specifies how the sunglass rods should be fastened to fixation points. It determines the size and angle of the bridge support that simulates the nose. The standard requires a degree of adjustment in relation to the bridge support that is 40 mm horizontally and vertically.

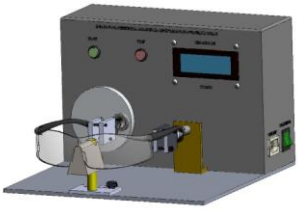
The equipment must be able to transmit a smooth, cyclic movement to one of the joints, being 30 mm for each side, in a total of 60 mm in diameter, at a rate of 40 revolutions per minute. It leaves open and as optional iftest is performed on the right, left, or both rod. Due to the majority of the population being right-handed, our system is for testing only the right rod. There is no national equipment for these tests available in the market and only a couple in theinternational market.

Precedent to the beginning of the test, the stems are measured at pre-established points, and this distance is recorded as d1. The sample is placed in the equipment, securing the two rods in their respective fixing points, and the rotation begins with 500 cycles. The sample is then removed from the apparatus and the distance between the rods measured at the same measuring point initially measured, recording this measurement as d2. Also, any fractures, cracks or changes in the movement of the rods should be recorded.

The difference between the measured values d1 and d2 can not exceed 5mm.

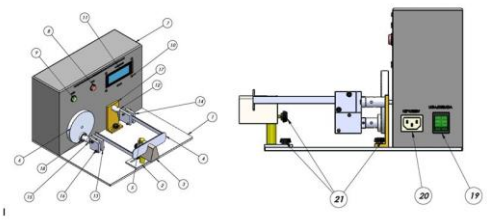
Based on the prerequisites of the standard, the first version of the mechanical design was developed using SOLIDWORKS software [5]. Figure 1 shows the design of the system and Figures 2 (a) and 2 (b) show the detail of the system.

Figura 1 – Desenho protótipo mecânico.



Fonte: O autor (2019).

Figura 2 – Vistas do protótipo.



(a) **(b)**

Picture's subtitle:

1	Support base
2	Adjustable sunglasses bridge support for sun protection
3	Nose bridge
4	Test sample
5	Pin Guide
6	Rotary disc
7	BoxSTOPSTART
8	Fixing display
9	Display (Cycles / Rotation Per Minute)
10	Universal ball joint
11	Point of attachment
12	Rod fixing
13	Point of attachment
14	Quick release bolt
15	Adjustable stand
16	Bearing
17	On/Off
18	Energy input
19	Quick release bolt

The hardware consists of a display for sampling the amount of rotation cycles and other procedural information, a motor rotating at 40 revolutions per minute, for the rod rotation test and an ARDUINO® [6] ATmega328 microcontroller for controlling the display and a stepper motor. A four-winding NEMA model, which has four windings, is controlled by the ATmega328 and power is 12V;a the control module for the ULN2803 stepper motor, has a set of seven Darlington transistor drivers that allow the drive of inductive loads and a limit switch to control the number of cycles by sending the signal to the microcontroller and transmites the information to the display. A touch display will be implemented to prototype, which in addition to displaying the number of cycles and the rotation per minute, allows the user to enter the additional data, such as: serial number of the sample to be tested, d1, d2, rotation value per minute, number of cycles, make notes of deformations and cracks, so that at the end of the test, a report will be provided with all the information.

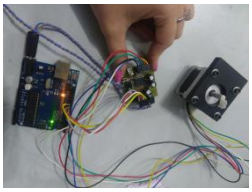
Results

The mechanical part of the prototype was designed and tested in SOLIDWORKS® software and the system is being assembled.

Figure 3 shows pictures of one of the parts of the holder (the "nose"), which might seem to be simple, but it plays a very important role in this system. It has to provide the tested sunglasses to be hold at all time, but loosened as if sunglasses were worn on the face.

Figure 3: Mechanical "nose"of the system

Figure 4 show the simulation of the electronic circuit of the motor.



Discussion and Conclusions

The mechanical design was designed in the CAD design software and the whole file for manufacturing is under review for verification of compliance with the standard. The mechanical and hardware tests are undergoing, and are beingcarried out in parallel with the software. The importance of this work is that not many scientists are working in this field of development for testing samples for standards. Only a couple of companies in the world sell the equipment for sunglasses testing, In Brazil there is no formal certification lab for sunglasses standard testing and one of the many reasons is the lack of systems sold in Brazil. Also, every 5 years standards are revised and tests alter, which means that equipments for testing should alter. There is an enormous dependence on international technology and qualified people for testing sunglasses standards in Brazil.Even our standard NBR ISO12312-1:2015 is a mirror standard from an European standard. Although efforts of our team has been progressively done in order to have an eye safe standard for sunglasses for our tropical country [10], as we did in 2013, when we were part of revising the Brazilian standard (NBR15111:2013), it has been repealed in 2015, for industries convenience and one of the many reasons is that there is no lab in Brazil able to perform every required test on sunglasses standards, which falls back to the issue of not having testing equipments at affordable prices. So, this work is one of the many systems that our lab is developing [11, 12, 13], to bridge this gap.

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