White Paper

Template Analysis in Practice

Allowing the ‘common’ user to come to an optimal productivity

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Summary
Scia Engineer's *Template Analysis* provides a quick, dedicated, easy-to-use solution for very complex, repetitive calculations. In Scia Engineer an engineer is able to model e.g. a two span beam, define supports, loads and combinations. The output document can be defined: which output tables, which pictures etc. Once this project is defined the user calculates the project and gets the results on screen and in the document. The user decides whether or not these kinds of projects are daily business and if he wants to make the input much easier. Then the user can decide to parameterize the structure, the loads, the output document, etc., using *parametric modeling*. Once he has parameterized the structure, he can save this parameterized project as a so called template.

Nemetschek Scia developed a special program called Scia ODA. In Scia ODA common users can launch this template and the only thing they have to do is, is fill in the parameters. There are no other buttons or menus available: just give in the parameters, run the project and print the document. The document is always harmonized according to the company standard, without errors, and instantly created. The template is a quick high-end solution for repetitive complex tasks.

Introduction
In the daily practice of engineers, especially the ones working in the precast industry, repetitive calculations have to be done in a productive way. However, today's calculations often consist of a very sophisticated (non)-linear calculation, allowing or forcing the engineer to come to a very economical design. Furthermore that specific calculation must consist also of all kinds of possible checks, like checks of deflections, capacity, fire and allowable stresses. All three demands: productivity, sophistication and detailed checks can be achieved by using (dedicated) software.

Since the early 90's the engineers rely on their self-made spreadsheets or DOS-based applications to perform such calculations. The switch from DOS to Windows in the 90's did not change this behavior much. Yet with the introduction of the new Eurocodes in 2010, new advanced checks (i.e. fire resistance), new colleagues working offshore (Eastern Europe or India) and with the possibility of *Roundtrip Engineering* (integrated CAD and CAE software [1]), the way people worked for the last fifteen years is again challenged.

Scia Engineer environment
In Scia Engineer the structural engineer is able to perform a very detailed analysis (dynamic, prestressing, non-linear) of any kind of structure, whether it is a steel hall, concrete building or a prestressed bridge. The input of data is very easy and straightforward (object oriented and what-you-see-is-what-you-get). The number of structures one can model is almost limitless, as the various customer projects nominated in the Scia User contest 2007 testify, see figure 1.

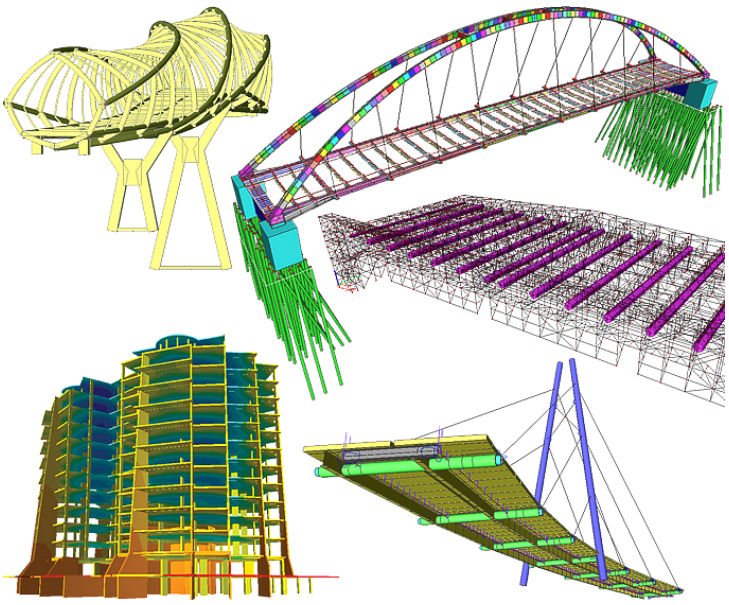

Figure 1 Compilation of Customer Projects from User Contest 2007.

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For each of those structures detailed checks or additional designs (reinforcement/steel connections) can be performed according to DIN, EC2, BS, ACI, etc. Finally a nice documentation option is available for the user in order to publish the results of this calculation either numerically and/or graphically and allow them to be checked easily by the authorities or colleagues. In practice the work method in Scia Engineer goes from the inputting phase, to the calculation phase, to the checking phase and finally the documentation phase, see figure 2.

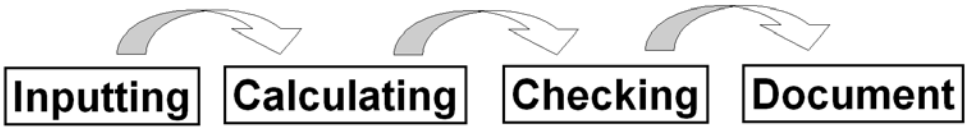

Figure 2 The stages of the calculation for a Scia Engineer project.
In practise one adapts often the input during the checking phase.

For repetitive calculations this approach is not so efficient, since there is usually no time to input all this data over and over again. However the possibility to design, check and optimize each detail in the structure is something especially the leading engineer or people from R&D in the company are most interested in. By introducing the concept of 'template' projects or '*template analysis*' Scia is able to combine the wish of the leading engineer for detailed analysis with the demand for productivity and efficiency.

Template Analysis

Now imagine yourself as leading engineer, who is defining a calculation in the form of a template document like in a spread sheet or a word document. In this template you would perform a very detailed analysis of i.e. a prestressed, precast beam. It includes all necessary calculations, including the mobile loads, LTB-check, cracking of concrete and deflections. You are able to use special formulae to perform all necessary checks and define yourself what output you would like to see. Imagine that all this data is available to you only as being the 'main user'. Then after finalization of the document you send your template to your colleagues, 'the common users', and allow them only to change only some parameters in the document, i.e. the diameter of the stirrups, the design moment or the dimensions of the cross-section.

You know that the advantage of this work method is that everybody in the whole company (i.e. Western and European workers alike) will work in the same way (uniformly) and the documented output is harmonized, see figure 3. When the national code for your country changes or you come to an improved insight you update the published template as a revision or a complete new version.

Concrete Section; version 1.05	04/07/2002	
Section Height	**500**	mm
Flange Width	**200**	mm
Flange Height	**150**	mm
Web Width	**200**	mm
Web Height	350	mm
Position Neutral Axis (short term)	244,5	mm
Position Neutral Axis (long term)	229,1	mm
Position Neutral Axis (ULS)	231,2	mm
Section Area	1,00E+05	mm^2
Applied Links/Stirrups	**Ø8**	
Type of Structure	Beam	
Characteristic Cube Pressure Strength, f'_{ck}	B25	MPa
Creep Factor	**3,6**	
Design Moment	**66,3**	kNm
M_d/bd^2	1.594	kN/m^2
Calculated Position Reinforcement bottom	456,0	mm
Applied Position Reinforcement bottom		mm
Environmental Class at bottom	**2**	
Minimal Cover at Bottom	30	mm
$d_{s;bottom}$	44,0	mm
Applied Cover at Bottom	**30**	mm
$k_{c;1;bottom}$	1,00	
$k_{c;2;bottom}$	1,00	
$A_{s;req;bottom}$	355	mm^2
Number of Reinforcement Layers bottom	**1**	no.
Applied Reinforcement bottom	**4 Ø12**	
Applied Additional Reinforcement bottom	**0 Ø10**	
$A_{s;app;bottom}$	452	mm^2

Figure 3 Example of a Template in MS Excel®. Fields in 'Bold' are only for input by common users. The rest of the content is locked for editing. Only the author or 'main user' can change this background or calculation data.

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Templates in Scia Engineer

Today in Scia Engineer one can –without any programming- make exactly the same kind of templates as described in the previous paragraph, i.e. the 'main user' creates a template project and prepares the template as follows:

1. He parameterizes the predefined input data for use by the 'common user', i.e. for instance the length of the beam is parameterized as the variable 'L', or the height of the cross-sections as 'h_{css}', see [2] and figure 4.

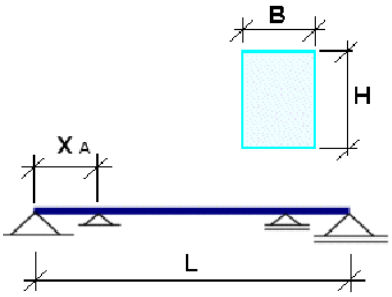

Figure 4 Example of a parameterized beam setup.

2. He defines advanced data like LTB restraints, the reinforcement, see figure 5.

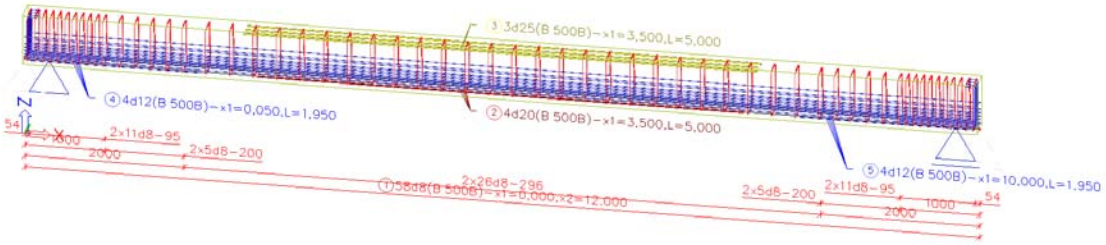

Figure 5 Example of a precast, prestressed beam in Scia Engineer, including the predefined stirrups and detailing reinforcement.

3. He defines the necessary types of calculations, and checks. He always makes sure all required checks according the national codes are done.
4. He creates various kinds of documents, i.e. one for the checking authorities or one for internal use. He can decide on making a document for all kinds of languages, English, German, French, Czech. He makes sure there are no mistakes in the output, and harmonizes –if necessary- the output for the whole company.
5. He stores the template on a read-only environment and grants access to the 'common users'.

By creating a new template the 'main user' considerably decreases the number of phases of the calculation, see figure 6, for the common users. Only the input and output phases remain. The main user has already defined the calculation stage and the checking stage and automatically the program performs the calculations and checks when the common user goes to the document. If it is necessary special actions can be performed by the common user to fulfil the checks. Additionally the predefined input and output has decreased the time spend on preparation of the input and output. Irrelevant input/output data are blocked and the common user immediately sees the results of his actions.

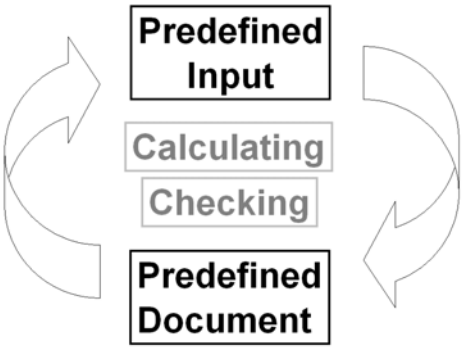

Figure 6 The stages of the calculation for a template project in Scia Engineer.

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Templates in Scia ODA

Scia ODA is a special application that can open Scia Engineer templates. It has a dedicated environment especially for quick and easy input and output of calculations. In Scia ODA (ODA stands for One Dialogue Application) the common user opens the template from a predefined location, i.e. from the network server. Then the user can immediately start entering the required data as defined by the main user, see figures 7 and 8. The second and possibly the final step is the preparation of the document. The user selects the appropriate document and after the automatic refresh he is able to review all the results and input data and finally print the document. Possibly he will make some adaptations in the input data to come to an optimal solution. He reviews the data in the final document without having to prepare a new document or picture, see figure 9

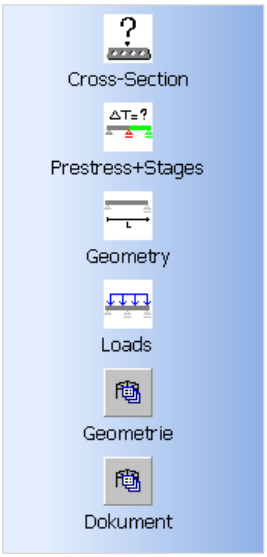

Figure 7 Menu-structure as defined by the 'main user'. An Icon represents each tab page. All data regarding i.e. the cross-section, like beam height and width are found under that Icon and on that tab page.

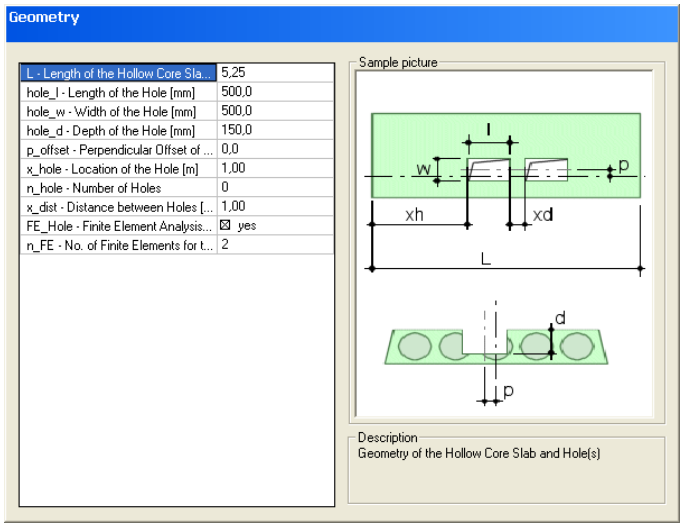

Figure 8 User-defined tab page of the Geometrical Data. (In this case a hollow core slab)

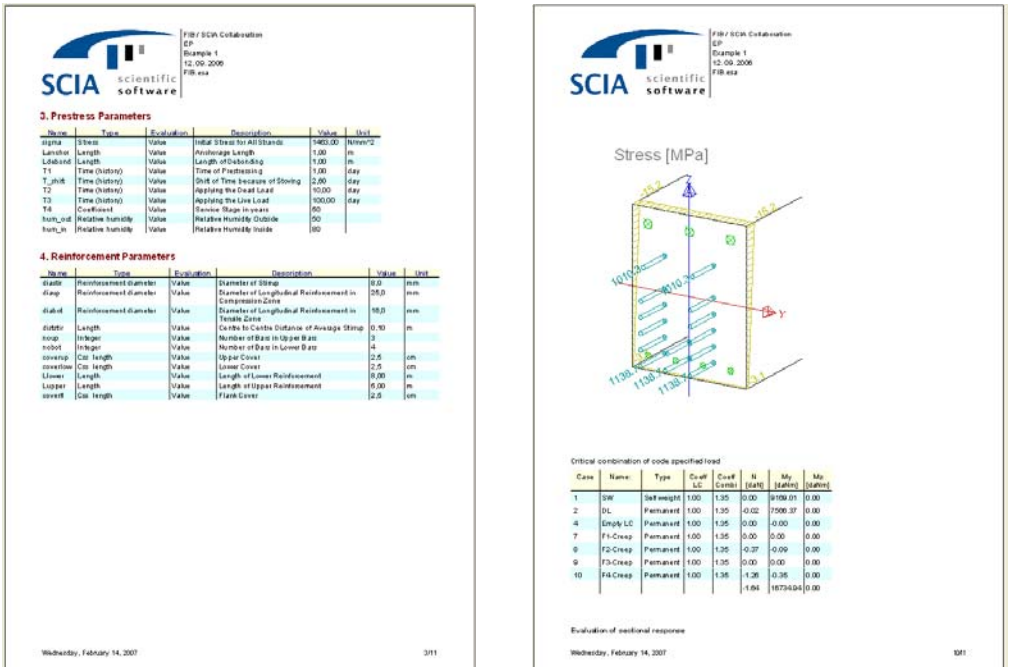

Figure 9 Typical input and output page(s) of Scia ODA document (data is represented both graphically and numerically)

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But that is not all. We can also use these templates in our 3D CAD/Modelling application Allplan. One can imagine that you have created a lot of these templates for all kinds of structures or single elements. You can use them perfectly in Scia Engineer or in Scia ODA. But you could also use these templates for modeling a whole structure in Allplan, see figure 10.

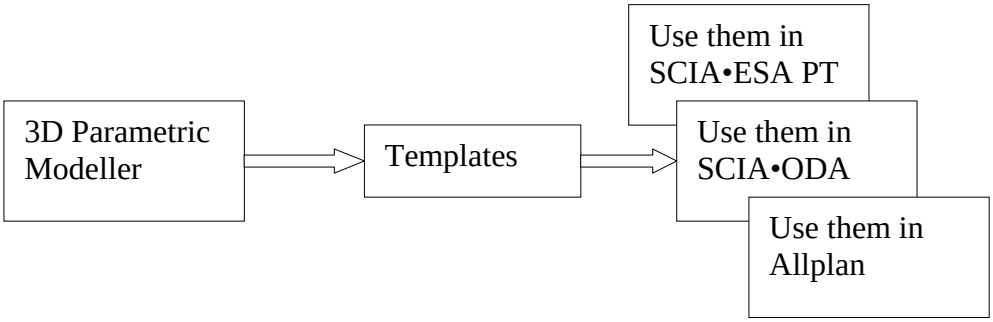

Figure 10 Templates is CAD/CAE applications (Allplan/Scia Engineer/Scia ODA)

It is even possible to model all kinds of complicated shapes, like stairs, curved roofs, ect., with our parametric modeler. without any relation to the analysis. Store them as templates and make your own set of parametric objects. In Allplan you can use them during your modeling, see figure 11. You can mix them with the object directly modeled within Allplan.

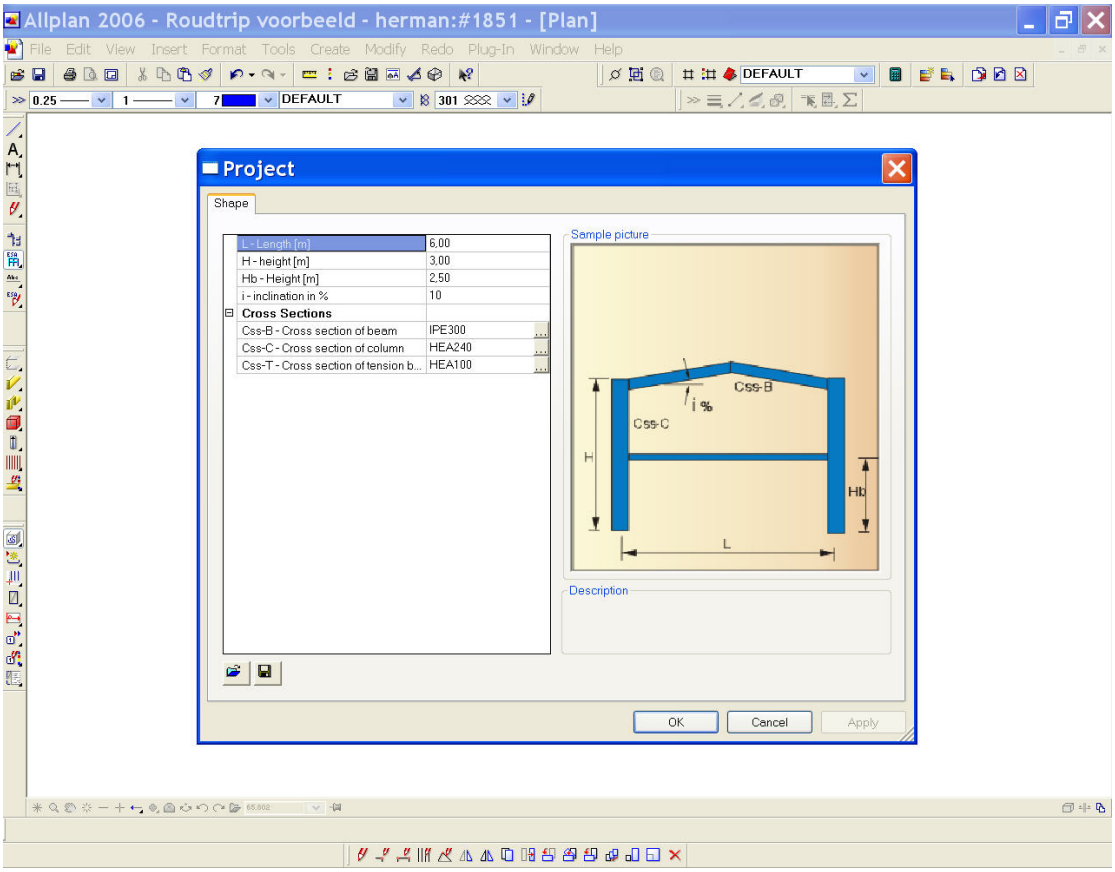

Figure 11 Template Modelling in CAD application: Allplan.

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Conclusion

Scia Engineer technology allows the definition of template projects. *Template Analysis* is useful for engineers who perform a lot of repetitive, yet not necessarily easy calculations. The ‘main user’ is responsible for the content of the template, creates those templates in Scia Engineer and defines the required input data, type of calculations, number of checks and the type of documentations. The ‘common users’ will use these predefined templates in Scia ODA on a daily basis and come to an optimal productivity. They enter only the necessary data and review the results in the document. They cannot make mistakes, since the predefined document does not allow them. Using the *template analysis* technology a new step towards improved productivity, harmonization and advanced checking can be easily taken.

[1] Roundtrip Engineering, dr.ir. J.P. Rammant, ir. H.J. Oogink, 2007.
[2] Parametric Modelling in Practise, ing. E.S. Peltenburg MSEng, 2007.

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