DE GRUYTER OPEN

Vol. 11, Issue 2/2015, 147-151 DOI: 10.1515/cee-2015-0019

ENHANCEMENT OF THE WORK IN SCIA ENGINEER'S ENVIRONMENT BY EMPLOYMENT OF XML PROGRAMMING LANGUAGE

Ján KORTIŠ[1,*],

[1] Department of Structural Mechanics, Faculty of Civil Engineering, University of Žilina, Univerzitná 8215/1, 010 26 Žilina.
[*] corresponding author: jan.kortis@fstav.uniza.sk.

Abstract

The productivity of the work of engineers in the design of building structures by applying the rules of technical standards [1] has been increasing by using different software products for recent years. The software products offer engineers new possibilities to design different structures. However, there are problems especially for design of structures with similar static schemes as it is needed to follow the same work-steps. This can be more effective if the steps are done automatically by using a programming language for leading the processes that are done by software. The design process of timber structure which is done in the environment of Scia Engineer software is presented in the article. XML Programming Language is used for automatization of the design and the XML code is modified in the Excel environment by using VBA Programming language [2], [3].

Keywords:

Timber structure;
Technical standards;
Design of structures;
XML programming language;
Roof structure.

1. Introduction

The demands of customers for the precise, fast and creative work of engineers on the design of the buildings have been increasing for the last decades. This is especially associated with the development of the software packages which application helps to finish this demanding task. Despite this powerful tool, there are still some gaps in the functionality which are difficult to cover. It is mainly because of an expensive development of them. Having your own program seems to be one way to satisfy this request. It seems that this statement has not been true since many companies that develop software packages started to offer their own programming languages. The advantage of this solution is that you need to program only a small part of the whole application and primarily use other functionalities that are parts of the software. Sometimes you only need to automatize some steps so you only write a program containing some instructions for the software. In this case, a good example is Scia Engineer that use XML as a program language. It can be used to change the parameters that are input for design of a structure. The XML code can be automatically changed by using Excel which contains VBA language. The article shows an example of application of this automatization on design of timber roof structure.

2. The description of the automatization

The first step for automation of the design of the roof structure by using software Scia Engineer is creating the model of the structure. The geometry and material characteristics as well as the loading are defined as parameters which have to have appropriate names (Fig. 1).

Then the solution is done to check if the structure is supported correctly and the results are good. The output document is created where are all required values of results which are needed for the next steps of the design. The file is saved as a common file format for Scia Engineer which contains all information about the geometry, parameter as well as the output documents with required results. It is later used to start the solution by using the solver core of the Scia Engineer without opening the graphic window. The last step that is done within the Scia Engineer environment is to generate XML code. It contains commands which also define parameter of geometry that can be changed by using VBA code in Excel.

The second task is to create a leading program in Excel which can change the input parameters and use the output of the solution for the next steps of the design. The input values of the parameters are defined in the cells of the table (Fig. 2).

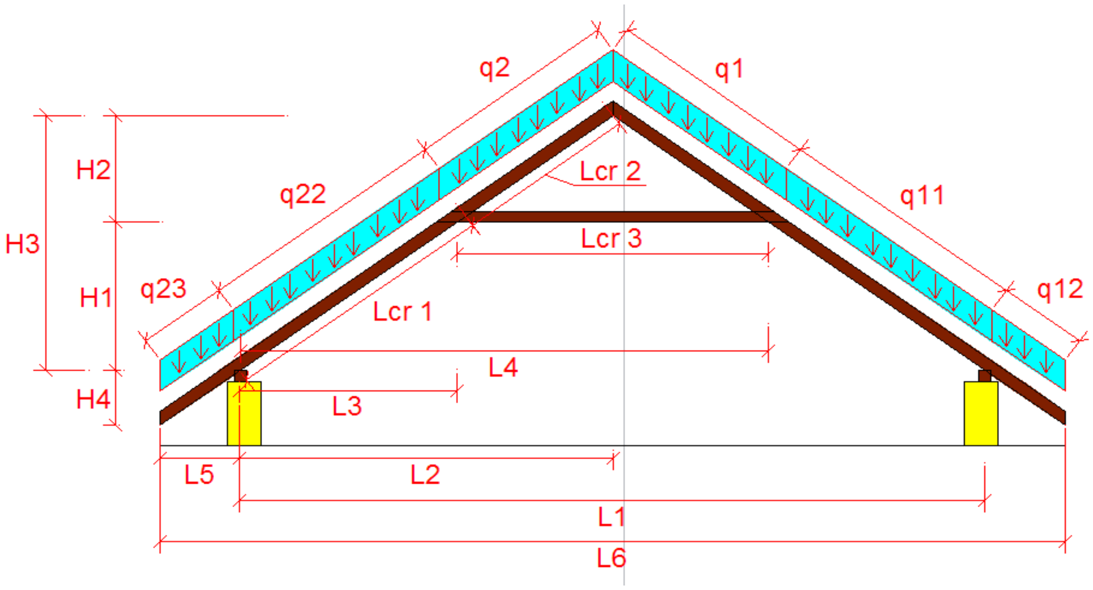

Fig. 1: The geometry of the timber roof structure.

Length		
L1	7.6	m
L2	3.8	m
L3	2.730	m
L4	4.870	m
L5	-0.4	m
L6	8	m

Width		
H1	2.55	m
H2	1	m
H3	3.55	m
H4	-0.37	m

Cross-section b/h		
h1	0.14	m
b1	0.08	m
h2	0.14	m
b2	0.04	m
a	0.08	m

Loading		
q1	-1980	N/m
q11	-1980	N/m
q12	-1980	N/m
q2	-1980	N/m
q22	-1980	N/m
q23	-1980	N/m

START

Fig. 2: The parameters of the timber roof structure.

The VBA code is used to change the values of input parameters in the XML code. It is done by a very simple way. The values of parameter in the XML file are rewritten and replaced by the input values from the Excel table. The most important part of the VBA code is the command *Shell* that start the solution by Scia Engineer.

Example of the Shell command:

Shell ("C:\Program Files\Scia\Engineer2009.0\Esa_XML.exe LIN C:\sciaexcel1\hambalokbakalarka.esa C:\sciaexcel1\hambalok.xml /tHTML /oC:\sciaexcel1\hambalokout.xls")

The command contains the location of four files. The first one is a special Scia Engineer application which is used only to start the solver without starting graphic window. The second file contains the geometry of the model. The input parameters are read from the third XML file that is generated by the previous commands written in VBA code. The last file contains the values that are defined in the output documents. This one is generated at the end of the solution. It is an XLS file that contains tables with required values as well as pictures. It is possible to open it by Excel and rewritten the results from it into the table in Excel (Fig. 3).

INTERNAL FORCES

M1 =	-0.52	KNm	-0.52
M2 =	1.51	KNm	1.51
M3 =	-1.81	KNm	-1.81
N1 =	-0.8	KN	-0.8
N2 =	-10.12	KN	-10.12
N3 =	-1.79	KN	-1.79
N4 =	-7.95	KN	-7.95
V1 =	-2.28	KN	-2.28
V2 =	0.43	KN	0.43
V3 =	-2.3	KN	-2.3
V4 =	-1.24	KN	-1.24

Fig. 3: An example of output in a form of external forces.

The position in which the internal forces are defined in the output document depends on the shape of the structure. So it is important to know at the beginning of the development of the automation design to know what will be needed in the following steps of the design. The user must prepare it very carefully. It is also good to export pictures with the internal forces to check if the labels that are used for results are correct.

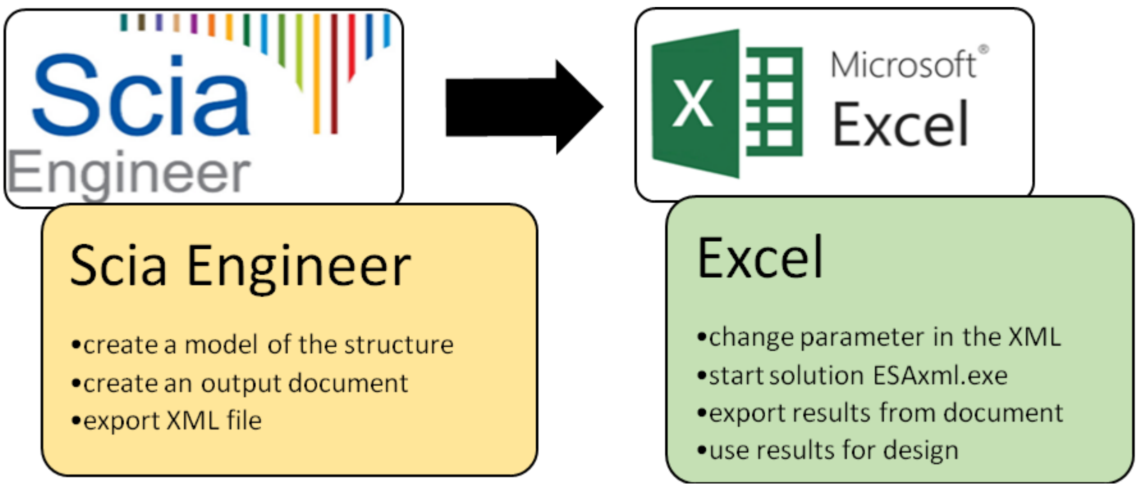

Fig. 4: The processes in which both softwares are used.

3. The design of the timber roof structure

The design of the dimensions of the members of the timber roof structure is done by using the result from the solution. It is done automatically. The only thing that must be done is to choose the appropriate strength class of the timber. It is very simple because there is defined table that contains all characteristics of timber that is needed in the design algorithm. (Fig. 5).

C18 ▾

STRENGTH CLASS		C18
Strength properties, v N/mm²		
Characteristics bending strength	**fm,k**	18
Characteristics compressive strength along the grain	**fc,0,k**	18
Characteristics shear strength	**fv,k**	2
Stiffness properties [kN/ mm²]		
Mean value of modulus of elasticity	**E_0,mean**	11
Fifth percentile value of modulus of elasticity	**E0,05**	6
Density [kg/m³]		
Density	**ρ_K**	320

Fig. 5: The table that is used to choose the demanding strength class of the timber.

The material characteristics change with the regard to the chosen strength class. They are selected from the tables that are located in another sheet. It is a kind of database that contains values that are defined in the technical standards for design of timber structures.

The last step is to check if the members of timber roof structure have good dimensions. (Fig.6) There are prepared formulas for this purpose. The values in the cells are solved by using the results from the previous solution. If the requirements are not satisfied the color of the cells changed from green to red. It shows that the dimensions of the members are not good.

1. RAFTER- analysis of the element BENDING + AXIAL COMPRESSION

STABILITY OF MEMBER

$iy = \sqrt{\frac{Iy}{A}} =$ 40.41 mm

$\sigma c,crit = \frac{\pi^2 * E0,05}{\lambda y^2} =$ 6.93 MPa

$\lambda = \frac{Lcry}{iy} =$ 92.42

$\sigma c,0,d = \frac{Ned}{A} =$ 0.904 MPa

$\sigma m,y,d = \frac{Myed}{Wy} =$ 5.778 MPa

$\lambda rel = \sqrt{\frac{fc,0,k}{\sigma c,crit}} =$ 1.61

ky = 0.5*(1+βc*(λrel-0,3)+λrel^2) = 1.931

$kc = \frac{1}{ky+\sqrt{ky^2-\lambda rel,y^2}} =$ 0.58

ULTIMATE LIMIT SATE BENDING + AXIAL COMPRESSION

$$\frac{\sigma c,0,d}{kcy*fc,0,d} + \frac{\sigma m,y,d}{fm,d} < 1$$

0.589 < 1

Fig. 7: An example of the ultimate limit state for the member of timber structure.

4. Conclusions

The practical application of the XML language for managing the solution and design of the timber roof structure in the Scia Engineer environment shows that the common work of engineers can be done faster and more effectively. However, the engineer should be able to use programming languages what might be a problem in these days. But in the future there is expected that young engineer will be able to use programs in this ways so their work would be more focused on creative part and the routine operation will be done automatically.

References

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