**Kishanganga Hydroelectric project**

The Double Shield Universal TBM, manufactured by SELI, is boring the HeadRace Tunnel (HRT) 14,630 m long, 2500 m a.s.l on Himalayan Mountains, in the frame of the Kishanganga HE Project 330MW in Jammu & Kashmir (India). The tunnel has a OD6,18 m and a ID5,20 m. The excavation is full secton from one only attack.

**Geology**

The following geological chart summarizes the geological information enclosed in the design documents delivered to SELI, highlighting the likely rock class distribution that might have been encountered by the TBM, and those conditions which might be critical in terms of TBM progress. Nevertheless, only visual surface investigation has been performed, which is very poor in order to reveal main fault zones, hydrogeology and thermal conditions. Anyway, shear and squeezing zones, significant water pressure and flow and geothermal anomalous conditions may be encountered in some areas, according to the studies performed.

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| **Generalised Rock Type** | **Parameter** | **RMR 89(1)** | **GSI** |
| Razdhan Formation | Meta-sandstones, with interbedded siltstone | 56 to 78 | 40 to 60 |
|   | Thinly bedded meta-siltstones | 50 to 60 | 35 to 45 |
|   | Folded siltstone with phyllite and associated shearing | 10 to 50 | 10 to 30 |
| Hasthoji Formation | Very thinly to thinly bedded shales with interbeds of meta-siltstone | 20 to 50 | 15 to 30 |
| Hafkhalan Formation | Thinly bedded meta-siltstone | 40 to 57 | 30 to 45 |

**Mucking, Waterproofing and Lining**

For mucking transport used conveyor belts and muck cars until the external tippler system. Final shifting to dumping yard by trucks. Four cameras and recorder installed in TBM to control de-mucking system and train shifting. The main contractor HCC (Hindustan Construction Company, provided TATA dumpers vehicles.

No support foreseen, Tunnel lining is with concrete pre-cast segments in honeycomb pattern, 30 cm thick

Pea-gravel injection to fill the annular gap between rock and concrete segments. Two grouting injection steps: contact grouting and consolidation grouting.

Joints sealing between segments by special mortar to avoid water leakage and allow grouting injection performed through LORINN 2C cement plants composed by mixers, agitators and pumps (installed in TBM and external yard).

**Equipment**

During the works a Communication System Voice is installed on back-up in 6 positions in addition two telephone lines available along TBM, to allow internal and external connectivity; traffic lights are installed along TBM and at rail switches along tunnel.

Other equipment: **permanent and emergency lighting** (Emergency light Heavy duty waterproof fluorescent light 15 lux, 2 hours; Walkways light equipped with 30 lux; Works area equipped with 300 lux); **ventilation system** (1600 mm Ø tunnel ventilation duct, 150 m of duct on cartridge, De-duster booster fan Model GAL7 – Max flow 8 m³/m – Total pressure 5000 Pa, clean air line booster fan Model ESN8 – Max flow 15 m³/m – Total pressure 2400 Pa); **safety systems** *(*Gas detection system sensors for CH4, CO, CO2, O2, H2S, HCN; Emergency diesel generator power 150 kVA; Rescue chamber present in TBM ); **fire suppression system** composed by 22 fire extinguishers; d**e-watering system**, composed by 2 submersible pumps max flow 5000 l/min, Mill.ar WellPoint WAMCE 150.

**Advancement**

The tunnel excavation, started 14th of April 2011 is full section, reached the advancement of almost 7,000 m. Best records ever in India with Double Shield TBM: 816 m and 626 m achieved in November and June 2012. Best daily progress: 40 m. The breakthrough is previewed in September 2014. Completion expected by 2015. Visit <http://www.nhpcindia.com/index.htm>, [www.hccindia.com](http://www.hccindia.com) and [www.selitunnel.com](http://www.selitunnel.com). 49/12.