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RISK ASSESSMENT SOFTWARE USING LIGHTNING PARAMETERS IN TROPICAL ZONE

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Abstract – The lightning risk assessment is the first steps when a lightning protection system is going to be implemented. The international standard IEC 62305-2 describes a methodology that is applied worldwide.. Colombia has harmonized a national standard based on IEC 62305 series. The most important aspect of the harmonization are the lightning parameters, which are values adopted for tropical zone. This paper present the software developed to compute de lightning risk for the national standard NTC-4552-2. The software is an online tool based on IEC 62305-2 and NTC 4552-2 and calculates the basic risk assessment for structures and people. The evaluation of the annual number of dangerous events N takes values from the lightning ground flash density map in Colombia (the map was obtained with 300x300 km2 areas). Some compassion with other standards and software was carried out.

1 INTRODUCTION

In order to consider lightning protection measures for a structure or service a risk assessment methodology had been developed by different author and standards. One of them is the international standard IEC 62305-2 [1] which is well know and applied worldwide.

The Colombian Standard Institute ICONTEC harmonized a national standard according to the international standard IEC 62305; the new Colombian Technical Standard named NTC 4552-1, -2 and -3, 2007 Lightning Protection System will be published in November 2007. The technical committee has considered take into account the lightning parameters found in different studies and researches held in tropical zone[2][3].

Even though the methodology adapted in NTC 4552-2 is the same of the IEC 62305-2, the lightning parameters correspond to measurements in tropical regions [7], [8]. To make easier and fast calculations, a software risk computation was developed.

The evaluation of the annual number of dangerous events N takes values from the lightning ground flash density map in Colombia. The software was developed as a web application using PHP language. The risk software web site contains information above grounding flash density in Colombia using means areas of 300x300 km^2.

The software characteristics and procedure exposed in this paper was compared with the software based on IEC 62305-2.

Additionally, the risk assessment values obtained with the software using tropical zone parameters were compared with studies cases and results calculated with the IEC 62305-2, which uses temperate zone parameters.

2 SOFTWARE DESCRIPTION

The lightning risk methodology has a lot of components and values. For a risk assessment case, the calculation for each risk component is tedious and could spend a lot of time as well. A spreadsheet or a simple software which implemented the methodology is a useful tool in the risk evaluation. It allows to reduce calculates time and to handle the risk parameters. The software given by the IEC 62305 is a good tool for basic risk calculation, but it is necessary to have a tool with Colombian's parameters in the case of national standard. All the above requests were the base of the idea in the software tool.

2.1 Software characteristics

Nowadays, the internet is the most useful tool for world access information. A lot of people have an internet access and use it for different applications. There are many languages as java, Perl, ASP and PHP whose permit to make better applications. These topics were taken into account to develop the software tool; therefore, an online risk calculation was created. The software risk calculation was created with the PHP tool as a script

language and using the advantage of oriented object programming. PHP is open source and the version used was 5.1.6. The software used as a web server was Apache. The current version for Apache is 2.2.3 and it is freewere too. With this two free tools, the software risk was developed as a web site page, the data inputs and appearance is like a usually web page (Fig. 1).

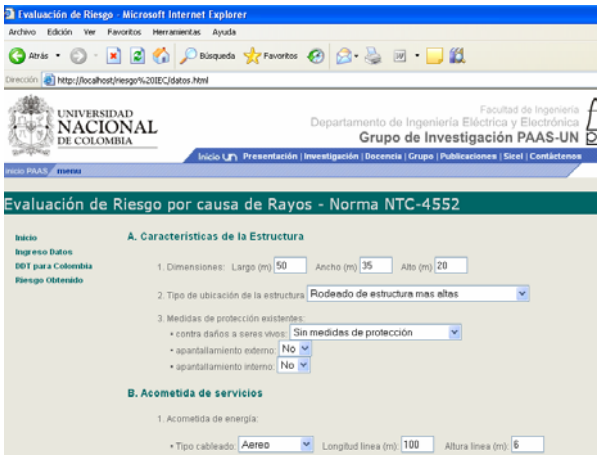

Fig. 1 – Web page for software risk calculation

3 RISK SOFTWARE TOOL

In this chapter it is presented the software process and the methodology applied; the local data parameters for Colombian case are presented as well.

3.1 Risk computation

The software developed computes basic risk assessment for structures or for the services. The software can evaluate the risk for one of them at the same time.

When the object to protect is selected (structure or service), the type of loss and the relevant risk to be evaluated must be selecting:

- R_1, R_2, R_3 and R_4 to be evaluated in a structure
- R'_2 and R'_4 to be evaluated in a service

In this step, at least one of the risks will be selected; all risks for the object selected could be evaluated in the same simulation case.

Once the risk selection was made, the next page appears and the user have to fulfil a form with the object characteristics, type of building, dimensions, type of loss, public service, shielding and the other information requested by risk methodology. The web page is updated according to the input data.

Finally, the user submits the information form and the risk calculation is achieved, a new web page shows the risk values obtained and next risk values are given:

- Risk related to source of damage: direct stroke, R_D or R'_D, and indirect stroke R_I or R'_I.
- Risk related to type of damage: injury to living beings R_S, physical damage R_F or R'_F, and failure of internal systems R_O or R'_O.
- Risk components: R_A, R_B, R_C, R_M, R_U, R_V, R_W, R_Z, for structures and R'_B, R'_C, R'_V, R'_W, R'_Z for services.

If the risk values are greater than the tolerable risk, a list of protection measures is given. The user can select the protection measures that could be implemented or designed; the software recalculates the risk values. The tolerable risk values R_T are the same of the IEC 62305-2. A diagram block of the software procedures are shown in the Fig. 2.

The software developed does not evaluate the risk values for structures partitioned in zones and neither for services partitioned in sections. Additionally, the evaluation of cost effectiveness of protection is not achieved.

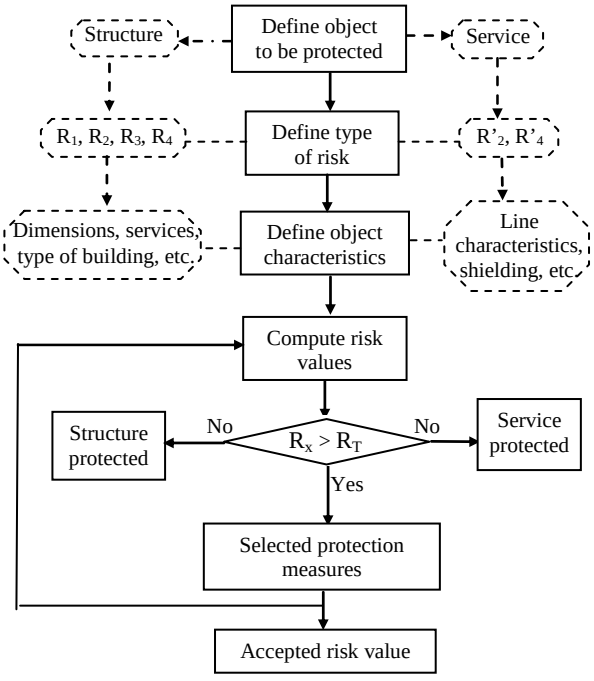

Fig. 2 – Risk software procedure

3.2 Annual number of dangerous events for Colombia

The risk management methodology requires the average annual number N of dangerous events due to lightning; this value depends of local thunderstorms activity, hence, the lightning ground flask density GFD is the parameter

required in this calculation. If GFD is not known, a relationship with the thunderstorms days per year *TD* could be used.

The annual number of dangerous events *N* is calculated using colombian data. This values could be taken from the GFD obtained with 300x300 km2 areas shown in Fig. 3.

The equation used f in the national standard NTC 4552-2 for the thunderstorms days is [7]:

$$GFD = 0{,}0017 * TD^{1.56} \qquad (1)$$

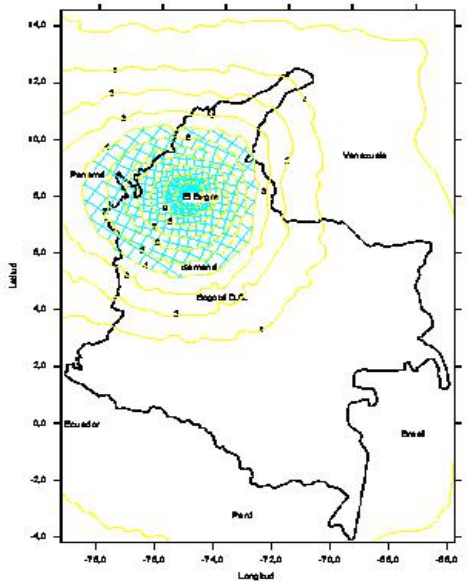

Fig. 3 – Colombia GFD map
(areas of 300x300km – 1999 data)

4 EXAMPLE AND COMPARISON WITH OTHER STANDARDS

In order to validate the software results a comparison was made with other risk evaluation software based on the IEC 62305-2 methodology. The software used in this comparison are the simplified Risk Assessment Calculator (RAC) [4] and the Alternative Lightning Risk Calculator (ALRISK) [5].

The first one is the software tool given with the IEC 62305-2; it is a basic tool which does not implement all the possibilities of the risk methodology, it is an introduction to the users in the knowledge of the risk management. The second one is whole tool developed by the Warsaw University of Technology of Poland; the software gives more detail descriptions and possibilities for the risk evaluation.

The example data to make the comparison and validation is one the examples used by M. Loboda et al, in other software risk comparison [5]. For these purpose, the object to be protected will be the office building which characteristics are shown in Table 1.

Table 1: Input data for office building example.

Parameter	Value
Dimensions	40x 20x 25 m
Ground Flash density	2.8 /km^2/year
Location factor	Surrounded same height
Environment factor	Urban
Protection measures (steep and touch voltage)	Warning notices, electrical insulation
LPS level	IV
Incoming service	2 buried
Line Length	250 m
Transformer	None
Internal wiring precaution	None
Line Shielding	None
Resistance screen	Rs < 1
Withstand of internal system	2.5 kV
Special Hazard	Average level
Risk of fire	High
Soil resistivity	500 Ωm
Floor surface	Agriculture
Fire protection	Manual
Type of structure	Office (L_f = 0.05)
Amount of loss due to failure of internal systems	Low (Lo=1e-3)

Table 2, shows the risk values obtained with the software developed for the national standard NTC Online Tool, with the Risk Assessment Calculator (RAC) and with the Alternative Lightning Risk Calculator (ALRISK). The risk values of RAC and ALRISK were taken from the reference [5]. The NTC online tool values are similar to the ALRISK values; the differences are less than 1% and could be due to approximation factors.

Table 2: Risk values with different software (Values x 10^{-5})

Risk	NTC Online Tool	IEC ALRISK	IEC RAC
R_D	13.5	14.80	3.86
R_I	49.1	48.10	29.00
R_1	**62.54**	**62.80**	**32.90**

The differences between RAC with the other two software risk values are almost 50%, hence, the protected measures to minimize the risk could be less exigent than the other cases. Most accurate risk values will be obtained if the software uses step by step the risk methodology and all possibilities.

Another important comparison was carried out in the case of national standard NTC 4552-2 and the Colombian lightning parameters. In that way, if the same office building was located in Colombia, the ground flash density values changes and the annual number of dangerous events too. For example, in Medellin city, Lat 6.07° Long 75.26º, the GFD is 10.3 flash/km^2/year [7], the risk evaluation values are shown in Table 3.

Table 3: Risk values for office building in Colombia (Values x 10^{-5})

Risk	NTC Online Tool
R_D	49.5
R_I	181.0
R_1	**230.5**

The risk values show that in the case of countries with high GDF and TD, as the case of tropical zone, the risk of loss due to lightning strikes is higher than the values for temperate zones. The lightning protection measures will be more severe as well.

5 CONCLUSIONS

The paper shows a software tool for the lightning risk assessment based on the international standard IEC 62305-2 and based on the Colombian Technical Standard NTC 4552-2.

One of the advantages of the risk software tool is that it will be access by means of the web site; therefore, it will be used by any person in any place. On the other hand, it is not necessary any specific software for use the tool, just need an internet connection and an internet browser.

It is very important to use a risk management tool with the real lightning parameters values for the geographical zone; it is the case of Colombia and the standard NTC 4554-2 risk management.

In the future works it is necessary to include risk calculations for structures partitioned in zones and services partitioned in sections. Furthermore, the evaluation of cost effectiveness of protection will be developed in future works as well.

ACKNOWLEDGEMENT

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