

MINUTES

Document number	tbc
Meeting date	Tuesday 16 th January 2018
Meeting location	Triton Square
Meeting title	Tunnelling presentation and discussion
HS2 contact or group	Reg. 13 , Reg. 13 Reg. 13 ,
Stakeholder	Affinity Water
Topic keywords	TBM, slurry

Attendees

- Reg. 13 – HS2 Affinity Water Reg. 13
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- Reg. 13 – Align Reg. 13
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- Reg. 13 – Align Reg. 13
- Reg. 13 – Affinity Water Reg. 13
- Reg. 13 – EA HS2 Core Team – Reg. 13
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- Reg. 13 – EA HS2 Core Team – Reg. 13

Final meeting notes (key topics)

Variable density TBM to be used (an adapted form of slurry TBM). No bentonite will be used, no additional chemicals/polymers. Summary of the current view of TBM operation provided below:

South Portal TBM – The long average advance rate for the TBMs is approx. 20m per day per TBM. That will result in the (solid) excavation of around 2,500-3,000m³/day. Inevitably there will be periods the TBM goes faster (and slower) but that is the assumed excavation rate for now.

TBM Operation – The operation of a VD machine is highly technical and I would not want to try and explain its operation in a few lines here. In summary, however, the TBM will operate with an air bubble behind the excavation chamber that will retain a pressure within the excavation chamber during excavation or stoppages. We are adding water as the medium to form a homogenous paste which is removed from the chamber via a screw conveyor into a slurrifier box where the material is mixed and then discharged to the south portal via a pipe line. On surface the material will be treated and dried for placement around the South Portal area. The addition of cement/lime may be required to stabilise the material.

The excavation chamber is always full of material that, combined with the pressurized bubble, allow balancing of the water table. The axis of the TBM cutter head is used as the average chamber pressure (note that based on the 10m dia of the cutter head there is a 1 bar differential pressure between bottom and the top). The extent of over-pressurisation of the chamber compared to hydrostatic will depend largely on the geology and the noted hydrostatic pressure and changes recorded - Over-pressurisation could be 0.2 bar or 0.5 bar, or even higher if required, and such pressures will be initially based on calculation and then based on the experience of the TBM operator and resultant effects recorded of excavation from surface/groundwater monitoring. The density of the excavated material is controlled by regulating the addition of water into the excavation chamber to control the loss in ground in case of fault areas or karsts. Any abnormal loss in ground will automatically impact a change in the air bubble level so the pilot can adjust the density or ultimately isolate the bubble chamber balancing the water table stopping any leakages in the environment. The material needs to be pumped to the South Portal so the water is also be added directly into the slurrifier box at the rear of the screw conveyor for transportation through pipeline in lower density than density set-up into the excavation chamber. The liquefied material is transported through pipe line in a loop operating at ~2.000 m³/h between the TBM and the STP (Slurry Treatment Plant) where the slurry is cleaned before returning back to the TBM. The excess slurry with fines is treated through filter presses achieving moisture content for disposal and compaction.

The design of this TBM is at a very early stage – as Align develop the TBM there will be an opportunity to discuss its operation further with Align and possibly the successful TBM manufacturer – Such useful discussions/presentation are probably 9-12 months away

The percentage of lime/cement to be added is under study at the moment and will depend on a number of factors including the quality/particle size of the excavated material, the final design requirement for placement, the operation/effectiveness of the Slurry Treatment Plant (STP) and also the weather.

The works are being performed in France by MS (Slurry Treatment Plant supplier) and Align to study the methods of treating the chalk/flints to be encountered based on GI data/samples received from HS2 – MS have experience working in Chalk on projects in London. Bouygues have worked with MS on many projects (most recently in Hong Kong) and the team are building on that information. Some results are available to help specify the STP but an initial report/results will not be available until March 2018.

Align have kindly provided a copy of a paper presented in Hong Kong on the VD operation and the use of slurry TBMs. Although the VD proposed for the Chiltern Tunnels will not be identical to that in Hong Kong (due to geology/requirements) the paper provides an idea of the VD operation.

The design of the Cross Passages are still under review – Shotcrete will certainly be used as a temporary support – the final water-proofing/permanent lining design is under development, but is likely to be an in situ lining.

Further points noted during the meeting:

- Identification of flint via ground investigation is important due to the resultant wear on the TBM; the location of significant faults too.
- The grout used behind the segmental concrete lining is likely to be a cement/bentonite mixture with silica, which rapidly turns to a gel and sets in approximately 20-30 minutes.
- Cross passages will be progressed by mechanical excavation, then the ground treatment for the cross passage will be carried out immediately after the first TBM and before the second TBM arrives at this location. Note the comment above about cross passage design still under review.
- All necessary datasheets for materials used will be shared at the earliest opportunity with HS2, the EA and Affinity Water.
- Does the addition of quicklime for the drying process, albeit in low quantities, adversely affect the pH of the filter cake and its subsequent use in landscaping?
- The issue was raised of whether there is a risk of the release of fines to the Chalk aquifer if filter cake is placed over aquifer outcrop and is then subject to rewetting and disaggregation.
- It would be very useful to have a description of the chemical and physical characteristics of the filter cake so that other re-use opportunities could be explored. Work to underpin this is ongoing in France (see above).
- Dewatering for vent shaft construction – still to be confirmed if this will be necessary. Pumping tests are still planned at vent shaft locations in 2018 to more confidently establish local hydraulic parameters.
- During a pumping test, or as a result of any subsequent dewatering, any discharge of water back to ground needs to meet the requirements of Reg 31 of the Water Supply (Water Quality) Regulations 2016. AW would expect that any materials or chemicals used (for pumps, seals, pipes, valves etc for the abstraction and reinjection would be expected to meet the requirements of Reg 31, in order to protect the aquifer. These are the regulations that water companies have to comply with for their materials.
- Affinity Water will share production borehole depths/construction with Align, for comparison with tunnel elevation and GI results.
- South Portal piling – currently under design review and is dependent on a number of design factors currently being worked through by Align in Stage 1.
- It is worth noting that the current drought situation is worsening and there is a need to consider the PR / political aspect of undertaking vent shaft pumping tests if water restrictions are in place later this year.