DETAILS OF INTERESTING CLAIM

No: DOIC 50

Type of Insurance:

CAR-ALOP

Description of damaged item:

The sewage tunnel damage

Cause of Loss:

(3) Faulty design

Claim Cost:

The overall delay was 26 months, no amount was stated

Description of Incident and Loss Prevention Measures initiated:

Description of project:
The sewage tunnel (10.6 km, 3.6-m-diameter) was bored using an EPB TBM. The tunnel was driven at depths of 15–25 m through water-bearing glacial and alluvial soils under the bank of the river. The project included ten shafts spaced at up to 1.8 km of 7.5–12.5 m diameter and depths of up to 30 m. The tunnel lining comprised a six-segment, tapered trapezoidal, 250 mm thick conventionally reinforced ring with EPDM gaskets.

Ground conditions surrounding the tunnel comprise alluvial and glacial deposits. The alluvial deposits consist of clay, silt, sand, gravel and peat, which lie on the glacial deposits comprising clay, fine to medium sand and gravel. The upper chalk is at depths beneath the tunnel.

Two aquifers are present along the route. The upper, hydrostatic, aquifer is approximately 2 m below ground level. The second is tidal, situated beneath the laminated clays, in the lower glacial deposit and chalk.

Lo**ss** occurrence:
The incident occurred after considerable tunnelling was complete, in a section next to a shaft. The section seat of the incident had been completed for eight days. At 00.30 hrs, signs of water inflow at a segment joint were reported at a point some 200 m behind the face of the TBM. The water was carrying fine sand into the tunnel. Despite efforts to stem the flow of material, water and sand inflow levels rapidly increased and the tunnel became destabilised. At 03.00 hrs the same day, the tunnel was evacuated and subsequently collapsed. The collapse was focused some 6 m to the east of a maintenance shaft. Immediately following the collapse the nearby road was closed and properties evacuated; both as precautionary measures. At the location of the collapse, the ground surface sank by some 2.5 m within a depression some 60 m in diameter. In total, approximately 100 m of tunnel was affected by the collapse.

Outline the interesting or unusual aspects of this claim or problems experienced during settlement:

Cause of the loss:
No immediate cause for the collapse was apparent. The investigation methodology included intensive ground investigation of the collapse location. A three-dimensional model was developed of the soils to assess the possible modes of failure. The leaks are most likely to have been caused by movement of the tunnel relative to shaft, which led to opening up of the circle joints and shearing between adjacent rings, causing local structural failure around the gasket. The movement was most likely attributable to compression of the peat above the crown, caused by the upward buoyant pressure of the tunnel combined with loosening of the ground by shaft sinking/tunnelling and dewatering of the peat layer by a leak into tunnel or shaft.

Planning the repair:
Several options, including tunnel diversion, cofferdam construction, jet grouting and artificial freeze were reviewed for the reconstruction of the tunnel. With the exception of tunnel diversion, all options considered involved stabilising the ground and reconstructing the collapsed section of tunnel along its original alignment. Supporting the ground by artificial ground freeze and supporting the tunnel with a sprayed concrete lining was adopted, as this was deemed to provide the optimum solution when considering the local ground conditions, safety, programme, build ability and cost.

Repair works:
The reconstruction of the collapsed section was conducted in five stages. The length of the construction stages was governed by drilling constraints and ranged from approximately 20–25 m in length. The tunnel axis was at a depth of approximately 15 m below ground level. Each construction stage was supported and closed to the surrounding ground and ground water horizontally with a circular ice wall and vertically with a frozen bulkhead. A road header, with the capability of using either a rotary cutter or a pneumatic breaker was used for excavation. Hand mining was used to trim the profile. The shotcrete was batched using heated aggregates and hot water. In addition a geocomposite insulating layer was attached to the side of the tunnel prior to spraying the shotcrete. The overall delay in completion resulting from the time necessary for soils investigations, redesigning and repairing the collapsed section was 26 months.

Information was taken from IMIA WGP 48, Page 41
http://www.imia.com/downloads/imia_papers/wgp48_2006.pdf