An insider's approach to concurrent tunnel engineering with inadequate data and strict construction schedule

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ABSTRACT: The fast track design and construction model, with emphasis in large tunnelling projects is addressed. The specific model is in most cases determined and characterized by the necessity for concurrent execution of design and construction within a very strict and demanding environment, both in terms of time schedule and client requirements, and in lack of any previous studies and adequate geotechnical investigation data. Working as a coherent team, managing the inherent significant design and construction risk and finding the way to success in such demanding tunnelling projects, offers a great challenge to the designer(s), the contractor and the owner of the project. The authors emphasize on the tunnel design management issues that usually arise from the specific process and analyze the crucial features that the designer must dispose in order to actively support such projects with a leading role, giving relevant examples from a hydraulic tunnel project in Albania, designed during construction with a successful fast track procedure.

Keywords: Fast Track Process, Design Management, Strict Time-Schedule, Geotechnical Risk

1 Introduction

Within the environment of severe worldwide crisis, predominant in the current financial conditions, the available funds for infrastructure projects are significantly decreased and any investment needs to be materialized within very short time periods in order to produce the desired profit the soonest possible. The present status of large international construction projects, having the timely and sufficient funding as its main driver and being strongly affected by this environment, often calls for Fast Track engineering procedures, instead of the traditional Design – Bid – Build process.

The Fast Tracking approach as a construction management technique was introduced during the 1970s, in an attempt to meet challenges such as the growing engineering complexity of projects, the increased state regulations, serious inflation periods and government pressures, towards a faster and more economical construction. As an evolution of Phased Construction, Fast Tracking introduced the overlapping of design and construction even in single work packages of a construction project (Fazio et. Al, 2008), as indicatively shown in Figure 1.

Kwakye (1991) defined the Fast – Track model as "a managerial approach to the achievement of early project delivery, involving the application of innovations in the management of construction procurement and recent advances in the process, bringing into play:

- the integration of construction and design phases,
- the involvement of the contractor in both the design and construction phases,
- overlapping of work packages to enable construction of sections of the project to proceed while the design for other sections is being progressed and
- the employment of the expertise of suppliers in design and construction".

Hence, the main characteristic of a Fast Track procedure is its highly irregular nature, imposed by particular emergency conditions and not by choice, that requires the concurrent execution of design and construction within a very strict, demanding and therefore stressful environment. The following factors, either solely or in combination, act as generators of such particular conditions:

- Financial constraints and time shortage. Being the major factor creating the necessity for Fast Track procedures, limited funding in the long term imposes strict time constraints due to the need for maximization of profit, which requires maximization of the exploitation period of the project – investment. The client wants the project to be delivered as soon as possible, even if the construction cost is increased, aiming to balance this possible additional cost by the earlier commencement of operation and thus the augmentation of the exploitation period. In that concept, sequences, concerning both design and construction, must initiate as soon as possible and run in parallel in order to save time and achieve early completion of the project to make it sustainable.
- Client requirements. Increasing demands of clients in terms of flexibility of the project configuration during its construction, is one of the most common reasons for concurrent execution of design and construction. A finalized design with no connection to the construction, either time wise or in terms of cooperation, determined and carried out under a different contract, cannot offer this flexibility and any adaptation of the design to the requirements of the client in the middle of the construction process, is difficult and time consuming, not to mention expensive.

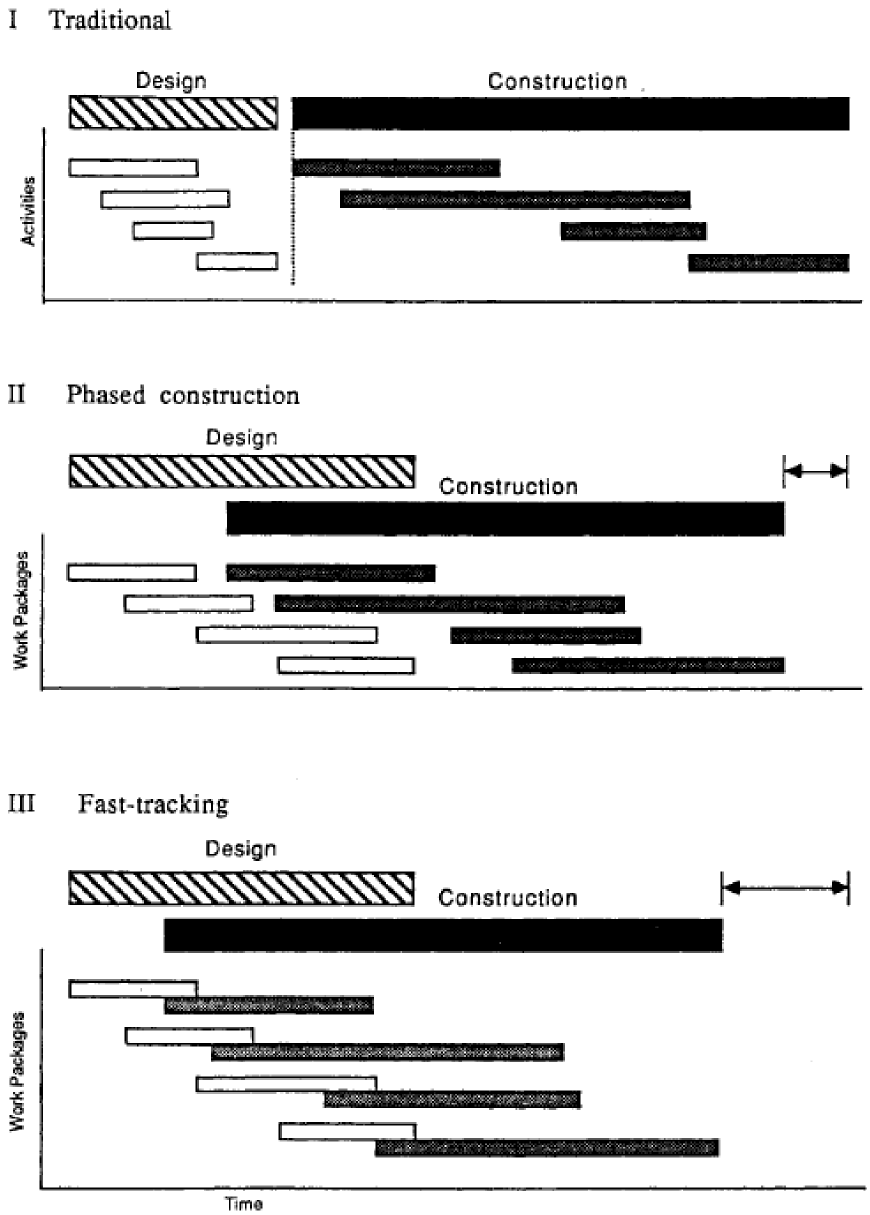

Figure 1. Traditional, phased construction and fast-tracking approaches (Fazio et. Al, 2008)

Within the framework of the specific irregular conditions and requirements, “traditional” prerequisites and given “conveniences” for the designer, such as rational available time for the compilation of the design reports and drawings, proper and carefully planned, executed and evaluated geotechnical investigation, previous, preliminary design stages and space for reservations and additional investigation in case of uncertainties do not exist by default.

The significance of all the above particularities and therefore the involved risk of a Fast Track process, rise proportionally to the scale, uncertainties and difficulties of each specific construction project. For the case of long tunnel construction within unpredictable and heterogeneous geotechnical environments, this specific task becomes highly demanding and the risk is magnified not only due to the scale of the project, but also due to its constant dependence on the geotechnical conditions, along a large area where serious changes of geology, tectonics and hydraulic conditions may take place, forming unfavourable features for the project and jeopardizing its timely completion. On the other hand, it is exactly this irregular, demanding character of the Fast Track tunnel design and construction process that makes it a big challenge for all involved parties to find the way to success in such large tunnelling projects. Koronakis et. al (2012) set a framework of the fast track approach in tunnelling projects, emphasizing on contractual, liability and design management issues, based on lessons learnt from fast track motorway and tunnelling projects in Greece and Albania.

2 Design Management Issues

Focusing on the tunnel designer operating business in regions affected by the financial crisis, getting involved in Fast Track procedures of large tunnelling projects’ construction is almost essential and it actually means living in the rhythm of the current time, the current construction industry era. In other words, the competent tunnel designer has to decide, work, act and therefore “live fast”. However, in order not to “die young”, a skilled tunnel designer, acting both as an engineer and a businessman, has to face and successfully handle tough and unconventional design management problems, such as those concerning:

1. The geotechnical uncertainty and risks. The need for immediate commencement of tunnel construction, offers no time for a proper and targeted geotechnical investigation planning, execution and evaluation, not to mention the lack of any previous studies assessing the geotechnical conditions and the potential design issues without an intense time pressure, giving a relatively “safe initial path” to the final design. As a result, the Fast Track procedure in tunnelling projects carries an inherent and inevitable uncertainty, which the designer has to work with until the end of the project’s construction, being aware of and ready for the risks that he is about to take. As already mentioned, tunnels are by far the construction projects where unexpected unfavourable geotechnical features can be encountered, being the works that deeply penetrate the ground and reach earth sections that are far from any observation potential from the surface. Taking into account that (a) the soil and rock formations are the most heterogeneous, anisotropic and uncertain engineering materials, (b) tunnels are linear works that penetrate the ground not point-wise, but longitudinally and (c) underground openings, at least during their excavation and temporary support phase, actually utilize the ground as a construction material, it is easy to realize that tunnelling should be the first example just after the definition of geotechnical risk.
2. The need for rapid and unconventional decision making. Having no data to start from, means that you have to start, in order to get data. The inflexible target is the commencement and early delivery of the constructed product. In that concept, the designer has to design and has to do it fast. The necessary rational conservatism due to the inherent uncertainty and risk of this task and the limited budget by default, suggest a fragile balance. Traditional rhythms and practices cannot serve the common scope anymore and the designer has to come up with decisions to problems that usually need time and elaboration, therefore has to think out of the box, keeping in mind that any decision is very difficult to be recalled, as it is executed almost “upon issuance”.
3. The interaction with other design disciplines. The common understanding and tight interface between the design teams is necessary, in a degree far beyond that of a traditional concept. The conventional exchange of numbers, reports and drawings, with distinct and non overlapping boundaries concerning the engineering subjects and the decision making and problem solving responsibilities, are in any case not enough. Any “stubborn” and “sterile” behaviours have no place during Fast Track design of multi-disciplinary construction projects and tunnels are always

such projects. On the contrary, all design teams have to act free from egoism and participate in a productive brainstorming, although under stress and time pressure. A possible problem in the hydraulic design is a problem for the tunnel designer too, a tunnel alignment that serves the road designer but crosses a zone that is more risky concerning its geology, hinders the final common goal, which is the early delivery of the project. In order to be able to not only assist, but have an active role during this process, the tunnel designer has to show special cooperative and adaptability skills, be ready to accept criticism to any idea or decision and have the breadth of engineering knowledge to quickly and sufficiently evaluate the proposed solutions for the project as a whole, and not solely as a geotechnical work. The ability to convince a design team, especially members of another discipline, another business, to consume more energy and time, under a specific and predetermined lump sum payment agreement, in order to serve other design teams and the project as a whole, is very important.

4. The execution of final designs within very short time periods with very limited or no available information from previous studies. The designer is found in a demand to supply the contractor with integrated tunnel designs, having almost nothing to start from. Knowing how and where to set the baseline for the design, is a skill that comes with time, through success and failure in similar projects, similar geotechnical conditions, similar unconventional design and construction circumstances. The deep knowledge of what the designer cannot know when commencing a tunnel design without specific geotechnical data from the area of the project is a prerequisite in order to evaluate the inevitable risks. “When you don’t know, you must at least be aware of it”. The role of experience is here of great value. Having already performed designs of similar works, in similar geological environments, with similar geotechnical uncertainties and construction risks, offers the designer the required comfort to get involved into a process of concurrent tunnel engineering.
5. Complex contractual and liability issues. No matter how determined and obliged the parties of the project (owner, designer, contractor) are to actively and truly collaborate within the “rules of the game” of the Fast Track design and construction model, good will and trust are usually not guaranteed and are not enough. Complex liability issues have to be clearly resolved within the project’s contract. However, this is not a simple task at all, since the liability “limits” are not easily recognizable, as in the case of a traditional Design – Bid – Build process. The fact that the tunnel designer provides detailed drawings to be constructed “the next day”, without sufficient data and many times without time to finalize calculations, in order to assist the speed of construction, does not mean that he is the only one responsible for a potential setback or failure, even if the design is followed strictly during construction. It has been proved that the current technical perception is not capable to produce satisfactory contracts for Fast Track projects, as agreements between contracting parties on a legal basis are much more difficult than agreements on engineering issues. Additionally, there are still no established contractual standards as it regards to fast track procedures, including useful guidelines for the distribution of responsibilities and risks. Until the international engineering community overturns this shortfall, the tunnel engineer has to put a lot of effort, insight and stamina into such contracts, so as to protect his business, personnel and reputation from a possible uneven and unfair allocation of liability.

The interactive relationship and close, tested and long-term cooperation between the designer and the contractor, the constant and dynamic presence of the designer on site, the immediate feedback from the construction site and the effective evaluation of relevant information, as well as the growing experience and added value from mistakes and setbacks in previous concurrent engineering tunnelling projects, are some of the keys to successful and beneficial completion for all the involved parties, which however will certainly not come easy.

3 A Tunnelling Example

3.1 Description – Project Framework

The water transfer tunnel of Rrapun 3 & 4 Hydro-electric projects in the area of Librazhd in Albania, is a 2300m long pressurized hydraulic tunnel, with an excavation diameter of ~5.5m, excavated with the conventional and drill and blast method through molassic formations in the vicinity of a major thrust zone of an ophiolithic complex mass on them. The tunnel will be used to transfer water from a dam constructed on Rrapuni River through a mountain side to the power production plant. The project planning in November 2013 involved the construction of a second, ~250m long tunnel that would divert water from a tributary stream of Rrapuni River, through a small hill into the main conduit, before entering the main tunnel, thus increasing the total annual power production.

The nature of the tunnelling project that was not included in the initial project planning, as well as the Client (C & S Energy Sh.p.k.), created a context of limited budget and need for rapid construction, in order to profit from the project's operation as soon as possible. Therefore, the commencement of tunnel construction was of major importance and in fact from multiple excavation faces (construction of an access tunnel), in order to speed the excavation process. In addition, (a) the absence of previous (e.g. preliminary) designs or any relevant geotechnical data and (b) the serious difficulties and restrictions related to the execution of exploratory boreholes, due to the unfavourable area morphology and the timely process of licensing for the creation of access roads from the local forest service, called for important and immediate design decisions with limited of even no geotechnical data and thus with increased geotechnical risk.

3.2 Fast – Track "Marks" on the Project

The final design of a long tunnel excavated conventionally through a molassic geological environment, when performed by experienced tunnel engineers within a traditional framework, offering all necessary information and the asset of previous design stages, cannot be considered as particularly risky. The molassic environment is usually free from major tectonic events, exhibiting characteristics that have been recognized and decoded, based on extensive experience from tunnel excavation in the Balkanic Region. In that concept, construction of the specific project under the traditional Design – Bid – Build process, would not be of much interest for a publication. However, issues that were major for the specific Fast Track construction process, but would not suggest important factors during a conventional Design – Bid – Build project, imposed significant particularities that had to be taken into account and affected basic design aspects.

3.2.1 Issues during Early Design Stages

The availability of mechanical equipment of the contractor on site, being a major factor of the total project's financial balance, could not be omitted during the determination of the tunnel's geometry and dimensions that would otherwise be based only on hydraulic criteria. For that reason, the initially proposed typical tunnel cross section, proposed by the hydraulic designer in order to achieve adequate project performance during operation, with the minimum required excavation volume had to be modified during the hydraulic design. Specifically, the specific cross section proved to be quite small for the available modern excavation and transport equipment of the contractor on site (due to the already in progress construction activity of the contractor in the broader area of the project). The cost of renting or transporting equipment of smaller dimensions on site, proved to be higher than the additional construction cost due to the tunnel's cross section enlargement.

Additionally, from the first design stages, the geotechnical engineer had to always take into account the availability of any construction material (tunnel support types and measures, slope stabilization and corrosion protection products), the duration and cost of its procurement from the local market of Albania or from Greece. The constant and close communication and consultation with the contractor and the presence of a designer's representative on-site was absolutely necessary so as not to lose valuable time with minor or major modifications in the excavation and support concept of the tunnel, as the cost and timely availability of materials were important aspects of the fast track process and the common goal of early commencement of construction.

An additional aspect, rising only due to the particularities of the project and the need for immediate construction, was the consideration of the water levels in the adjacent Rrapuni River. As the works had to begin in the middle of winter, protection against flooding of the construction site was an issue of major importance that had to be resolved timely, including determination of entrance and exit portal places and levels and of construction site's access roads geometry. It is prudent that during a conventional Design – Bid – Build project, the design would just have to prescribe the commencement of works during the summer, so that any protective works could be performed simultaneously to the underground construction.

3.2.2 Portal Design

The design of the portal cuts of the main and the access tunnel was performed based on a careful geological mapping and the experience of the designer from tunnelling in similar formations in Albania and Greece. This experience was of great value, considering that molassic formations often exhibit slope instability, as their clayey components are prone to weathering when exposed to the environmental factors, forming weathering mantles of considerable and variable thickness. The construction was executed based on detailed drawings issued before the compilation of any design report and without any data from exploratory boreholes. In order to minimize the inherent risk of the process:

- The initial position of the entrance portal (determined by the hydraulic designer) was twice modified after geotechnical evaluation of the portal cuts and due to certain space constraints (existence of residential buildings and old pillboxes uphill of the tunnel entrance) and the significant presence of weathering mantle on the portal slopes, imposing additional work load on the hydraulic designer that had to realign a part of the tunnel after every modification in order to achieve specific alignment and energy loss requirements. It is easily understood that execution of a proper geotechnical investigation and, much more, a preliminary design, would allow early recognition of such problems and a timely positioning of the entrance portal. The understanding of the “fast track induced” additional work by the hydraulic designer was an example of common understanding and awareness of the increased possibility of such “back and forth” procedures.
- The observational method was applied from the beginning of the excavation works. Cooperation and common understanding between the designer and the contractor was again a prerequisite. Although excavation works had to proceed quickly, the revealed excavated slope faces were constantly evaluated by the contractor and the designer constantly present on-site, in order to check and improve the basic assumptions of the design (geotechnical profile, in-situ formations’ geotechnical conditions), as imprinted on the construction drawings.
- The designed retaining and slope protection measures enabled the fine-tuning during construction, with careful guidelines on the drawings, concerning modifications and adjustment of the slope stabilization scheme to the revealed conditions, without the constant need for re-issuance of the drawings. The specific process required a contractor aware of the existing design risks and not short-sighted, willing to temporarily slow down the excavation works in order to reduce the possibility of a subsequent failure, although being under a constant time pressure to proceed with underground excavation the soonest possible.

The above presented prerequisites, applied with the best possible way by both parties, guaranteed the beginning of the underground construction with only minor problems.

3.2.3 Underground Excavation Design

The underground excavation design for the main tunnel, was based on (a) the limited geotechnical data acquired from only 2 executed boreholes of a total length less than 100m, an inadequate amount of information, considering the length (~2300m) and the maximum overburden (105m) of the tunnel and (b) the actual geotechnical conditions from the construction of the access tunnel (~85m long), whose excavation preceded in order to create two additional boring faces, practically using the surface geological mapping and construction drawings mainly based on the observational method.

The available information had to be rapidly evaluated by the Designer, in order to produce construction drawings for the underground tunnel stretch that included specific geometrical configurations, such as the cavern on the junction of the access tunnel to the main tunnel and the required widened sections and perpendicular galleries for the crossing of vehicles and the temporary deposition and managing of the excavated materials. Significant uncertainties had to be accounted for during the preparation of the construction drawings of the tunnel’s initial support, however always allowing for the construction to proceed with the least possible setbacks. Specifically:

1. The distinction of rock mass classes, to which specific initial support sections would be assigned, being based solely on (a) the few meters of exploratory boreholes and access tunnel excavation, (b) the surface mapping (molassic formations significantly differ regarding their underground and surface geotechnical characteristics) and (c) the available experience of the designer, was anything but simple. Therefore, the number and principles of the support

classes should be such that would (a) provide a rational support scheme for each anticipated rock mass condition, away from serious over-dimensioning or creation of additional risks, (b) favour speed of construction without frequent changes in the applied support category and (c) provide the necessary flexibility, allowing small and clearly described adjustments to local variations of tunnelling conditions.

2. The longitudinal distribution of rock mass classes was highly uncertain. The available information was practically pointwise, with significant risk involved in any attempt to create a continuous geotechnical profile for the tunnel and therefore allow for a better organization of the construction site and the procurement process. Both the designer and the contractor had to accept the problems induced to each party by this uncertainty. The designer by exhausting his experience in providing the most rational distribution of rock mass classes, with a serious risk of causing procurement problems, and the contractor by assisting the designer to limit this uncertainty as construction proceeded, by performing horizontal exploratory drill holes on the tunnel face (thus imposing an additional delay to the excavation process), along the sections foreseen by the designer, in order to predict the existence and width of some potential weak fault zones.
3. The existence or not of the trust zone of the ophiolithic complex on the molassic formations at the tunnel level. Having no proper access and licensing to execute a relevant borehole, the geometry of the specific thrust zone was uncertain. The condition of the ophiolithic complex along the thrust zone, wherever this could be observed from the ground surface, was very unfavourable and thus its potential presence on the tunnel face would suggest adverse geotechnical conditions, resulting in a serious burden to the construction of the tunnel, both in terms of time and cost. As the contractor had to give a prediction of the tunnel construction’s lump sum to the client, this possibility had to be evaluated. Therefore, the designer had to make a perilous prediction, within a very short time period and with indisputable lack of data. The final decision to predict that the presence of ophiolithic material along the tunnel would be very unlikely, involved a common risk for the tunnel designer and the contractor as a team. This controversial area was crossed in May 2014 and no ophiolithic formation was encountered.

Under the aforementioned circumstances, the management of the balance between the considerable geotechnical risk and the limited budget of the project (need for rationally conservative design approach), necessitated the constant and true cooperation of all design disciplines and the contractor, under common understanding of both the design and construction risks by all parties. The tunnel excavation was completed within 7.5 months in July 2014 without significant problems.

The table presented in Figure 2 below, graphically illustrates the sequence of design, investigation and construction stages from the commencement of the tunnel design up to the finalization of the tunnel’s excavation and initial support. The table indicates that:

- The excavation and initial support of a 2300m long, 5.5m diameter tunnel, together with its supporting works, was completed using conventional means within less than 8.5m from the beginning of its design.
- Construction works begun just 3.5 weeks after the signing of the design contract. With this very short period of time, the designer and the contractor had already agreed on the optimum excavation geometry and the designer had prepared detailed construction drawings for the entrance portal, although these drawings had to be twice modified due to the equal number of changes of the portal’s location.
- Construction of (a) the entrance portals of the main and the access tunnel, (b) the total length of the access tunnel, (c) the cavern in the junction of the access and the main tunnel and (d) a considerable length (430m, approx. 20% of its total length) of the main tunnel, was completed before the submission of the final excavation and initial support design report (less than 17 weeks from the design contract commencement). This means that approx. 25% of the total excavation and initial support activities were completed before the submission of any design report.
- Design and construction activities were overlapped for a total time period of 13 weeks (3 months). During a traditional Design – Bid – Build model (a) the construction cannot commence before submission of the tunnel design and (b) an additional time period of approx. 3 months for the execution and evaluation of the geotechnical investigation precedes the design (whereas during a

Fast Track model the investigation is performed simultaneously to the design). Therefore, the total time saved was approx. 6 months (80% of the total construction period), without even accounting for the project's bid procedure. This practically means that due to the applied Fast Track process, the excavation and initial support of the tunnel was completed at a time when in case of a Design – Bid – Build procedure it would not have even started.

- In spite of the limited geotechnical information, the lack of any preliminary design and the constant time pressure applied on the designer, the construction was constantly "fueled" with proper consulting guidelines and timely submitted construction drawings. As a result, construction proceeded uninterrupted from the first day of portal works to the day of the final breakthrough.
- The entrance portals of the main and the access tunnel and half of the access tunnel's length were constructed before any evaluation of laboratory testing results.
- The underground excavation and initial support for both the main and the access tunnel initiated based on draft construction drawings of the relevant support categories and before issuance of the final construction drawings, as there was mutual agreement on the geometrical and technical characteristics of the tunnel's initial support between the tunnel designer and the contractor. The constant presence of the designer on-site was again of major importance.

The aforementioned observations create a framework of events and particularities that clearly demonstrate not only some of the most important technical and managerial advantages, but also some of the unavoidable and serious risks arising from the necessity of the Fast Track process as a design and construction model for a tunnelling project. The successful and timely completion of the tunnel's excavation was far from guaranteed and easy. Important setbacks or even failures could have occurred, even if a perfect management of the specific design and construction model could ever be achieved. The aforementioned results were not only assisted by the experience of both the contractor and the designer from similar Fast Track projects and their previous long-lasting cooperation, but also favored by the relatively homogeneous geology and the absence of large scale adverse tectonic features in the area of the project that allowed the increased excavation rates and enhanced the stability conditions.

3.2.4 Contractual and Design Liability Issues

The particularities of the specific tunnelling project, due to the unavoidable Fast – Track model followed for its realization, could not of course be limited to technical and engineering issues.

As regards to the designer's insurance for the project, the commencement of the tunnel's underground construction before any evaluation of laboratory tests, upon issuance of draft construction drawings and before completion of the final and integrated numerical and analytical computations for the tunnel's initial support dimensioning, suggests a strong "taboo" for the technical and insurance perception of underground works. The designer, accepted tto provide construction drawings that were not based on sound and site specific geotechnical information, being unsecured professionally and legally against a possible setback or failure during construction. Therefore, the designer accepted the relevant risks and at the same time relied on the built cooperation and trust with the contractor and the owner (that accepted the specific design and construction model and the subsequent allocation of the design related risks).

An example of a contractual risk for the tunnel designer is offered here by the initial prediction of a second tunnel to divert water from a tributary stream into the main conduit. After completion of the main tunnel's design and as its excavation was already at a very advanced stage, the geological mapping for the second tunnel revealed the existence of a potentially unstable mass around the exit portal's area. A quick assessment of the portal cut stability indicated that keeping the specific tunnel alignment would require a heavy, costly retaining structure for the portal configuration. Additionally, certain space constraints, related to existing local roads, imposed the relocation of the portal, as an alternative to the expensive retaining work, away from its initial position, thus increasing the tunnel length and hence the cost of the tunnel. The co-evaluation by the hydraulic designer, the tunnel designer and the contractor of all possible alternatives, led to the abolishment of the second tunnel and its substitution with a concrete canal that would go around the hill to meet the main conduit, as the optimum solution. Therefore, the tunnel designer had to deal with a reduction of his design scope, although not responsible for the abolishment of the second tunnel.

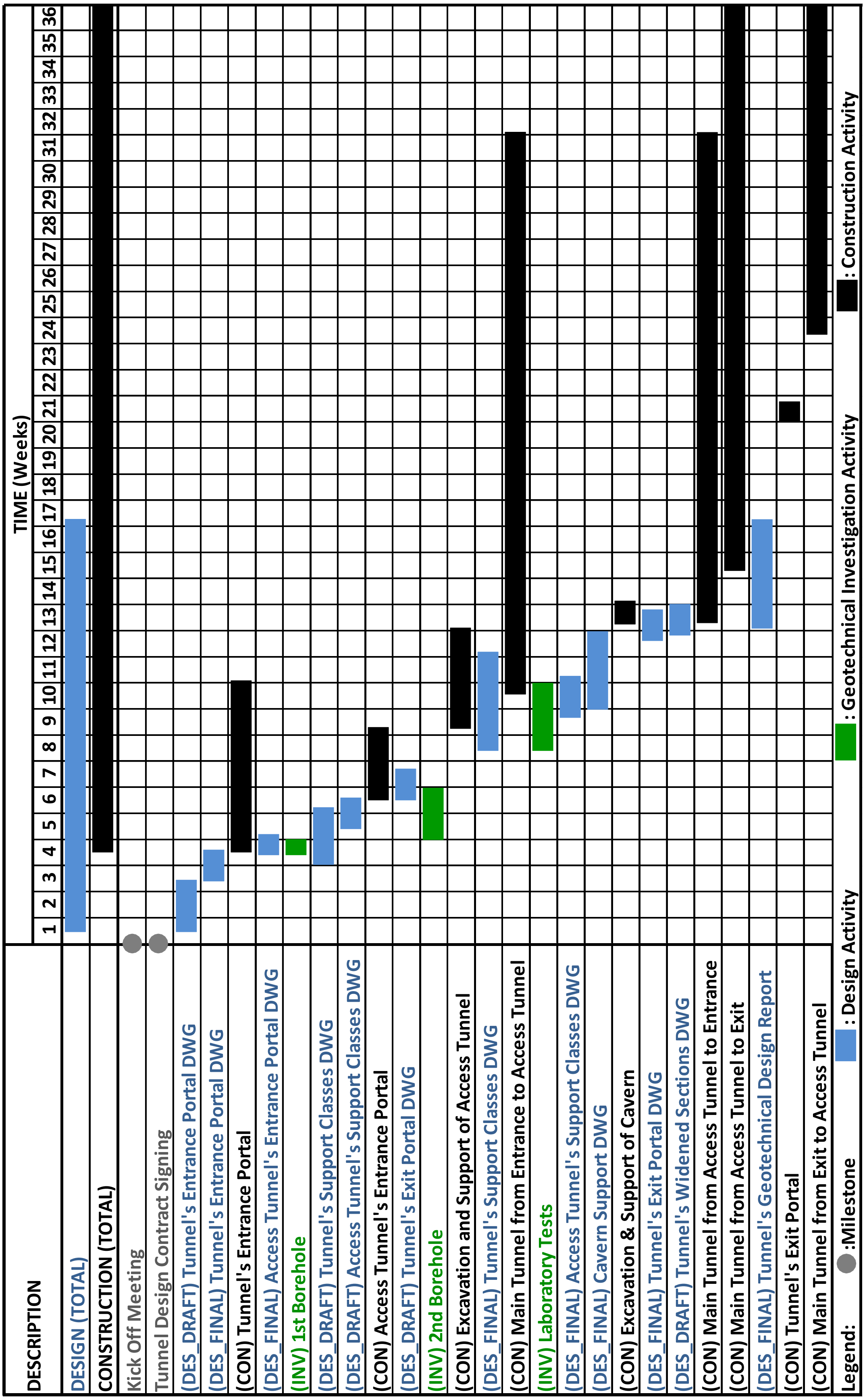

Figure 2. Sequence of design (light blue), investigation (green) and construction (black) actions of the water transfer tunnel of Rrapun 3 & 4 Hydro-electric projects. (Abbreviations. DES: Design activity, CON: Construction activity, INV: Investigation activity, DRAFT: Submission for approval by the contractor or/and other design discipline, FINAL: Formal Submission, DWG: Drawings)

4 Evaluation of Current Status

The Fast Track design and construction model for major infrastructure works, with tunnels being one of the main examples, cannot be applied as a choice, or as a model superior to the traditional one, but only as an absolute necessity in exceptional cases when the Design-Bid-Build model fails to ensure project sustainability. Therefore, it has to be performed only under very specific and carefully selected conditions. These conditions for a tunnelling project concern (a) an experienced and flexible design company, with deep technical knowledge and a management policy that can accept the relevant levels of geotechnical and contractual risks, (b) a contractor with serious experience in the construction of large and difficult tunnelling projects under very strict and demanding time schedules and most importantly (c) the existence of previous close, tested and long-term cooperation between the designer and the contractor in similar projects that can ensure their operation as a coherent team, sharing common goals, profits, risks and liability. These prerequisites are utterly essential and, at the same time, very difficult to find as a combination. In that sense, the best way to manage a Fast Track project, at least in terms of management and liability, is with the designer and the contractor belonging to the same legal entity, to a single compact business (in-house design department).

Tunnel designers aiming to get actively and competitively involved in large scale international tunnelling projects, forced by the present adverse financial conditions, have to decide to step off the traditional path of Design – Bid – Build Model. Although not a safe, advisable path, Fast Track can be effective when the early delivery of the project is the major concern of the client. However, success of the designer is not guaranteed and strongly depends on a set of prerequisites. Experienced, highly qualified human resources, fast decision making for difficult technical and management issues, minimizing the possibility of wrong decisions, understanding of other parties and dedication to the final goal, true cooperation with mitigation of personal ambition and constant and uncontrolled sharing of information, acceptance of high inherent risks with wide allocation, ability to work under irregular conditions under high pressure and stress, are some of the basic skills that the tunnel designer, as well as all the involved parties, have to demonstrate in order to “survive” and professionally profit from such a process. This demanding environment however can transform a tunnel design that would be relatively simple and unproblematic for a competent tunnel engineering team during a Design – Bid – Build procedure, into a challenging and highly risky process, where technical adequacy is of paramount importance but not enough. Every step performed free of global knowledge for the project and awareness of the above prerequisites can seriously jeopardize the construction time schedule and therefore the main success criterion of the Fast Track Project.

Bearing that in mind, the tunnel designer should not “hunt” or “get used to” such emergency solutions, regularly accepting serious divergences from the proper process and sequences to the tunnel designs, in pursuit of a short term excessive financial profit. Looking for a rational balance between the scientist and the businessman within, the designer’s hard decision to get involved in a Fast Track design and construction model, should be motivated by the intention to deliberately support sustainability of the project and his own business, under adverse financial conditions.

Acknowledgements

The authors would like to acknowledge the contractor of the water transfer tunnel of Rrapun 3 & 4 Hydro-electric projects, AKTOR SHOQERI ANONIME TEKNIKE, for the assignment of the specific design project, as well as for the close cooperation during the design stage and the providing of all necessary construction data for the scope of the present paper.

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