BOOK OF PROCEEDINGS

INTERNATIONAL CONFERENCE
13th - 14th October 2023

ISSUES OF HOUSING, PLANNING, AND RESILIENT DEVELOPMENT OF THE TERRITORY

Towards Euro-Mediterranean Perspectives

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Issues of Housing, Planning, and Resilient Development of the Territory Towards Euro-Mediterranean Perspectives

Conference Theme and Rationale

Albania, along with other Western Balkan countries, has undergone significant economic, social, and political changes in recent years. As a result, housing, planning, and the resilient management of territorial development have emerged as critical issues. This is because these regions face significant challenges in providing affordable housing, addressing the impact of urbanization on the environment, fostering evidence-based decision-making on the territory, and bringing forth the commitments towards climate neutrality.

The organizers use the term "multi-modality" to define complex situations (in matters of territorial planning, management, architecture, housing, public space, technology, etc.) that have historically encompassed Western Balkans and Mediterranean cities in a logic of coexistence and value co-creation. A combination of knowledge and heritage that throughout time and history have given life to civilization in this region of Europe. The active involvement of Albania in the existing network of the Mediterranean Basin and the EU, through a joint action plan with UN / UNECE, and the Albanian and regional authorities, including reputable scientific bodies such as the Academy of Sciences of Albania, makes this conference even more intriguing to explore fascinating areas of research. The conclusions, to be considered as a stage for open innovation, will include recommendations for further scientific and applied research, projects, and events.

The geographical focus of the conference covers three dimensions: i) Albania; ii) the Western Balkans; iii) Euro-Mediterranean countries. POLIS University aims to focus on the above-mentioned research areas that are of common interest to both Western Balkans and Mediterranean cities, including, but not limited to: housing policies, urban history and architecture typology, innovation and digitalization in urbanism, energy efficiency, resilience and environmental sustainability, governance and smart technologies for city management, education and gender aspects in urban planning research.

In this regard the main aim of this international conference is to bring together scholars, policymakers, and practitioners to examine the pressing issues of housing, planning, and land development in these regions, in a context of transition fatigue, climate challenges and post-pandemic realities.

Issues of Housing, Planning, and Resilient Development of the Territory Towards Euro-Mediterranean Perspectives

Conference Aim

The main aim of this international conference is to bring together researchers, policy makers and practitioners to examine the urgent issues of housing, planning and land development in these regions, in a context of transition, climate challenges and post-pandemic realities.

Objective

-Consolidation of the cooperation network between Albanian and non-Albanian researchers, lecturers, managers, with the aim of participating in joint research projects at the regional and international level;
-Support of local authorities with contemporary data, on the state of housing issues, planning and sustainable urban and environmental management, as well as representatives of public and private institutions operating in this field.

The conference is organized by POLIS University (U_POLIS) in cooperation with the Academy of Science of Albania, and supported by other local and international partners.
In the framework of resilience, the main conference theme is devoted to Issues of Housing, Planning, and Resilient Development of the Territory from a Euro-Mediterranean Perspective, including Albania, Western Balkans and the Mediterranean Basin. This event aims to bring together academics, policymakers, researchers, experts, practitioners, and stakeholders from diverse backgrounds to discuss and address critical challenges related to housing, urban planning, and the development of resilient territories.

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A PRELIMINARY INVESTIGATION INTO A VARIABLE SECTION BEAM USING ALGORITHM-AIDED DESIGN AS A WAY TO FACILITATE THE STRUCTURAL DESIGN PROCESS. Drafting Automation

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Abstract

The use of computational parametric design is known as algorithm-aided design. While designers generally rely on intuition and expertise to solve design challenges, computational design aims to enhance this process by codifying design decisions using computer language.

In this study, a useful tool that considers the structural aspects of a rectangular cross section of beam element was proposed. The process was conducted using the algorithm-aided design tool Grasshopper software. It involved determining a variable cross section of beam by facilitating the design phase. The proposed methodology can be particularly useful for practical applications, where numerous drawings have to be covered. In this scenario, the several cross sections generated by the software can alter various numbers of steel bars, ties and hoops. For upcoming CAD design proposals, it is suggested this procedure for automatically processing the results: extracting a wireframe and producing cross sections.

Three-dimensional finite elements now support the cross-section extraction. The skeletonization and vowelization of a finite element- and density-based topology optimization form the basis of the wireframe extraction. The geometrical parameters of each selected beam profile are then established utilizing at least square loss optimization and shape averaging based on image processing. Finally, a model that may be transformed into a parametric CAD model is accessible for use in future design work.

Keywords
Automation, parametric design, variable section beam, algorithm-aided design

Introduction

This paper investigates the method of algorithmic design as a way to facilitate the process of drafting of structural projects. The script was made from the author, using Grasshopper. The purpose of the script is to program the logic behind the drafting of reinforced concrete beams, according to Eurocode 2, in order for the program to draw itself all the possible scenarios of longitudinal sections and cross sections. The user can have the desired drawings by changing the values of the inputs, which are selected, keeping in mind the flexibility during work.

The inputs

The main problem, rather than creating the flow of the algorithm, was to decide the inputs. Since the drafting process has so many inputs, the author had to determine which input should the algorithm consider; Will it consider the material properties? What if it includes the bending moment? Should the script consider other inputs that are not destined to be chosed from Eurocode, like the maximal length of the rebars?

Programmers deal with similar problems all the time. The best solution to it usually is "What the client wants." In this case, the author is the client, which is the best case, as the author is a structural engineer and the input were chosen based on the experience of an engineer.

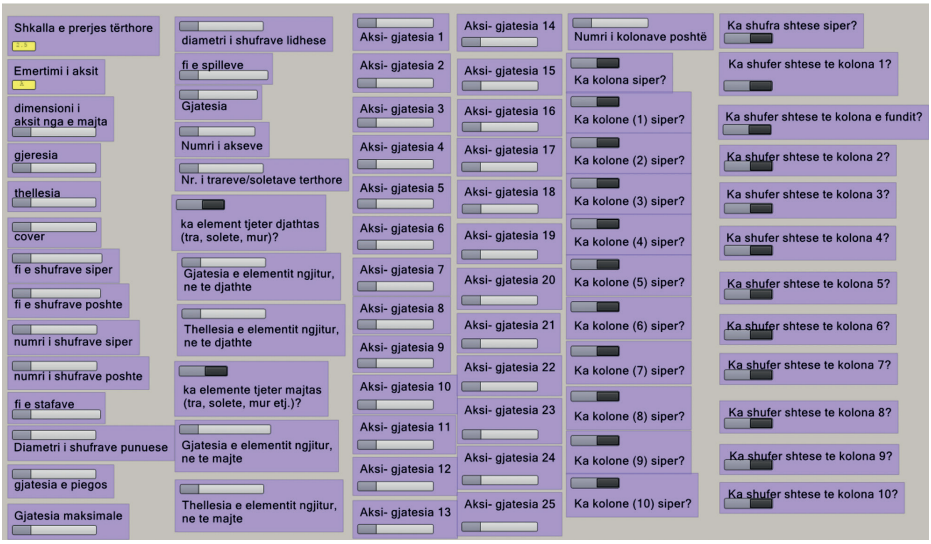

Figure 1 – The inputs (1)

The algorithm is destined to be controlled by a structural engineer. Hence, it does not have inputs for automatically calculating the rebar dimensions or the concrete cover. This input values should be added manually into the script. It is because there are too many reasons why the size of the rebars chosen do not necessarily respect the Eurocode formulas, in practice. One reason can be the requirements from the public administration, or it can be the over-standardization of the elements to save time and money, or even the good practice of structural engineers, guided by their experience.

Another input is the length of the maximal rebars, which is often neglected when designing software. The typical limit is 12 meters. However, this length is sometimes not preferable, as the rebars

tends to buckle during their transportation in site or during their implementation. Therefore, the author made an input for the user to consider the maximal length of the rebars.
A lot of inputs are made for the geometry of the beam which, again, has to be putted manually by the engineer. BIM software deal with this issue differently, by having inputs for 3D objects and, afterwards generating the 2D drafting automatically. This is not preferable, not only in the Albanian community of engineers, but in many other countries in Europe, as the structural engineers have not yet overcome the transition from the 2D page to the 3D workspace and the chances are that this gap will not be overtaken in the recent future. To help them, the script is designed with inputs in 2D, similarly as if the drafting would be made in a worksheet plan in Autocad. The difference here is that, while the drawing is time consuming, not changeable and includes human mistakes, drafting using "buttons" from the script resolves these issues. It saves precious time!
Another important input is the scale button, which allows the user to change the scale of the cross section, without changing the size of the text or symbols. The current programs need additional steps to make the dimensions and symbols immutable, while growing or lowering the size of the geometry. This script surpasses this limit. The last input is the "Bake" button. This tool allows the user to decide whether or not to let the program draw the beam. After the Bake process, the beam is not changeable, but the lines itself can be modified manually, as if they were drawn in Autocad

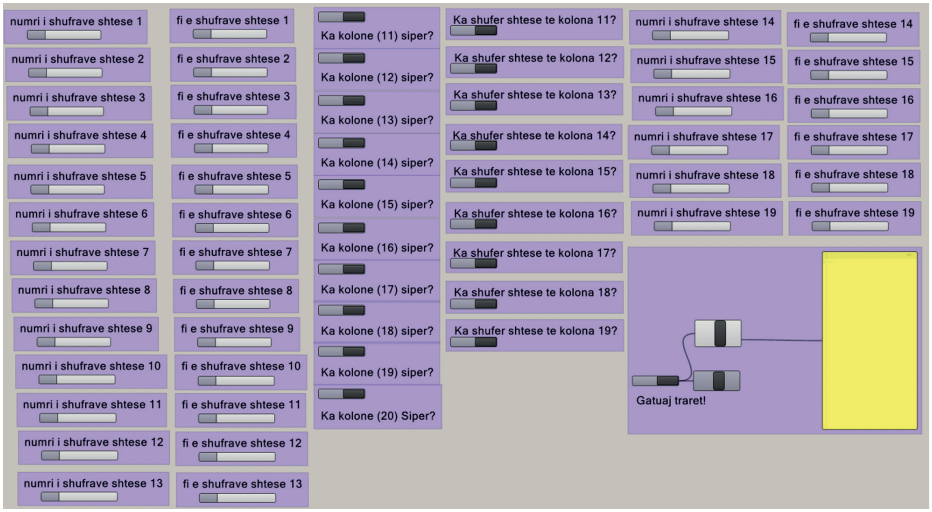

Figure 2 – The inputs (2)

(they can also be generated on Autocad).

The flow

Because of the large number of the inputs, the flow takes its time to amalgamate into a single output. The main issues here were to keep track and to manage all the possible connections between the inputs. Therefore, the author uses panels for the unwanted inputs and number sliders for the important ones. Another solution to this problem is the use of groups, clusters and scribbles inside the script.

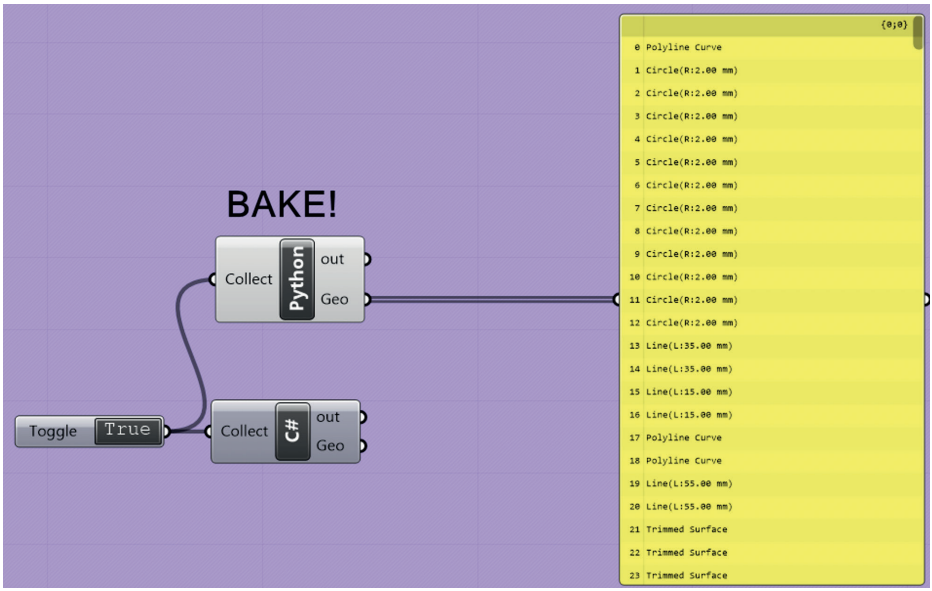

Figure 3 – The "Bake" button

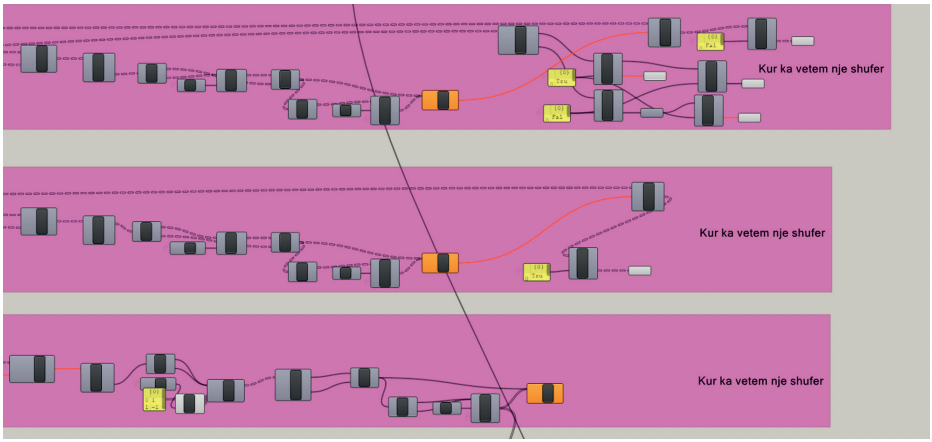

Figure 4 – Managing the script with groups and scribbles

Again, some of the possible inputs were deleted, because of the engineer's judgment. For example, considering the minimal distance between the rebars in the cross section, the script has a conditional clause that set the bars in one layer or in two or more layers automatically. Similarly, the algorithm considers not having rebar joints in short beams. Moreover, the script makes all the rebar lengths rounded by numbers fully distributed by 5, by not changing the joint length between them. In this case, the center of the joints is not on the axis for the lower bars and not on the exact middle of the span for the upper bars. Instead, these points move a little. It is important to not that this given tolerance is trivial to the integrity of the structure.

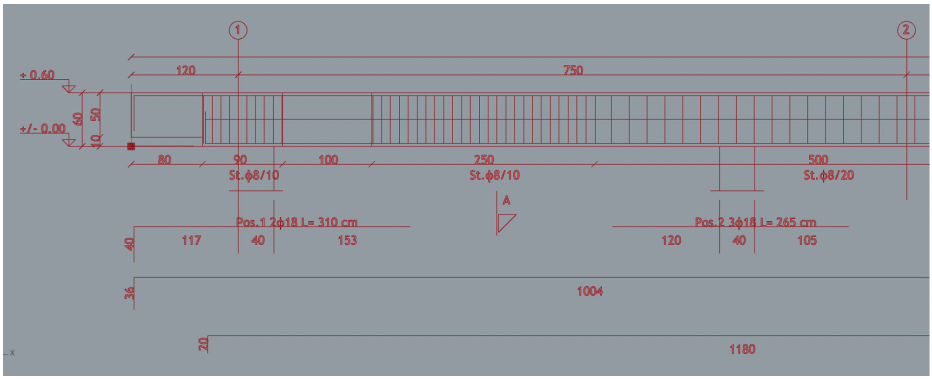

Figure 5 – The output bars are all rounded

Furthermore, when considering the additional upper bars, their lengths is set automatically, based on the Eurocode 2. They are rounded by numbers fully distributed by 5, as well. This round is important especially for projects in Albania, where the bars are cut on site. If bars have miscellaneous lengths, it results in a lot of wasted material.

Another automatic draw which the script realizes (though we are just scratching the surface here, as the script includes an enormous range of flows, regarding the engineer requirements), is the middle bars into the section beam, which are made with a conditioning clause, depending on the height of the beam. If the beam is deep enough, it will suffer from the out-of-plane moment and the stirrups will suffer from buckling. To prevent possible local failures in this particular cases, the script considers the drawing of middle bars. Also, according to Eurocode 8, upper bars should be connected with the lower bars with additional ties. The algorithm is designed to automatically draw ties and to connect at least one bar out of two of them in a row.

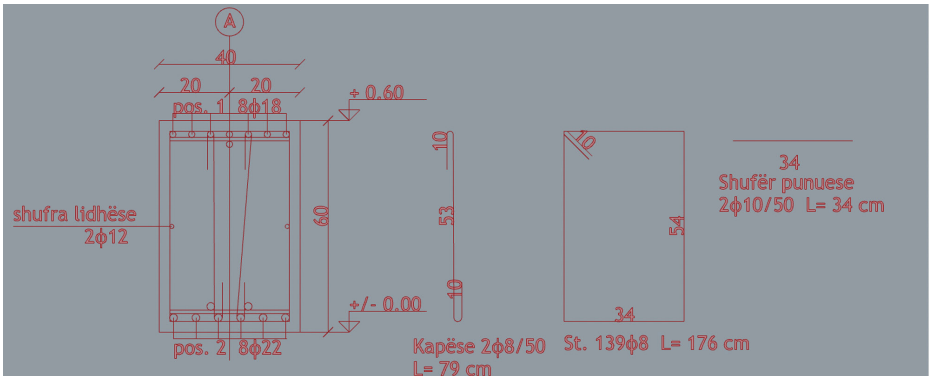

Figure 6 – The output of the cross section, with additional bars and ties

Lastly, the most important feature of the script is his flexible nature. Let's imagine a normal day of work in an engineering office. The drawings are made for the team leader. After his corrections, they are re-done, this time hoping that the client wont make changes. Usually, this is not the case, as clients tend to be volatile and they can be the reason for the project to change through all the

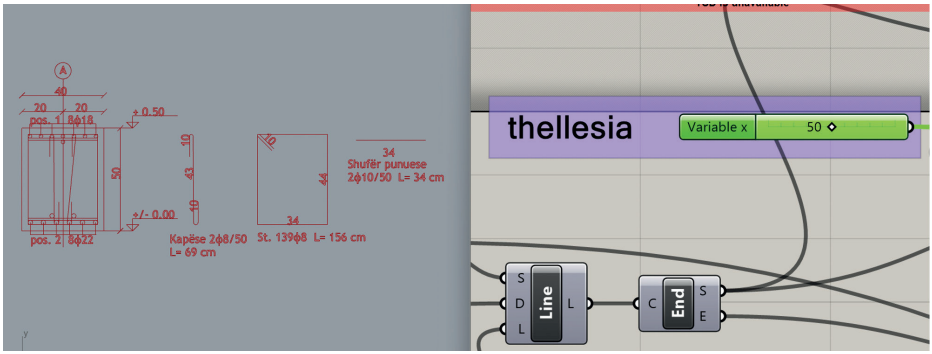

Figure 7 – An example of the work flexibility, where the drawings and the dimensions adapt to the new depth

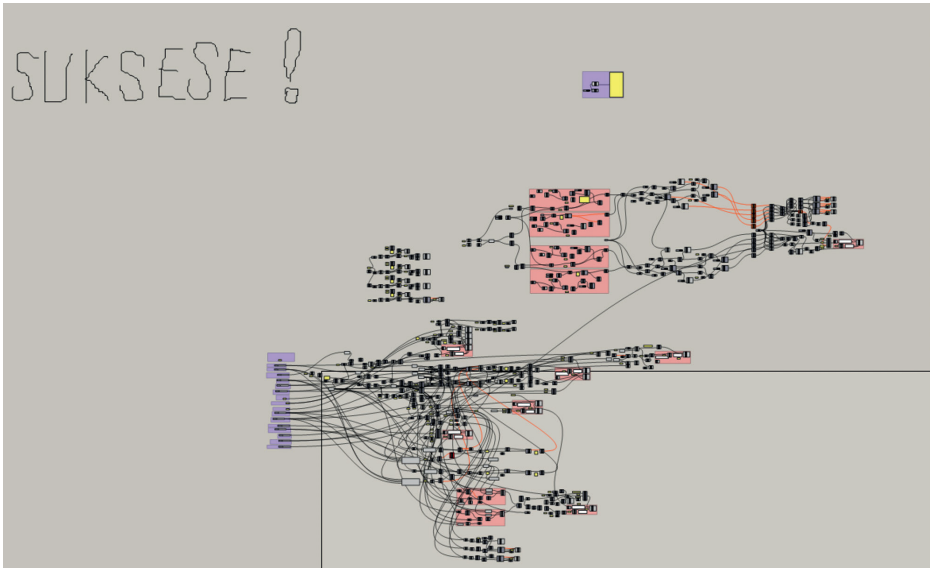

Figure 8 – The demo script given to the student in TAW 2023

steps of its design. However, the municipality tends to change the projects, as well. The projects can also change in site. Usually in Albania all of the above happen. The project may change even while finishing the floors (this is a crazy world we are living in). Sometimes not only the elements, but the entire project changes.

To prevent the possible mental breakdown during these changes, the script allows the user to be flexible and change only the corresponding inputs, not the entire project. The drawings, afterwards, adapt to the changes in an automatic way, by saving a lot of time.

Lastly, the script prevents human mistakes. The test was made during a workshop in Tirana Architecture Weeks 2023. A simpler version of the script was given to the students of the first year of civil engineering class and they were assigned to draw all the cross sections of beams of a five-

floor complex structure. Students lacked the skills to do this task with a conventional software. Moreover, they did not have the capabilities to understand the meaning behind the drawings. Nevertheless, the result was outstanding. It took only one day to explain the problem to them. They completed the drawings in four days. Also, the drawings themselves had less mistakes than the real drawings, which were done by experienced engineers.

Conclusion

Automating the boring stuff is the main issue this paper tackles. To do so, the author designed an algorithm and tested it. The results were promising, as the drawings were done with less mistakes and in a shorter time than with the conventional software. Also, an important task of this paper is deciding the inputs to use, which, in programming, has the same importance as designing the outputs. This issue is considered on accordance with the Eurocodes and the good practice. The algorithm considers only the drawing of the concrete beams. However, a similar algorithm can be made even for the other structural elements.

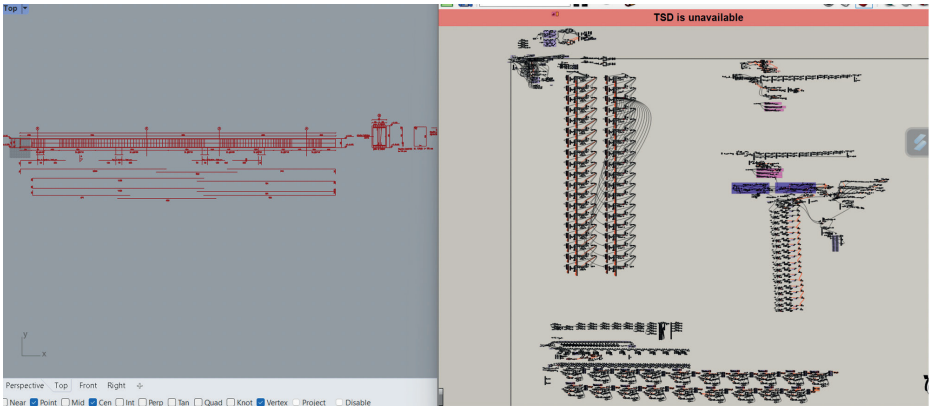

Figure 9 – The algorithm

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