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The key to planning ahead

On tunnel planning projects effective software programmes can lead to informed decisions prior to deployment of TBMs

TUNNEL construction is often impacted by soil classification as tunnel-boring machines (TBMs) are expensive and have a long design and delivery period. Incorrect estimation of this in the tender period may cause a project delay. This will not only impact profit but could result in bankruptcy of the contractor due to late delivery.

It is therefore vital that the estimate is done accurately and that the correct TBM capacity is chosen. Unfortunately, a major problem encountered these days is contradictory communication between the tender department that prepares the offer and the construction team that will do the work.

Time and resource restrictions can mean that the project schedule is a low priority and is only produced on paper and attached to the tender offer. The major focus tends to be on estimating cost and, since many projects today are international, companies are also trying to source data for local labour, material and equipment cost.

After a company wins a bid, different people start to be responsible for the construction and as they start to analyse the schedule, they may discover that it is not realistic. Many contractors use planning software because of client requirements.

This approach means they do the job and report using the planning software. This tends to mean that the schedule is unrealistic and is designed to suit the client.

This paper aims to explain how the implementation of Linear Projects' time location system (TILOS) planning and scheduling software can lead to successful project plans. As an example we will use soil classification in tunnel projects to demonstrate this.

THE HYPOTHETICAL SCENARIO

In this sample, hypothetical company XYZ Engineering is planning a 550m-long tunnel using a TBM and first focuses on the impact of soil classification for planning and controlling.

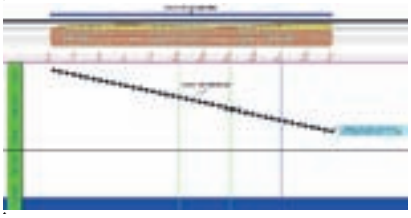


Figure 1: tunnel construction plan without accurate site investigation data

Case 1: no soil analysis

The area is unfamiliar and the company does not have time for a geotechnical investigation and does not want to risk the cost if it does not win the tender. To estimate the TBM work duration, XYZ Engineering must assess whether to gather information from its own experts, external tunnelling sources or TBM suppliers. The problem with data provided by different sources is that some people may say XYZ could achieve 5m per day while someone else says 40m per day.

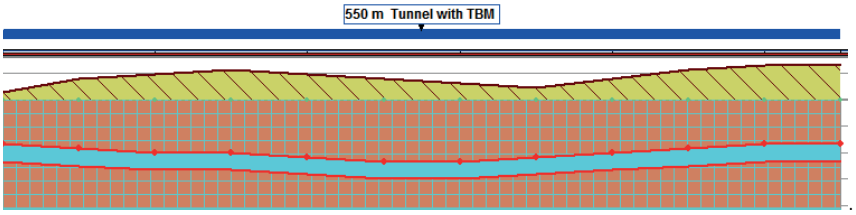
The person in charge of the tender plan needs to make a decision. If the person is optimistic, they may choose a 30m/day work rate for tunnel construction with the TBM.

Using TILOS, XYZ can enter this data and see graphically (Figure 1) when the work will take place, both in terms of time but more importantly for a linear project distance.

XYZ starts construction at the beginning of August and has the same productivity rate during the 550m of tunnel construction. This is clearly unrealistic but it can give an idea of average productivity rate. The estimated finish date is October 12.

Case 2: soil classification estimate

XYZ has access to an initial soil classification estimate, which could have come from the investor or engineers familiar with the site. This is not 100% definite but XYZ needs to rely on it. The company has the following soil category and work rate for the TBM and enters this data into TILOS (top right):



Profile of hypothetical sample tunnel project

Planned soil classification

Distance (m)	BKL	Work rate (1 shift)	Work rate (2 shift)
0	K4.2	6.35	12.7
75	K6.1	3.64	7.28
150	K6.4A	2.05	4.1
250	K6.2	3.27	6.54
350	K6.1	3.64	7.28
450	K4.2	6.35	12.7
550	K4.1	8.21	16.42

This approach is better than Case 1 as the soil classification is nearer to reality. The TBM starts in the first week of August and between 0m and 75m productivity is 14.561m/day.

After 75m, as the soil classification changes from K6.1 to K6.4, the speed of the TBM decreases to 8.2m/day. Soil classification also changes at 150m, 250m, 350m and 450m. At each stage the TBM speed also changes. The more realistic estimated finish date for the TBM is now November 17.

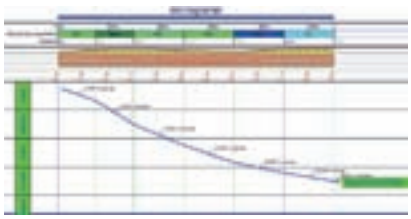


Figure 2: planning for TBM construction with more data

Case 3: detailed geotechnical investigation

Possibly after XYZ wins the tender it might invest and conduct a complete geotechnical investigation and ascertain the actual soil classification. If this is not the case, the actual soil classification will be reported by the TBM operator during the tunnelling work. For example:

Actual soil classification

Distance (m)	BKL	Work rate (1 shift)	Work rate (2 shift)
0	K4.2	6.35	12.7
50	K6.1	3.64	7.28
180	K6.4A	2.05	4.1
300	K6.2	3.27	6.54
380	K6.1	3.64	7.28
420	K4.2	6.35	12.7
550	K4.1	8.21	16.42

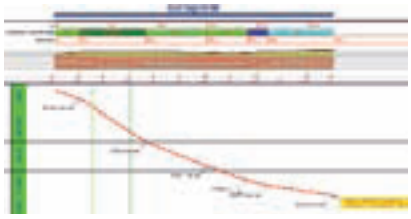


Figure 3 (above): accurate soil-classification results for the same project

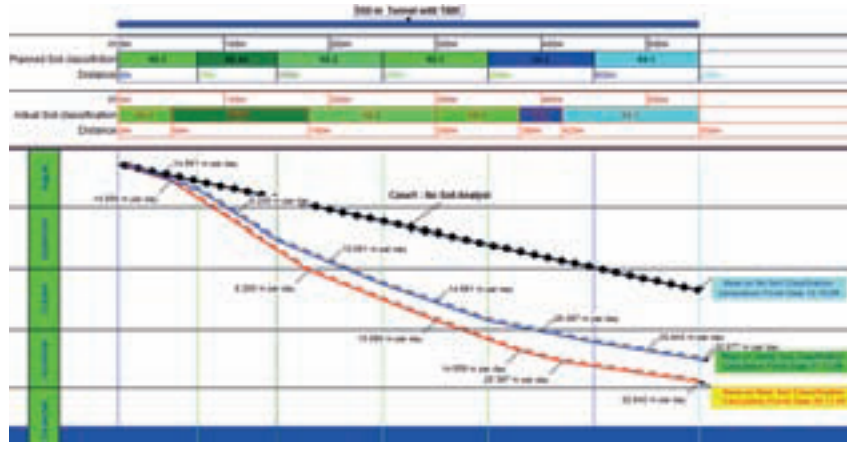


Figure 4 (right): analysis of all three cases on the same chart

The TBM speed between 0m and 50m is the same as in Case 2 because of the same soil classification. However, the soil classification changes after 50m and the speed changes as well. Speed changes at the following distances – 180, 300m, 380m and 420m – due to the differing soil classification.

The accurate finish date for the TBM works is November 26.

As the actual soil classification is different from the tender's estimated work rate and planned soil classification, it will impact the productivity of TBM work and XYZ can see the difference between the three cases on the same chart. TILOS will also give a clear analysis and comparison between the three cases.

IN CONCLUSION

This paper has demonstrated how much impact the correct estimation of TBM works can have on a project and how users can model this in TILOS.

In addition to this soil classification analysis, users can perform risk analysis of the soil classification to view project risks due to changing soil types.

TILOS can also help users understand more about segments, lining, signalling and the connection to stations during a comprehensive rail or metro project.

This article was written by Tekin Guvercin, CEO and founder of FND Future Network Development, a reseller of TILOS. For more information: www.fndsite.com; www.tilos.org