ΕΓΝΑΤΙΑ ΟΔΟΣ Α.Ε.

ΔΙΗΜΕΡΙΔΑ
"ΟΙ ΣΗΡΑΓΓΕΣ
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DESIGNER ON SITE DURING THE CONSTRUCTION OF EGNATIA ODOS TUNNELS – FIRST EXPERIENCES WITH A NEW CONCEPT

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ΠΕΡΙΛΗΨΗ

In tunnelling – especially in difficult ground conditions - the design process can never end as long as the excavation and support works are not finished, as we must calculate and evaluate at every round with changing properties of our main construction material. This means of course that we have to adopt our construction by changes in the design to the prevailing conditions. Therefore it is only necessary for the designer to participate in this running process and to leave all modifications of the excavation and support measures within his responsibility. It could be counterproductive if a basic design idea is not carefully adopted but inconsequentially mixed with elements of different design concepts by other engineers involved in the project.

The decision of Egnatia Odos to create in certain cases the concept of the „Designer on Site“ therefore is a consequent realisation and application of modern developments in tunnelling into daily practice. The joint venture Ingenierbuero EDR GmbH and Omikron Kappa Consulting Ltd is actually working within one of the first contracts as Designer on Site in the western region of Egnatia Odos. In the paper presented below, an overlook on our tasks and an impression of our first experiences in the daily work is presented.

1. DESIGNER ON SITE – A NEW CONCEPT IN THE CONSTRUCTION PROCESS

Up to now it is common practice in civil engineering projects that the design works are completely done when the execution starts on site using the approved drawings. The designer is not any more needed – apart from any errors that may be discovered on the executional drawings which demand a correction or an explanation from the designer. When the geometry of the structure is clearly described and the quantities and qualities of the construction materials are defined it is just a matter of transforming a design idea described on paper documents into a physical structure.

However, in tunnelling the matter is somewhat different and more complicated. The main construction material that we have to deal with during excavation and support is the material of the underground itself, the rock or soil we want to drive our tunnel through. The quality of this material is of course investigated in advance by geotechnical investigation programmes, but only up to a certain degree of reliability. And all experience shows that deviations from the geotechnical prediction are quite normal, as the variety of geological processes in forming soil and rock formations is tremendous and will never allow the exact description of the huge rock mass volume in comparison with the small quantity of samples gained by core drilling. Let us assume for the investigation of a road tunnel with 12 m of excavation diameter and a length of 1.000 m, that the quality of the surrounding rock mass should be known in a depth of additional 12 m around the tunnel. The rock mass we would like to know the mechanical behaviour for is about 1.000.000 cbm – the quantity of cores we gain even with an extensive investigation programme is only a few cbm!

This small example shows us that in tunnelling – especially in difficult ground conditions - the design process can never end as long as the excavation and support works are not finished, as we must calculate and evaluate at every round with changing properties of our main construction material. This means of course that we have to adopt our construction by changes in the design to the prevailing conditions if we do not want to build too expensive (if the conditions get better) or unsafe (if the conditions become more unfavourable). Therefore it is only necessary for the designer to participate in this running process and to leave all modifications of the excavation and support measures within his responsibility. In addition, we strongly believe that it could be counterproductive if a basic design idea is not carefully adopted but inconsequentially mixed with elements of different design concepts by other engineers involved in the project.

The decision of Egnatia Odos to create in certain cases the concept of the „Designer on Site“ therefore is a consequent realisation and application of modern developments in tunnelling into daily practice. As the joint venture Ingenierbuero EDR GmbH and Omikron Kappa Consulting Ltd is actually working within one of the first contracts as Designer on Site in the western region of Egnatia Odos, we are very glad about this opportunity to give an overlook on our tasks and an impression of our first experiences in the daily work.

2. DESIGNER ON SITE – SCOPE OF WORK

As described before, the Designer on Site has to evaluate the influence of changing geological and hydrogeological conditions on the actual design and to propose changes for the continuation of a safe and economic tunnel drive. With reference to this basic idea, Egnatia Odos has elaborated a detailed scope of work which is listed below in short form:

- Provision of experienced personnel on site
- Continuously check and record the geological face logging
- Make recommendations on the rock mass categories
- Make recommendations with regard to monitoring instrumentation
- Evaluation reporting of all monitoring data on a real time basis

- Make recommendations for local (minor) modifications
- Make recommendations for systematic (major) changes
- Provide details of necessary design revisions
- Provide adequate data management presentation software on site to fulfil all duties specified in this detailed scopes of work.
- Deviations of construction process from the existing design.

We clearly see by this scope of work how the work flow is organized: The collection and interpretation of data gained from the experiences on site is translated into design modifications and transferred by a report management system to the other institutions involved in the construction process. However, to avoid any misunderstanding, it is very important to understand the role of the Designer on Site with respect to his juridical position in comparison to the other parties involved in the project.

3. DESIGNER ON SITE – HIS POSITION IN A COMPLEX CONTRACTUAL SYSTEM

The most important instrument for a successful realisation of a civil engineering structure is of course a clear and well balanced contract between the two partners – the owner and the Contractor. It is obvious that both sides must clearly define their responsible representatives to avoid any misunderstanding which may occur if not authorized persons start to discuss contractual matters. For the tunnels of Egnatia Odos it is fixed, that the interests of the owner on site are represented by the Construction Manager (CM). Due to this contractual regulation it is obvious, that the Designer on Site cannot replace or at least complement the CM. The Designer on Site is only acting as a technical advisor for the CM, but all responsibility concerning the contractual affairs between Egnatia Odos and the Contractor must remain with the CM. Therefore the Designer on Site can only give proposals for any technical changes, but finally the CM must decide based on the advices if those changes are worth to be discussed with the Contractor and could lead to an advantage for the Owner or not. Those considerations can of course lead to the result, that a technical idea which seems to be reasonable for the Designer on Site, will not be followed by the CM, as in his opinion due to contractual reasons the realisation of this idea could lead to a disadvantage for the owner. Nevertheless it must be clear that the contractual responsibility versus the contractor is at least with the CM.

On the other hand it is also obvious that the additional eyes of the Designer on Site and his special technical experience can be a valuable aid for the CM, as by the Designer's presence the net of observation of the construction process is condensed and additional attention is given to the behaviour of the rock mass, appropriate execution according to the relevant drawings and to the quality of works.

From this example we can see, that a trustful cooperation between CM and the Designer on Site is a very important prerequisite for a successful application of this model. Both

partners must discuss the relevant matters with a respectful understanding for the different points of view in order to avoid misunderstandings or frustration.

As we can report from our experiences on site so far those fears are in our case only theoretical ones. Fortunately we have found a CM which is a well interested partner and open to any discussion. On the other hand we strongly advised our engineers to concentrate their efforts on their consultancy services for the CM and not to disturb the contractual relation between the CM and the Contractor. Future experiences with other sites and other persons must show if that constellation is the optimum one or if other solutions (for example the Designer on Site as part and lengthened arm of the Construction or Design Department of Egnatia Odos) should be preferred, in order to act on a more independent way.

4. DESIGNER ON SITE – THE TECHNICAL CONSCIENCE OF THE TUNNEL SITE

With the creation of the institution of the Designer on Site, Egnatia Odos is treading new paths. Regarding my own experience I cannot remember a similar consequent transformation of actual needs in an executional concept. It might be true, that in other countries, on other sites, the designer is closer linked to the execution on site as it was realized in the system of Egnatia Odos up to now. Of course it is normal practice on all sites that geological mapping and monitoring is done and a lot of data is collected. But very often this collection of data is made by different institutions and everybody is making his own conclusions – if they are really made.

In Germany different models are used to link the Designer to the construction process. In some cases the Designer gets his contract from the client for all phases of the design. In most of the public engineering projects, especially for tunnel projects, only the design up to the tender documents is made by the owner's designer. For the execution the final design of the project is included within the tender documents and made by the technical office of the contractor or a consulting engineer which is chosen by the contractor. Using this model, the owner tries to avoid any claims of the contractor caused by the late delivery of documents by the owner's designer, especially when changes during the running construction process must be implemented in the actual design. On the other hand it is clear that the influence of the owner on the final design is reduced by this model and may influence the quality of the structure, as the intentions of the contractor are not necessaryly congruent with the intentions of the owner. In addition the collection of geological data and mapping is in most cases not task of the designer but done by a geotechnical consultant working sometimes by order of the owner or sometimes by order of the contractor. Therefore we often see a disadvantageous split up of responsibilities which leads to technical deficiencies within the projects.

At the moment I am also working as Consultant and Checker for the German Railway Authority. Within my duties there is a very difficult project – a cut and cover tunnel under compressed air as the ground water table can not be lowered. I was faced with the problem that a lot of people but always different ones are announced to collect a lot of data like levels

of different ground water tables, deformation measurements, extensometer measurements, geological mapping and others. But there was no central brain foreseen to make **one** interpretation taking into account **all** results and to make this interpretation **fast** in order to be helpful for the execution. To avoid any misunderstandings during execution I have ordered that one of the geotechnical consultants must be nominated for this task and he must inform the designer, if any of the design parameters will not be as assumed.

Egnatia Odos is now going one step further. With the Designer on Site and the scope of work defined for this job there is now only one institution which is responsible for the workflow of the whole design process containing observation of the actual rock behaviour – collection of monitoring data – interpretation of results – conclusions for the design – proposals for the design – discussion with the CM – elaboration of new documents for further execution.

Due to the Designers permanent presence on site, a permanent review of the design and a continuous adaptation to changing conditions is possible - to the benefit of the Owner and of the Contractor. In addition the owner has all possibilities to influence the quality of the project, as he keeps the whole design process in his hand.

Of course it must be ensured, that in case of proposed and intended changes of the design – especially when the conditions get worse – the approval of these changes is done fast and not hindered by burocratic restrictions. With the implementation of the Designer on Site also efficient ways of decision must be installed.

5. DESIGNER ON SITE - EXPERIENCES AT THE TUNNELS ANTHOCHORI, AGIOS NIKOLAOS AND ANILION

The main design process is done ahead of the execution under certain assumptions and a more or less theoretical imagination based on the experiences of already executed projects, which are never completely equivalent to the new project. By the close link of the Designer on Site to the construction process, his understanding of the real behaviour of the rock mass and its influences on the design is sharpened. This direct contact with the reality enables him to realize in detail, if there are deficiencies in his design or unsafe assumpions or factors of safety which are too high and may be reduced.

In addition, we know from our own longterm experiences, that with the start of a new drive an additional factor becomes of major importance which can hardly be estimated before: This is the special experience of the executing company, especially of the crew on site. With regard to a safe and economic execution it is of course advantageous to realize special knowledge of a tunnelling crew and to implement it with careful tuning modifications in the design, as far as it is possible by the contract. This can be advantageous both for the Owner and the Contractor.

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Regarding the daily business, the scope of work defined by Egnatia Odos needs the fulfilment of the following main tasks:

- Inspection of the tunnelling works. In our opinion this is a very important point, as a Designer on Site, who is not leaving his office, is not qualified for his task.
- Collection of data (face logs, monitoring results, photos)
- Interpretation of data, evaluation of consequences
- Elaboration of recommendations
- Coordination with the CM
- Elaboration of the regular reports
- Coordination with the main office with respect to the elaboration of new documents

Unfortunately every engineering work is linked to the production of documents which mean additional work for the sender and the recipients of these papers. In addition, the production of documents is often more likely to hinder the intellectual dealing with a problem than to support it. On the other hand a careful documentation of all events is necessary, as it happens very often that observations, made at a certain date, may influence any later decisions and then need a review of this old documentation.

Therefore we have implemented right now a special development of our company for the use of our engineers on site. This electronic diary called “prodoc” (**pro**ject **doc**umentation) enables them to document all activities, events, and observations and to give comments to any kind of documents which have been checked or elaborated at the relevant day. Equipped with an e-mail function a fast information of all relevant institutions is possible.

At the moment this tool is installed on 7 sites in Germany, one in Nepal for a big pump storage power scheme and now is going to be applied here in Greece for three tunnels. On most of the sites the programme is used for documentation of all relevant construction process data and for quantity surveying. For the special service at the tunnels of Egnatia Odos we have made some adaptations which will be explained afterwards (see appendix)

The aim of this tool is a fast, clearly arranged and complete documentation. Experiences show that an amount of time of about 15 to 20 minutes is sufficient for this diary and gives after some time valuable archives of all events of a site. By special indexes an easy and fast search to all kind of headwords is possible. The engineer on site therefore is relieved from unproductive burocratic work and is able to concentrate on his real job.

As we can see up to now under the difficult conditions of Anthochori tunnel we are sure that only with a Designer on Site severe systematic changes of the design in a running excavation process can be done within a reasonable amount of time and cost. This task is a real consultancy service for the site as in our understanding this job is not only limited to the elaboration of documents but in some cases also needs a support of the Contractors crew for the proper execution of new methods.

This point makes our job sometimes difficult as we of course absolutely acknowledge the exclusive contractual relation between CM and Contractor which cannot be disturbed by us. On the other hand it is also clear that we do not want to take over responsibility for executional deficiencies that we realize on site but cannot change, especially when those deficiencies cannot be repaired later, as the excavation works have already proceeded. This is also a reason for our strong efforts concerning a careful documentation of all observations on site.

Nevertheless we must state that Egnatia Odos with the new concept “Designer on Site” has made a very important and consequent step forward to take advantage of the flexibility of modern tunnelling methods with respect to changing ground conditions. Such a close and official participation of the Designer in the running excavation process is not common in similar projects up to now. With respect to their ability in the international competition the experiences with this model will be a valuable support for the Designers Society in Greece.

6. CONCLUSION

With the installation of the Designer on Site Egnatia Odos has tread a new path to concentrate the responsibility for the complete design process also during execution and in case of changing conditions in one hand. As modern tunnelling methods need a certain flexibility and a rigid use of a design may lead either to unsafe or uneconomic results, especially under difficult and complex conditions a continuous adaptation of the design is necessary.

The Designer on Site is the consequent transfer of this realization into daily tunneling work. Although there is not very much experience gained so far we clearly see the advantage of this model which especially stands out under the difficult conditions of Anthochori Tunnel. As is shown by the results of the last months this model has proved its successful application and justified the expectations of its inventors. As the Designer on Site has to fulfil a large range of tasks and has a high responsibility with respect to quality and cost of a project we also can only recommend to Egnatia Odos to chose consultants with high qualifications for this job and to provide an appropriate financial frame for this kind of service.

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