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Mechanical comparison and statistical study of different material used in industry

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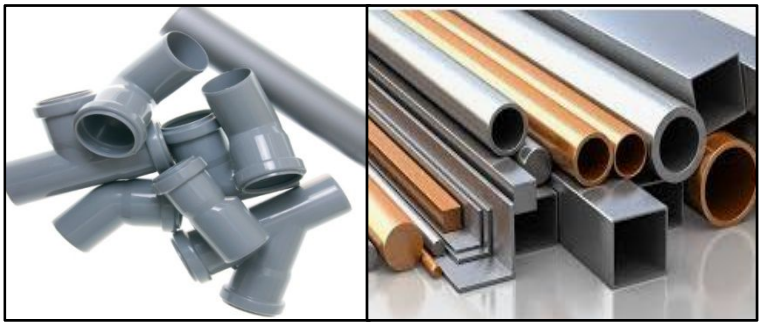
Abstract: The interest of the present work which is firstly the mastery of mechanical behavior of plastic and metallic material to improve and optimize the mechanical characteristics of the different materials(ABS material, PVC material, PR material and P265GH steel material), another characterization approach was considered in this paper; it is a statistical study of Student that allows the selection of the most reliable results with a risk threshold of 10% for the both types of materials. On the other hand, a Weibull statistical study is carried out to extract the Weibull elements and subsequently define the reliability theory and damage of Weibull.

Keywords: Mechanics, material, weibull, science, releability.



Graphical abstract

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1. Introduction

Plastic and metallic materials are often used in industry thanks to their enormous utilities; however, they are subjected to stresses of various kinds. Despite the protective ways surrounding the external a aggressions.

For example, the plastic material electrical insulation is affected by environmental factors, a power analysis of lightning on underground cables is performed by Chang Hong Chan [1], in the case of a momentary overvoltage resulting from lightning, electrical appliances in general and particularly underground electrical cables may be faced by serious damage in electrical insulation leading to the total damage of the cable. Thus, a remarkable influence of wire length and mass resistance grounding was observed. The results of this analysis demonstrate that the electrical insulation has been assigned. Chang also noticed a rapid increase of the cable tension.

Concerning the metallic material, the metallic materials of pressure vessels require special care given the importance and criticality of its mission, several researchers have carried out these studies by performing an analysis of the complete mechanical behavior of the material used [2]

The aim of this paper is to study the mechanical behavior of different material metallic and plastic. Results are supported by student statistical analysis that process the reliability and another statistical study results (Weibull) is performed to plot the reliability and damage curves. A comparative study of the different types of materials is conducted in order to review the various advantages and disadvantages of each material [3].

2. Experimentation

2.1 Studied Specimen

The three studied samples are:

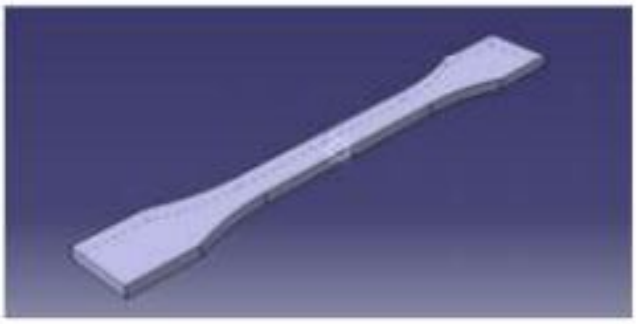

Fig. 1 Specimen of ABS material according to ASTM D638-03 [3-4]

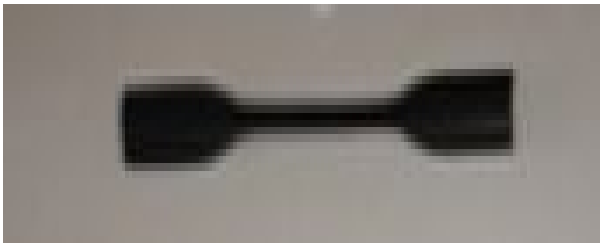

Fig.2 Specimen of PVC material [5]

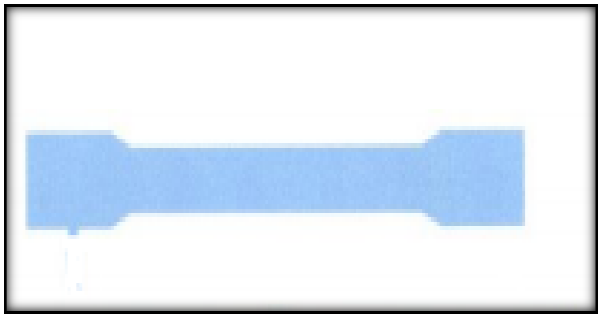

Fig.3 Specimen of PR material [6]

Fig.4 Specimen of P265GH steel material[2]

2.2 Mechanical properties of materials

Table 1. Mechanical properties of ABS material

Young's modulus E [MPa]	Elastic limit: σe [MPa]	Breaking stress: σ_g [MPa]	Elongation [%]	Poisson's ratio [v]
2.000	29	34	6	0,3

Table 2. Mechanical properties of PVC material

Young's modulus E [MPa]	Elastic limit: σe [MPa]	Breaking stress: σ_g [MPa]	Elongation [%]	Poisson's ratio [v]
160	7,8	14	143	0,47

Table 3. Mechanical properties of PR material

Young's modulus E [MPa]	Elastic limit: σe [MPa]	Breaking stress: σ_g [MPa]	Elongation [%]	Poisson's ratio [v]
2,8	10	23	237	0,5

Table 4. Mechanical properties of P265GH steel material

Young's modulus E [MPa]	Elastic limit: σe [MPa]	Breaking stress: σ_g [MPa]	Elongation [%]	Poisson's ratio [v]
2.105	320	470	35	0,3

2.2 Weibull distribution on maximum stress of Different plastic materials

The purpose of this study is to draw the probability of survival and failure for the materials studied.

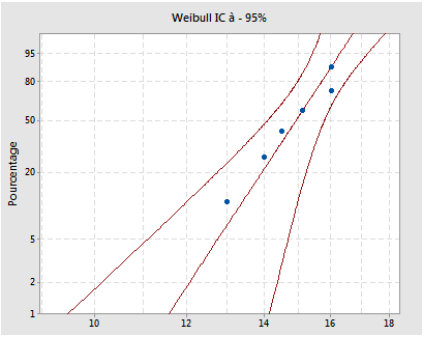

Fig. 5 Weibull distribution curve of ABS material

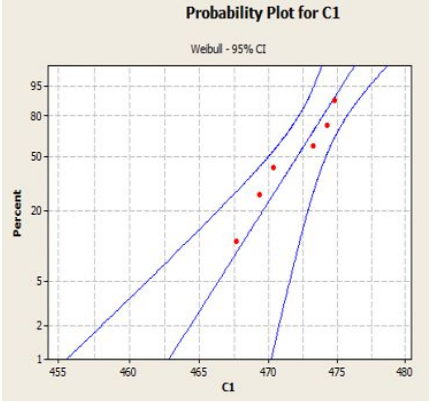

Fig. 6 Weibull distribution curve of the PVC material

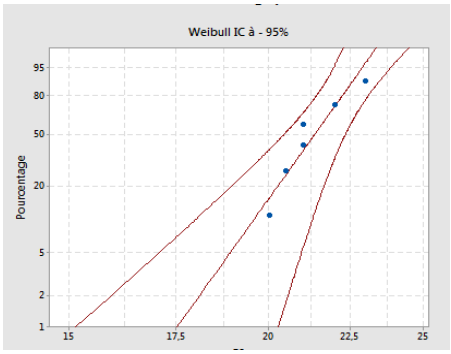

Fig. 7 Weibull distribution curve of PR material

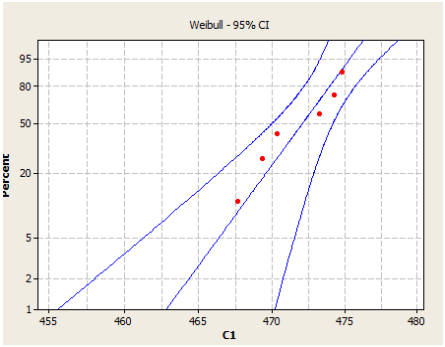

Fig. 8 Weibull distribution curve of the P265GH steel

We define Weibull characteristics of plastic and metallic material and we find:

For ABS material:

m = 31.32 and σ0 = 38.74 (1)

For PVC material:

m = 16, 65 and σ0 = 15,25 (2)

For PR material:

m = 21.32 and σ0 = 21.42 (3)

For P265GH steel material

m = 214.63 and σ0 = 472.88 (4)

3. Results and discussion

3.1 Weibull distribution

The probability of survival (reliability) of specimen undergoing stress could be modeled using the following Weibull model [7]:

$$Ps = e^{-(\frac{\sigma}{\sigma 0})^m} \quad (5)$$

The probability of survival curve and the probability of failure (damage) in function of life fraction β for the Plastic materials is presented in the figure 4,

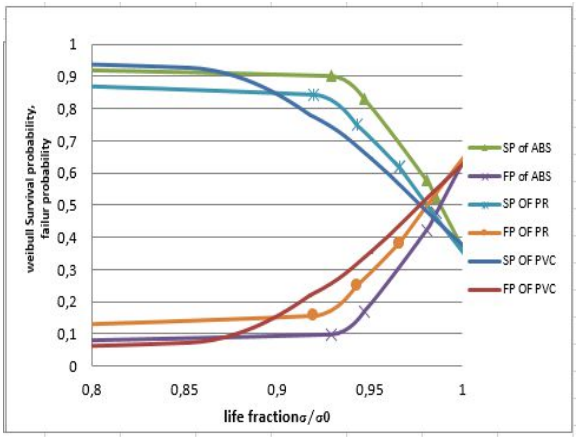

Fig. 9 Probability of Survival-Probability of failure curves in function of life fraction

to better understand the mechanical behavior of plastic materials, a study of the specific energy in the elastic phase has been carried out.

The specific energy in elastic phase is the energy associated with the elastic deformation of a material. The absorption capacity and energy release per unit mass of a substance undergo elastic deformation is expressed by the relationship [5]:

$$\frac{w}{m} = \frac{\sigma^2}{2\times\rho\times E} \quad \text{(J/kg)} \quad (6)$$

with

ρ: the density in kg / m^3

E: Young modulus in MPa

σ: maximum stress in MPa

So for the different components of our cable we studied the results summarized in the Table 4:

Table 4 Mechanical properties of P265GH steel material

Plastic material	Specify energy σe [J/Kg]
PVC material	306,3
PR material	744,2
PR material	210,25

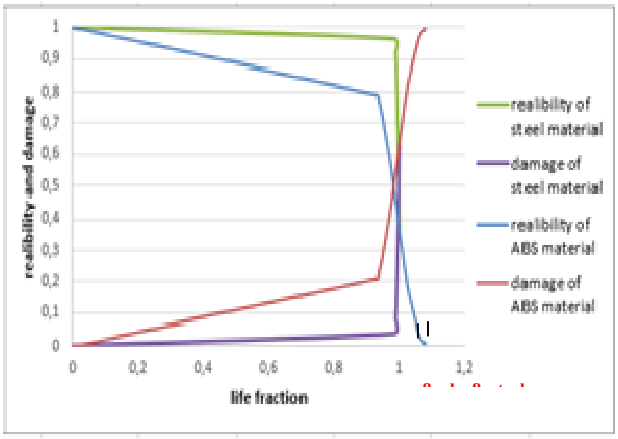

Fig. 10 Probability of survival-Probability of failure curves in function of life fraction

We find that survival probability of steel maintain a superior value until β=0.98.

We find that survival probability of ABS maintain a superior value of plastic material until β=0.98

And after we have β=0.97 for PR material and β=0.96. for PVC material.

According to figure 5, it is clear that the PVC material deteriorates so fast than the other materials, on the other hand and the ABS material have the reliable behavior than the other plastic materials

It is clear also that the life fraction of P265GH steel material is greater than the life fraction of plastic material.

The specific energy in elastic phase is the energy associated with the elastic deformation of a material. The absorption capacity and energy release per unit mass of a substance undergo elastic deformation is expressed by the relationship [6]:

$$\frac{w}{m} = \frac{\sigma^2}{2\times\rho\times E} \text{ (J/kg)}$$

with

ρ: the density in kg / m^3

E: Young modulus in MPa

σ: maximum stress in MPa

6. Conclusions

P265GH steel material have several strong advantages in their mechanical properties, they have a greater maximal stress and an important strain (35 % of strain)

On the other hand, ABS material has a great critical life time near that of P265GH steel material, which means that it has a important life time, also, ABS material has a minimal specific energy, and the PR and PVC material have a high energy ,

ABS steel material have several strong advantages in their mechanical properties, they have a greater maximal stress, in studied statistical analysis, it is noticed that the specimens of ABS material have a less dispersion than Other material;

On the other hand, ABS material has a minimal specific energy, and the PR and PVC material have a high energy, which means that it has an important life time

Weibull modulus m is a characteristic parameter of material defects dispersion, the lowest it is, the more

heterogeneous is the defect distribution. On the other hand, Weibull distribution permits the definition of survival probability therefore determine the damage, and thus to intervene in time for predictive maintenance.

References

[1] Chang-Chou Hwang,"Extensions to the finite element method for thermal analysis of underground cable systems",2002.

[2] M.Lahlou; A.Hachim; N.Mouhib ;H.Ouaomar ;M.Rachik& M.El Ghorba''Numerical modeling and analytical validation of stress intensity factor . of stress intensity factor of P265GHs steel.'' International Journal of Research (IJR)e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 06, June 2015

[3] LEBAS PIERRE "*Diagnosis underground cables by detecting partial discharges*" Graduation Study, Faculty of Applied Sciences University of Liège , 2010.

[4] E606 / E606M - 12 ASTM Standard Test Method for Strain-Controlled Fatigue Testing**.**

[5] Rajae GHANIM " Etude du comportment mécanique des ABS" Thèse de doctorat, Faculté abou CHOUAIB DOKKALI, ELJADIDA ,2016.

[6] ISO 6801-1 (International Organization for Standardization standard electrical cables).

[7] H.Ouaomar, N.Mouhib,M.Lahlou,M Elghorba. "Study of specific energy in elastic phase of the different elements of a low voltage underground power cable." International Journal of advanced Research, vol. 4, no. 6, pp. 406–408, 2015.