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# BIM IMPLEMENTATION: ROUTE 6 PRISHTINE – HANI I ELEZIT

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## Abstract

Over the years, in construction industry, BIM (building information modelling) is one of the most mentioned topics with the main question: "Do we need it?" The answer should be commonly known, like with every solution that modernizes the profession and society. BIM in linear construction projects (transportation facilities and structures, sewage/water supply) and landscape design are still "one step behind" with already accepted "BIM implementation" in AEC (Architecture, Engineering and Construction) industry and MEP (Mechanical, electrical, and plumbing) industry. With more than 10 years of experience KAP4 company is one of the leading brands in BIM – Croatia. Along with our knowledge, courage, and motivation, we successfully realized multitude projects in Croatia and Europe, mostly in AEC industry but also in linear construction projects. Through our biggest project in linear construction industry "ROUTE 6 PRISHTINE – HANI I ELEZIT" (Sections 2&3), on real life project we will show advantages of BIM implementation in road structures design (bridges, overpasses, underpasses, etc.), but also in survey data, road design and earthwork optimizations, along with challenges in process (changes in design, no BIM environment, etc.) and later BIM impact on our Client and associate designers on route. With dozens of BIM road/structure models on route we will demonstrate output results with drawings/documents full of information, improved graphic outputs, document and team design collaboration, process of design, associate designers' collaboration and facilitating the client to follow the whole process and documentation. Hopefully, and answer to first question, do we need it.

*Keywords: BIM, road structures design, KAP4 d.o.o., model, documentation, collaboration*

## 1 Introduction

Among knowledge, idea, experience, and other essential engineer skills, for quality and optimal solutions, time and information's are crucial. If we add control and managing, before time and information's, in "equation", then we can fulfil most of our engineers' potentials and deliver quality product (buildings & structures as ultimate goals) in reasonable time with minimum cost. And that is BIM, the tool (technology...) that give us power to control and manage information's trough whole process of design, construction, and management of building/structure.
From early days, society/professions seek progress through optimization of processes (time & expenses following...) and innovations that enables them. BIM – "Building information modelling" was introduced more than 50 years ago [1], and only last 10-20 years is accepted by part of profession/industry [2]. AEC (Architecture, Engineering and Construction) industry is leading part in BIM implementation and commonly known as "only" construction industry where BIM is effective, which for sure cannot be true.

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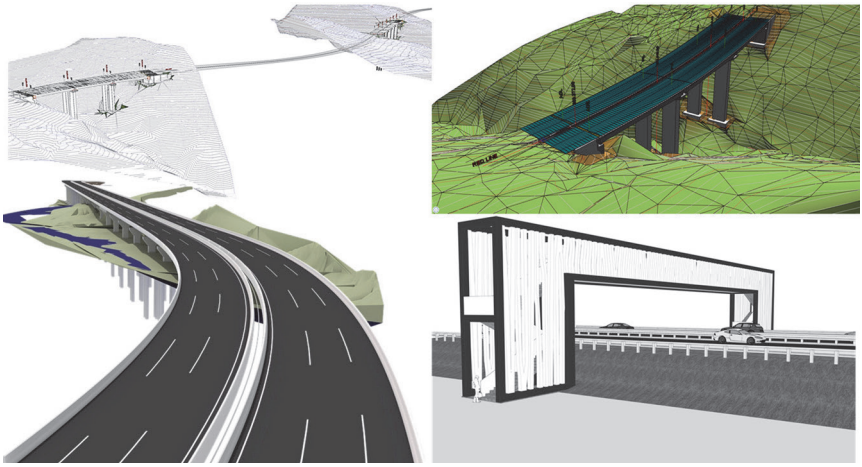

**Figure 1** ROUTE 6 BIM models – KAP4

BIM or Building Information Modelling is a process for creating and managing information on a construction project across the project lifecycle. One of the key outputs of this process is the Building Information Model, the digital description of every aspect of the built asset. This model draws on information assembled collaboratively and updated at key stages of a project. Creating a digital Building Information Model enables those who interact with the building to optimize their actions, resulting in a greater whole life value for the asset. [3]
Intention of this paper is to show benefits (or at least part of them) of BIM application through all phases of the project. Management of processes and information from the early-stage design, through the main and implementation design for the benefit (as the final goal) of construction and building usage (or generally, project itself) but also for benefit to all participants in construction.

## 2 BIM in design

### 2.1 Early-stage design

In the early-stage design phase, the available information and especially the possibilities of its use (and speed of exploitation) come to the fore. With route input data, terrain topography (3D scan or classical survey data), geomechanics, etc., the engineer can think globally and locally to create the best and most optimal solution.
From the global level and consideration of road route correction, through variant solutions of structures regarding location possibilities, access roads, on-site construction, or delivery, to more detailed approach of important structure elements regarding earthworks, slope stability, etc. Each individual solution / variant can be analysed relatively quickly with defined main quantities for construction and recognizing types, scope of works and their time-cost analysis.

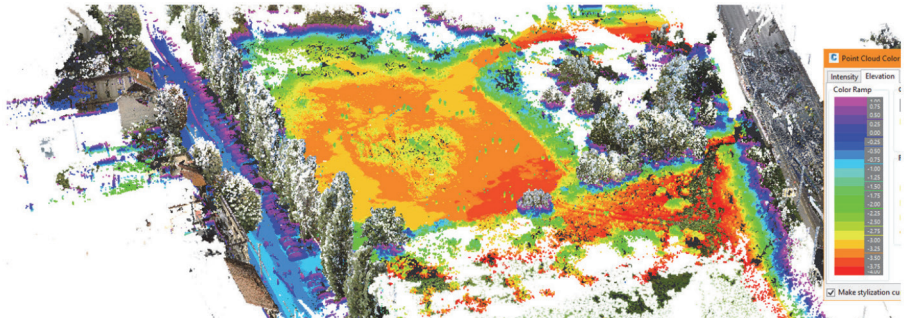


**Figure 2** Point cloud terrain topography – earthwork analysis

In the early-stage design phase, analysing bridges and other structures of section C3, significant earthworks were noticed (visually and quantitatively) to perform foundations of structures but also subsequent large areas of unstable cuts that needed to be permanently protected. The problematic part of the section (approx. 3 km) was modelled as designed and quantified. Parallel with that a completely new model was made with different approach. In addition to the visually clear difference, the quantities could be compared and analysed and then presented to the client for final confirmation and change of route.
Afterwards, given the possibilities of location, access, period when which structure should be in function for access to other facilities, etc., each building is observed separately, and variant solutions were made. Solutions were harmonized with the surrounding structures to present to the contractor and client and adapted to required technology and capabilities for faster, more economical, and simpler construction on site.
According to the selected building concept, the construction is further analysed to at least identify all key problems and present them to all participants in the project, if it is not already possible to solve them immediately before the next design phase.

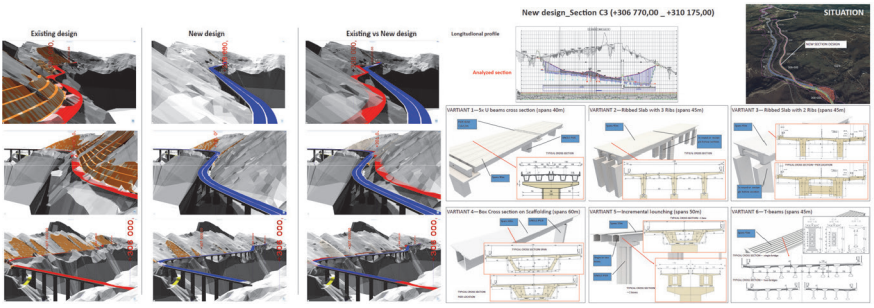


**Figure 3** Route optimizations & structure variants (global & local level of optimizations)

## 2.2 Main and implementation design

In BIM design, the process of creating documentation and the design itself moves in reverse order. The engineer has the ability (or rather, the opportunity) to build his building virtually and to identify all the key problems he must solve. He proves his solution with calculations, harmonizes all load bearing, non-load bearing and auxiliary elements (drainage installations, lighting, equipment, fences, etc.) and then approaches the preparation of documentation and drawings for construction. Of course, the drawings are not drawn but are automatically extracted from the BIM model and equipped with needed and desired information by the designer, contractor, and client. This gives the engineer extra time to think and create, instead of wasting the same on 2D drawings, manually calculating quantities, etc.

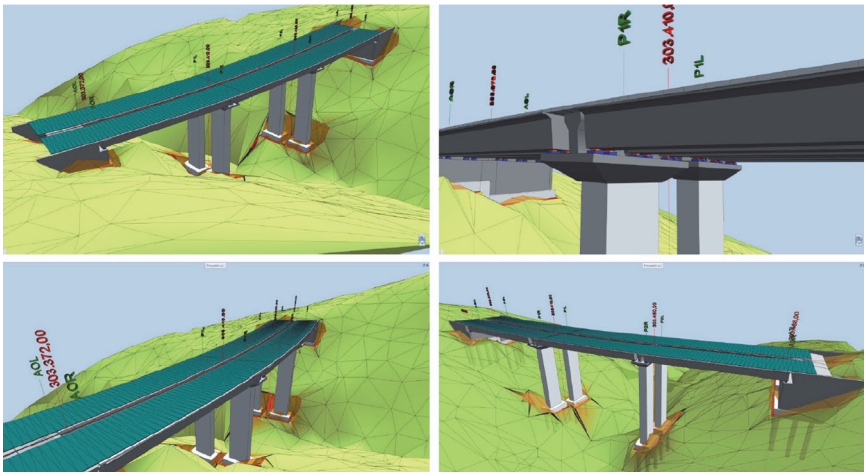

**Figure 4** Bridge level of details (main design BIM model)

At this stage, each element (or segment, set of elements) contains all necessary information for the designer and basic or advanced information (available to the designer) for the Contractor (order of construction, quantities, maximum dimensions and weight for delivery and installation, etc.) and the Client (time required for construction, costs ...). All this enables preparation of 4D, 5D, n-D BIM analysis for the Contractor and the Client, as well as better preparation, planning, and organization of the construction of the building.
All documentation (general drawings, 3D detailed reinforcement and formwork plans, survey data, automatic quantity reports) is made with superior precision and almost flawless (especially without human errors like in no-BIM environment).
3D representations on the drawings give a new level of simplicity to representation of complex solutions, explanations of construction from the technical aspect but also the order of execution, level, etc. The level of information (necessary and additional) on the drawings and documentation is at a very high level and there is almost no possibility of unknown, unforeseen problems and costs at a later stage of construction.

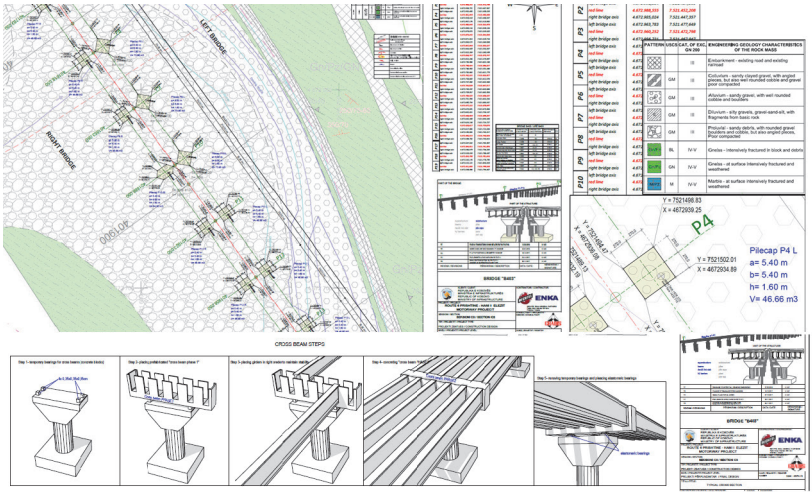


**Figure 5** Detailed general drawings with necessary and additional information

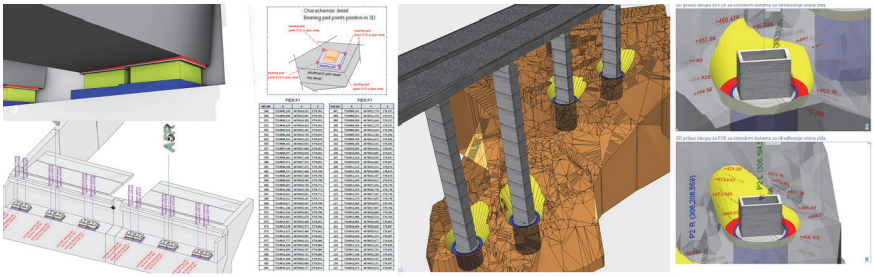

**Figure 6** Automatic detailed global coordinates (X,Y,Z) & 3d position representation

As in the previous phase, the collaboration and communication with the Contractor and the Client is constant, clear, and transparent and they are familiar with all technical solutions, construction and installation sequences and quantities, with quality visually representations. For communication, it is possible (and desirable) to launch BIM platforms for direct communication on the BIM model at this stage.

## 3 BIM in construction and maintenance

### 3.1 Construction and collaboration

With well-done project preparations in the earlier stages, the Contractor is already thoroughly familiar with the project and has at his disposal all the necessary information for quality organization and planning, which is certainly one of the main challenges at this stage. It is not necessary for the contractor to use BIM technologies (like in this project) and BIM model to improve it (supplement with new information), which is certainly recommended. In the previous phases of the project, quality approach of the designer and active participation of all necessary participants in the construction, it is possible to anticipate and solve all identified and potential problems/challenges, which provides an opportunity to actively monitor the project to its final purpose.

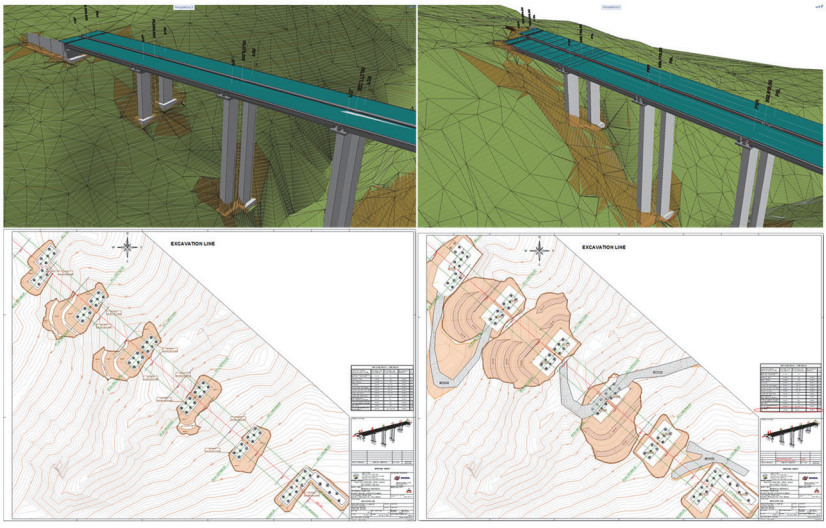


**Figure 7** Change in earthworks and pier heights after construction of an access road for heavy machinery

However, what if previously known conditions change? Then, of course, there are changes in the project and project documentation. The connection between the BIM model and the created documentation is constantly active. On the example of making the approach of heavy machinery to the location of the bridge, the descending ramps disrupted the planned existing condition of the ground. By adapting the terrain model to the new survey data and correcting the excavation (3D and then automatic 2D drawing and excavation quantities) in a short time, the impact of the change on the designed solution was known.
Such changes and all other needs, requirements and adjustments are best done through platforms for communication and collaboration of construction participants. With clear visual connections to the elements and/or parts of the structure, all communication and changes remain permanently and clearly visible to the necessary participants (via control rights) and all drawings, technical sheets, etc., are directly linked to the model and available with just a few clicks (current and archived versions of documents).
Changes (especially large-scale) are very rare and mostly must be caused by changes in project settings, technology, etc. All participants are actively involved in the project through earlier stages, structure is already virtually built, and more time is available for detailed cost/time planning before construction, etc.
All this allows participants feel of control and stability over the project. Result is additional energy, good relationships, and better cooperation between associates and ultimately, time&cost benefit to the project itself.

**Figure 8** Bridge on site vs virtual bridge (BIM model)

Most of the work for the designers in this phase is only actively monitoring construction site and, if necessary, preparation of additional displays and explanations of technical solutions. Designer can also record changes and enter additional information into the BIM model for later stages of building use. Also, for the Contractor or the Client, he can prepare measure proof of installed quantities and / or the required quantities of materials for ordering, installation, production, and delivery, with automatic (or custom made) reports from the BIM model.

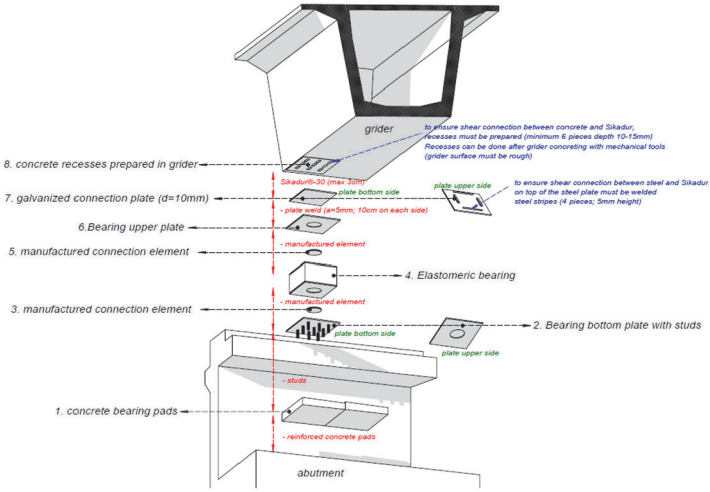


**Figure 9** Supplemental 3D detailed installation guides for contractor

## 3.2 As built and maintenance

As Built documentation is the standard for essential buildings. If the designer actively participates in the construction (updating the BIM model during the construction and thus automatically the drawings), the preparation of such documentation does not require very much time and effort. In addition to the 2D drawings and BIM models, active scanning (3D scan and point cloud) can record the exact position (georeferenced) of all hidden / closed elements (ground installations, piles, etc.) and can be submitted to the Client. Additionally, all certificates and technical documentation and serial numbers of equipment (installation / replacement dates, etc.) can be added to the BIM model as information (and/or document). Such as-built model (with as-built 2D documentation) can be submitted to the Client (or end user) who later can continue to use it for active maintenance of the building/structure.

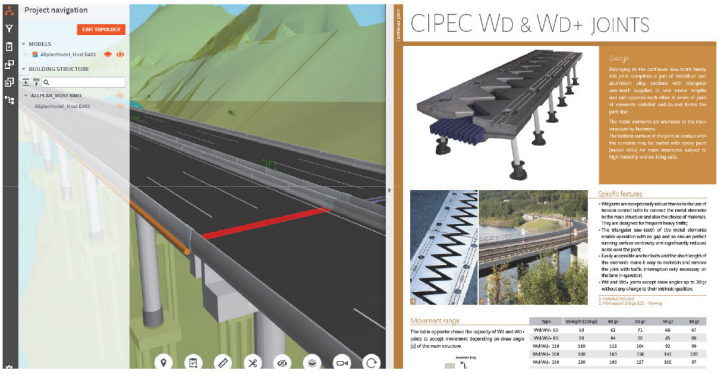


**Figure 10** Technical data can be added to BIM model for further maintenance

## 4 Conclusion

If you could have second chance to do same thing all over again, would you make same mistakes or you would avoid them? If you had necessary information which indicates problem, would it occur on site or you would eliminate it in earlier stage? If you knew all information, exact quantities, execution order, etc. and virtually examined whole structure that you are building, would you plan and organize site in same way? Etc.
These are rhetorical questions, but they can present main BIM advantages in simple examples. Virtual construction, or design and build (and maintenance) with BIM gives you more time (in all project phases) for better planning, optimisations of design and technical solutions, but also a control of the entire project and processes. Financial, organizational, logistical, construction issues (and other) can be recognized in early phases of design and eliminated so that they never even appear as a problem, additional cost, downtime, etc. on site.
Shortly, BIM design gives designer, contractor and client, key information's in right time to control the whole project and related processes.
In profession, common mistake is belief that BIM has advantages only for designer, or at least, mostly for designers. Yes, we spare much time making automatic drawings instead 2D drawing, using automatic quantities and reports instead of calculations, etc., but all that is to invest that time on actual design and solutions to the benefit for all participants in the construction and construction/project itself. Better planning and more efficient processes prevent unexpected issues and therefore additional cost, time, etc.
Another benefit is that Client (and contractor) can be included in early-stage design with clear & attractive visual representation, quantitative information, etc., so that they can actively participate and make decisions/suggestions. On previously shown project, client, contractor (and other designers on route) completely changed their perception about 3D, BIM design, collaboration, etc. but mostly about possibilities and advantages that come with BIM. Biggest "win" was that all structures were designed almost flawless at all and that both, contractor, and client, gained security, stability and (a sense of) control over all parts and processes on the project.

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