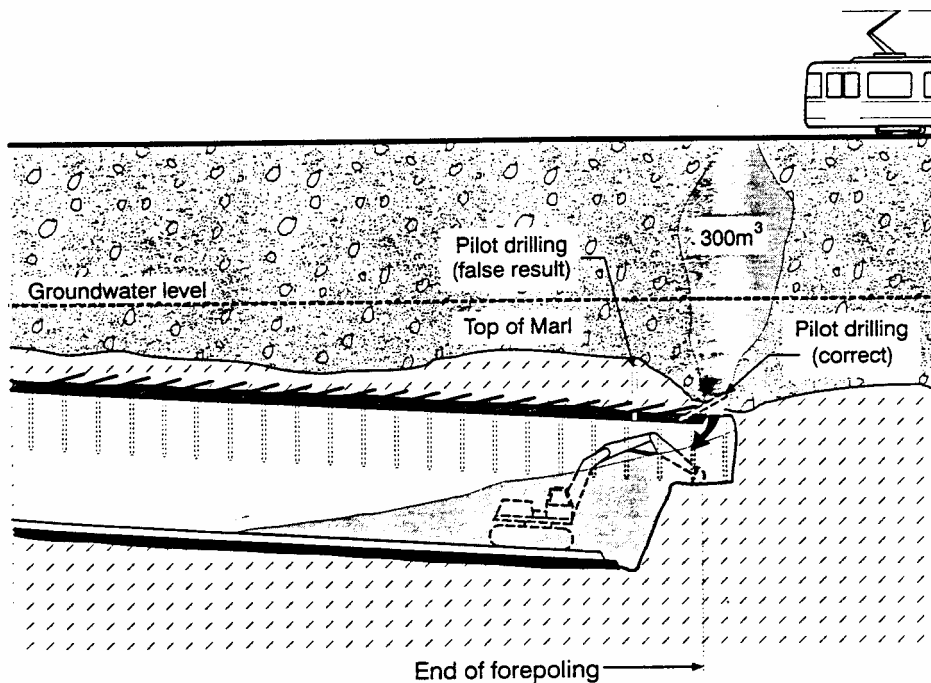
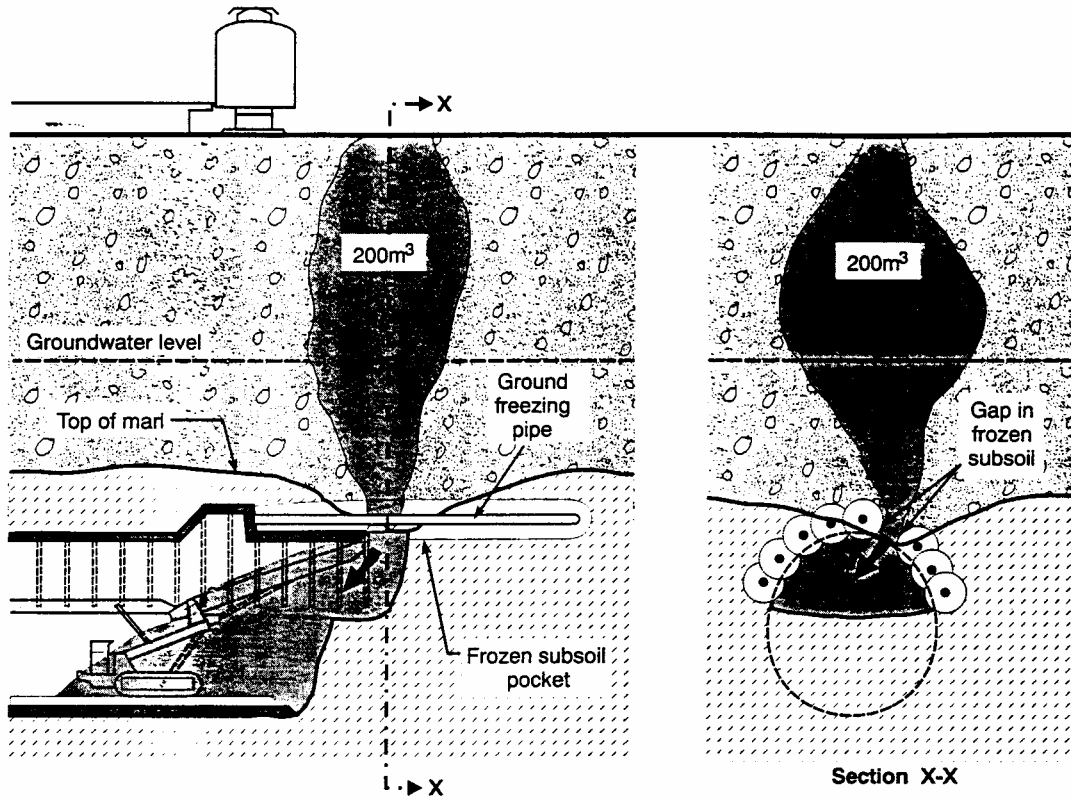


Incident at Munich, Germany
(after Weber, 1987)

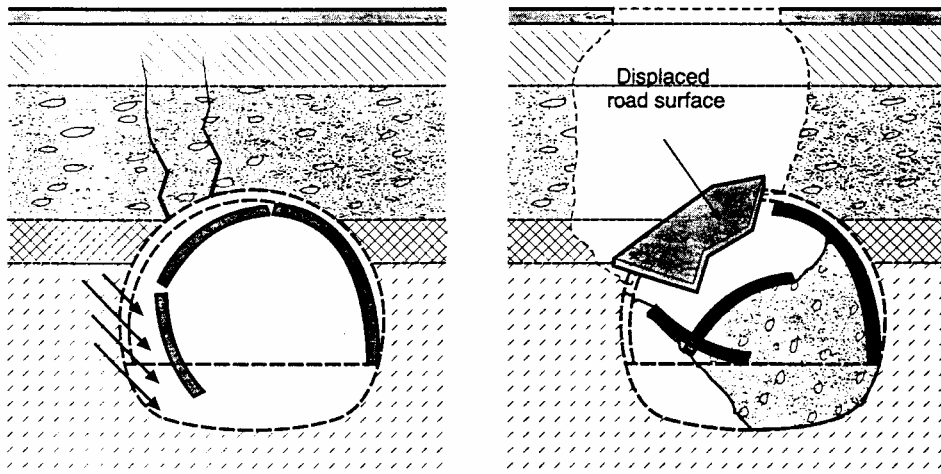


Incident at Munich, Germany.
(after Weber, 1987)

Σχήμα 8: Τύποι αστοχίας σηράγγων

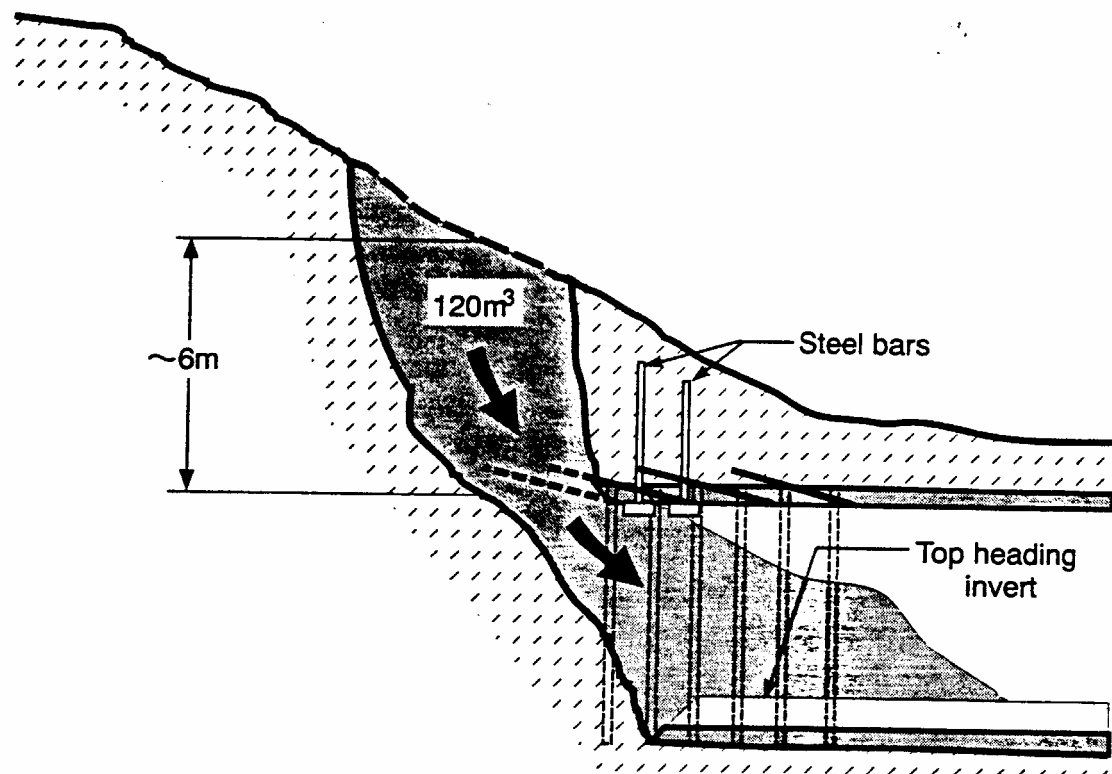


Incident at Munich, Germany.
(after Weber, 1987)



**Collapse due to excavation being too far in advance
of the ring closure Subway tunnel in Germany** *(after Muller, 1978)*

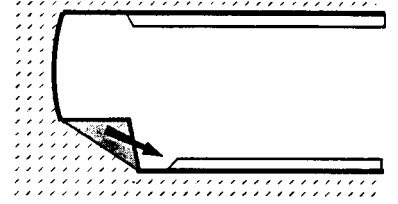
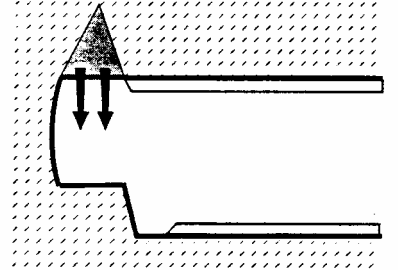
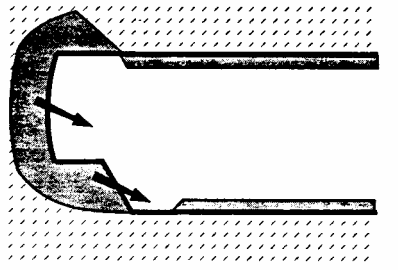
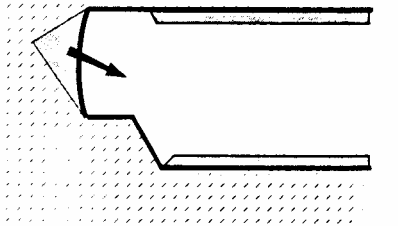
Σχήμα 9: Τύποι αστοχίας σηράγγων



Collapse of tunnel portal (Germany, location unknown)
(after Leichnetz, 1990)

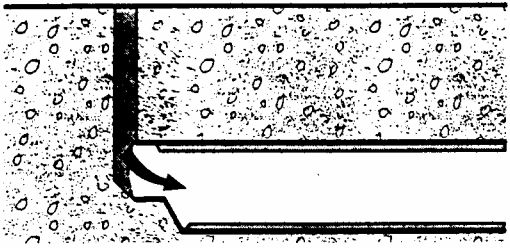
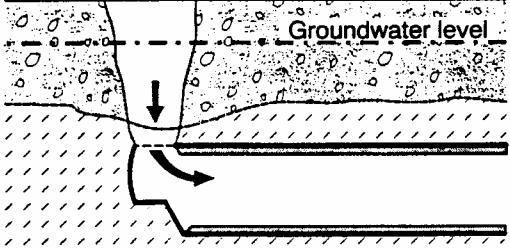
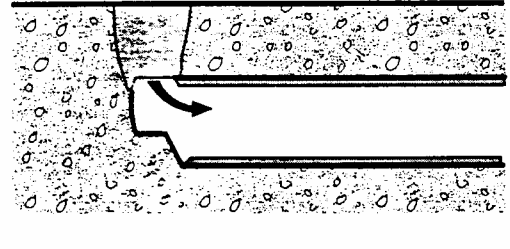
Σχήμα 10: Τύποι αστοχίας σηράγγων

..... Failure mechanisms: Ground collapse in heading

Number	Type of failure	Illustration of failure
(i)	<p>Heading in ground too weak for method May be due to discrete zones of weakness (discontinuities) including "greasy backs"</p> <p>Bench failures may be transverse or longitudinal</p>	<p>(a) Bench failures</p> 
		<p>(b) Crown failures</p> 
		<p>(c) Full face failures</p> 
		<p>(d) Local face failures</p> 

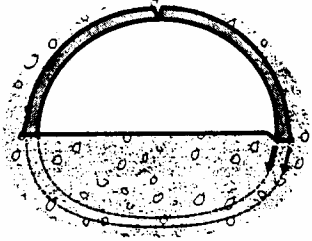
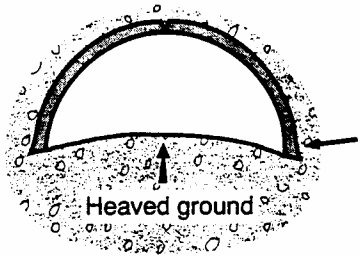
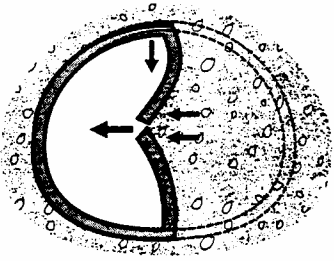
Σχήμα 11: Τύποι αστοχίας σηράγγων

Failure mechanisms: Ground collapse in heading

Number	Type of failure	Illustration of failure
(ii)	<p>Weakness in crown Due to vertical fissures, pipes and man made features (wells, etc.)</p>	
(iii)	<p>Insufficient cover to overlying permeable water bearing strata</p>	
(iv)	<p>Insufficient cover to surface</p>	

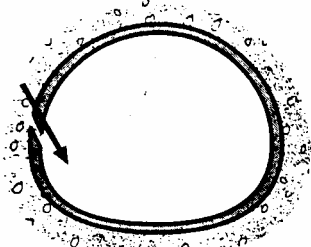
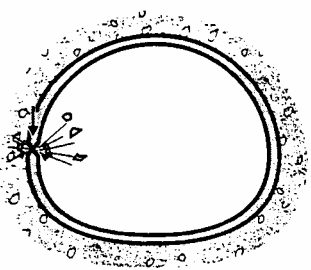
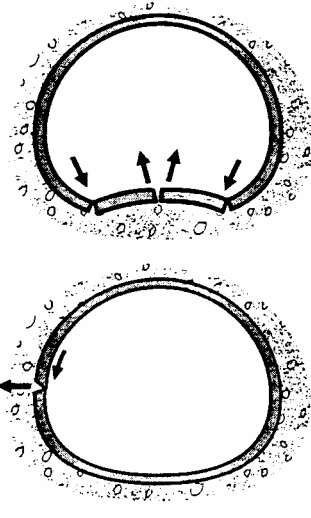
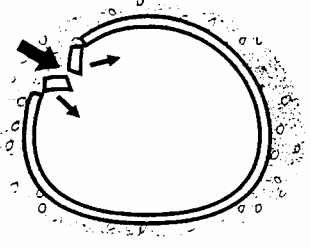
Σχήμα 12: Τύποι αστοχίας σηράγγων

Failure mechanisms: Failure of lining before ring closure

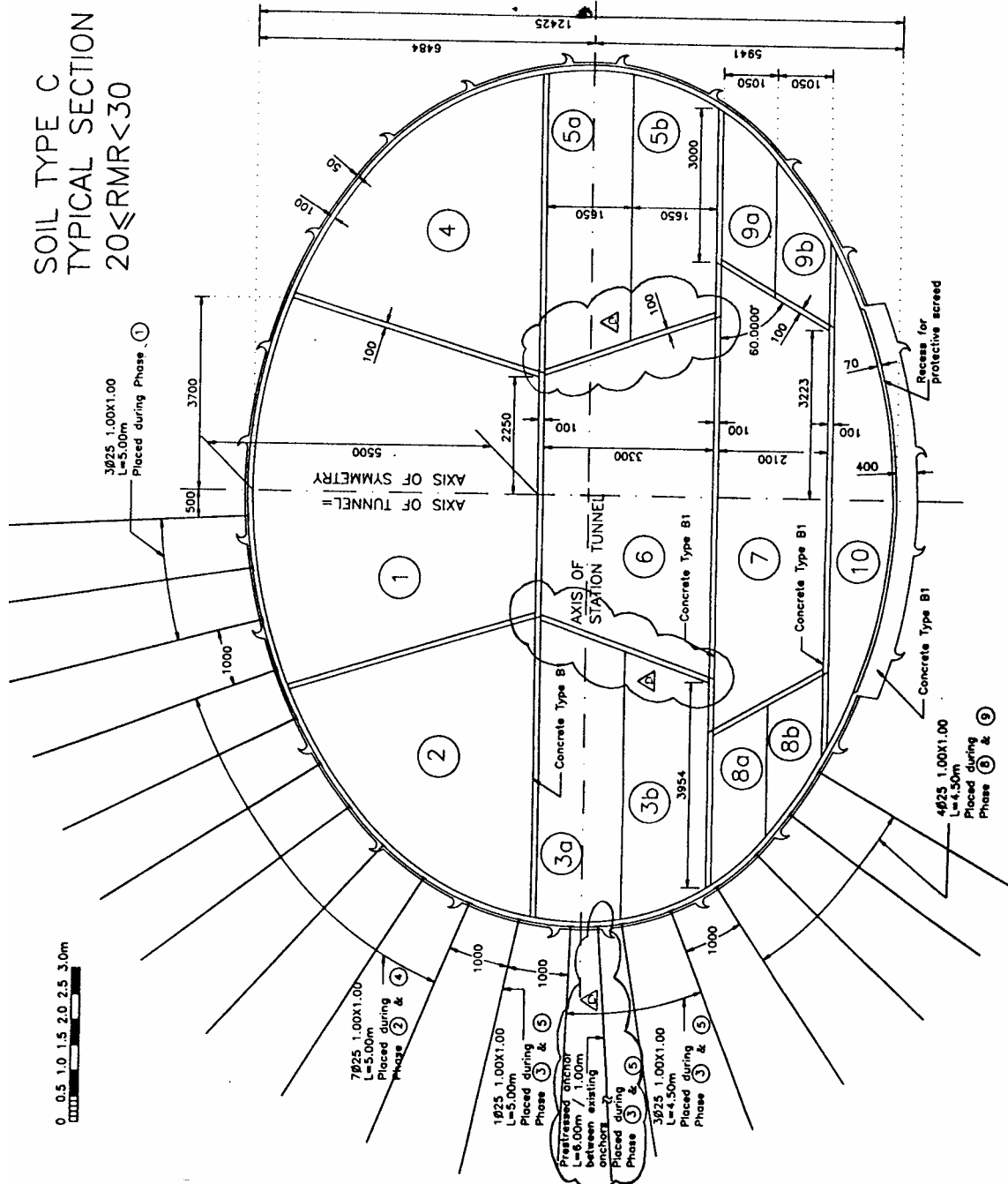
Number	Type of failure	Illustration of failure
(i)	Bearing failure of arch footings (Typically enlarged footings "Elephant's feet")	 <p>The diagram shows a cross-section of a tunnel with an inverted arch. The two footings at the base of the arch are significantly wider than the rest of the lining, resembling elephant feet. The ground around the footings is stippled, indicating soil. The arch is shown in a state of failure, with the footings sinking into the ground.</p>
(ii)	Failure due to horizontal movement of arch footing	 <p>The diagram shows a cross-section of a tunnel with an inverted arch. The ground around the arch is stippled. An upward arrow labeled "Heaved ground" points to the soil directly under the arch. A horizontal arrow on the right side of the arch indicates lateral movement. The arch is shown in a state of failure, with the ground heaving and moving horizontally.</p>
(iii)	Failure of side gallery wall	 <p>The diagram shows a cross-section of a tunnel with a side gallery. The side gallery wall is shown in a state of failure, with arrows indicating inward and outward movement. The ground around the tunnel is stippled.</p>

Σχήμα 13: Τύποι αστοχίας σηράγγων

Failure mechanisms: Failure of lining before or after ring closure

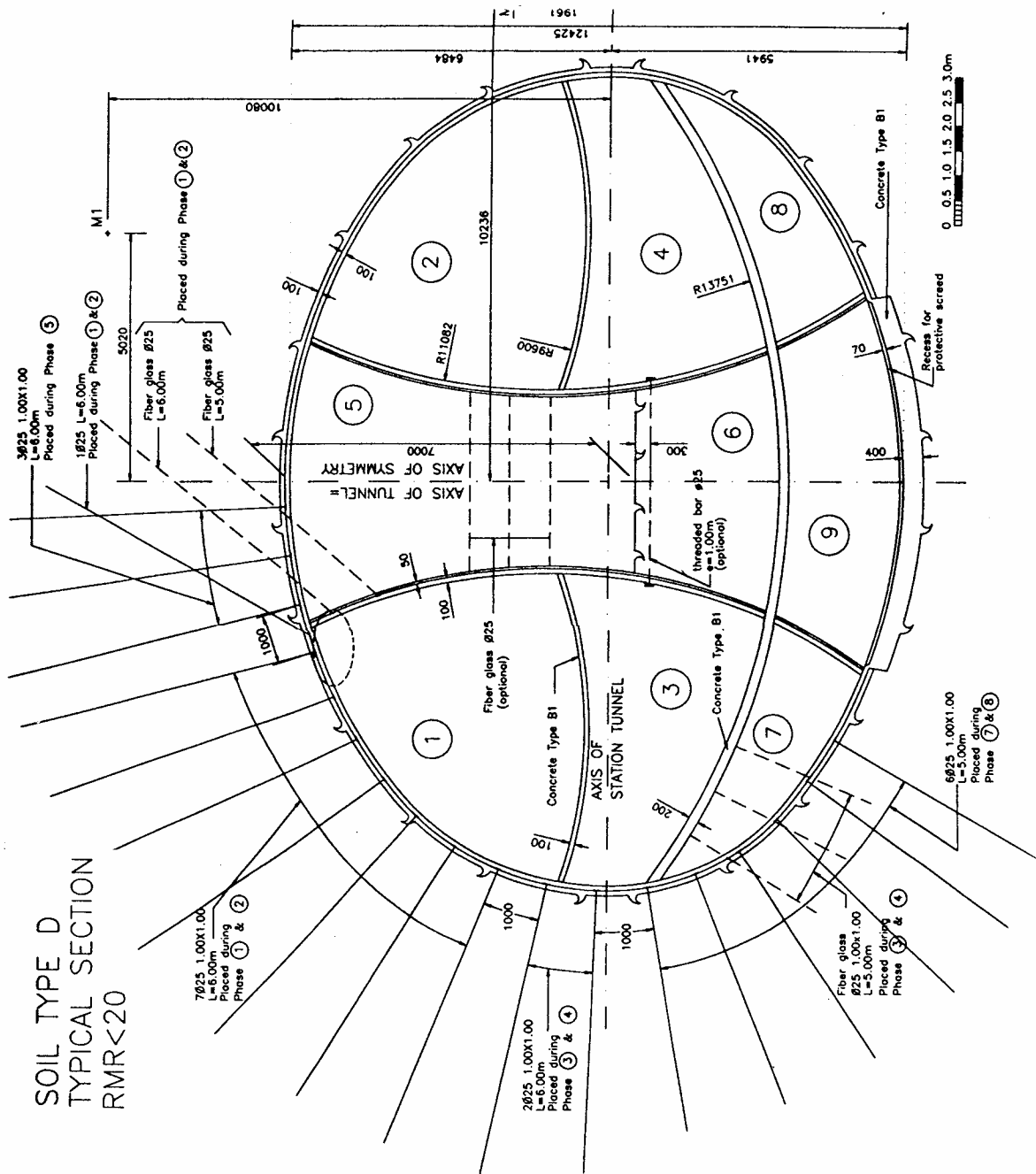
Number	Type of failure	Illustration of failure (after ring closure)
(i)	Shear failure	
(ii)	Compression failure	
(iii)	Combined bending and thrust	
(iv)	Punching failure	

Σχήμα 14: Τύποι αστοχίας σηράγγων

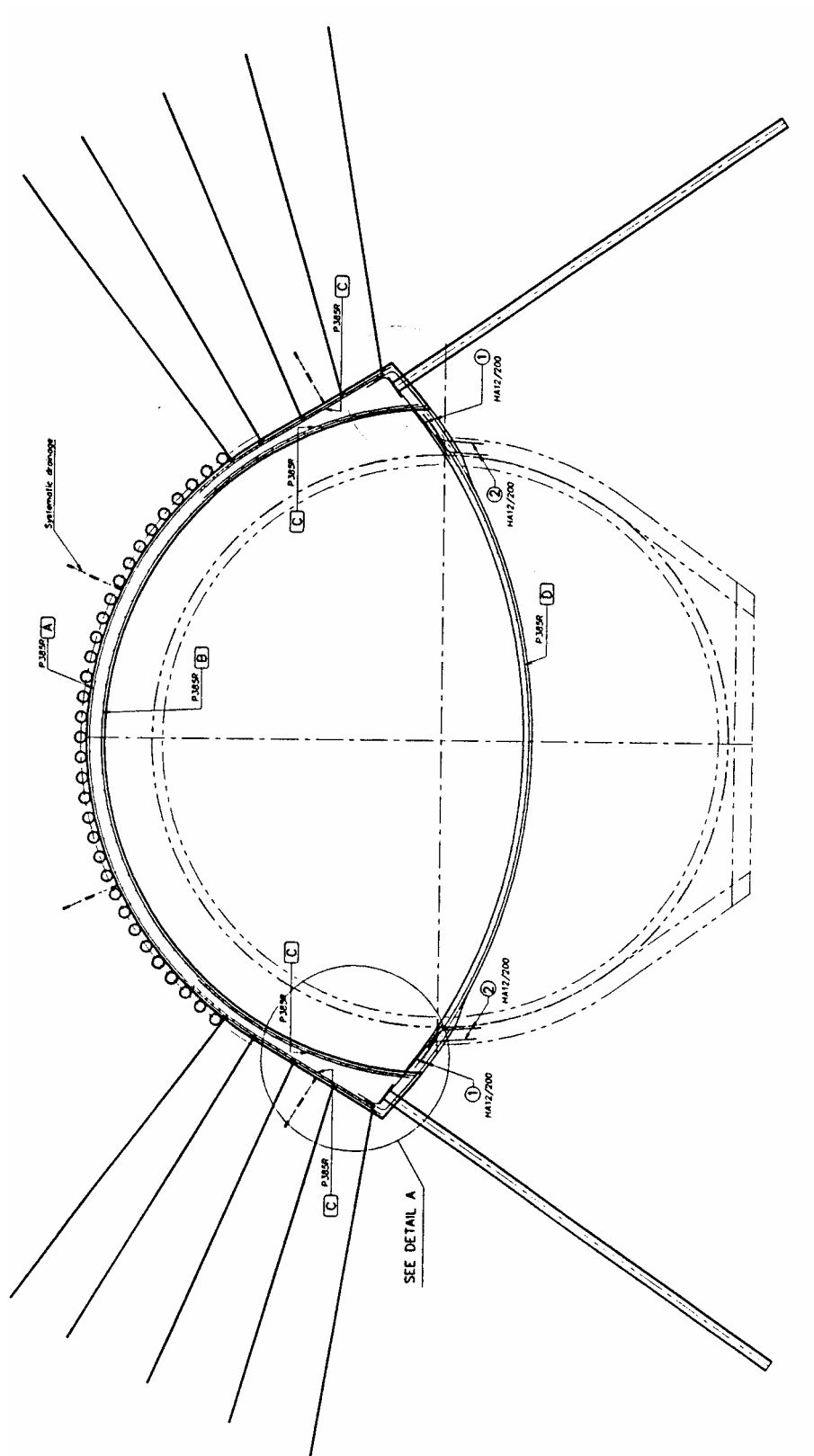


Σχήμα 15: Τυπική υποστήριξη σήραγγας με αγκύρια και εκτοξευόμενο σκυρόδεμα

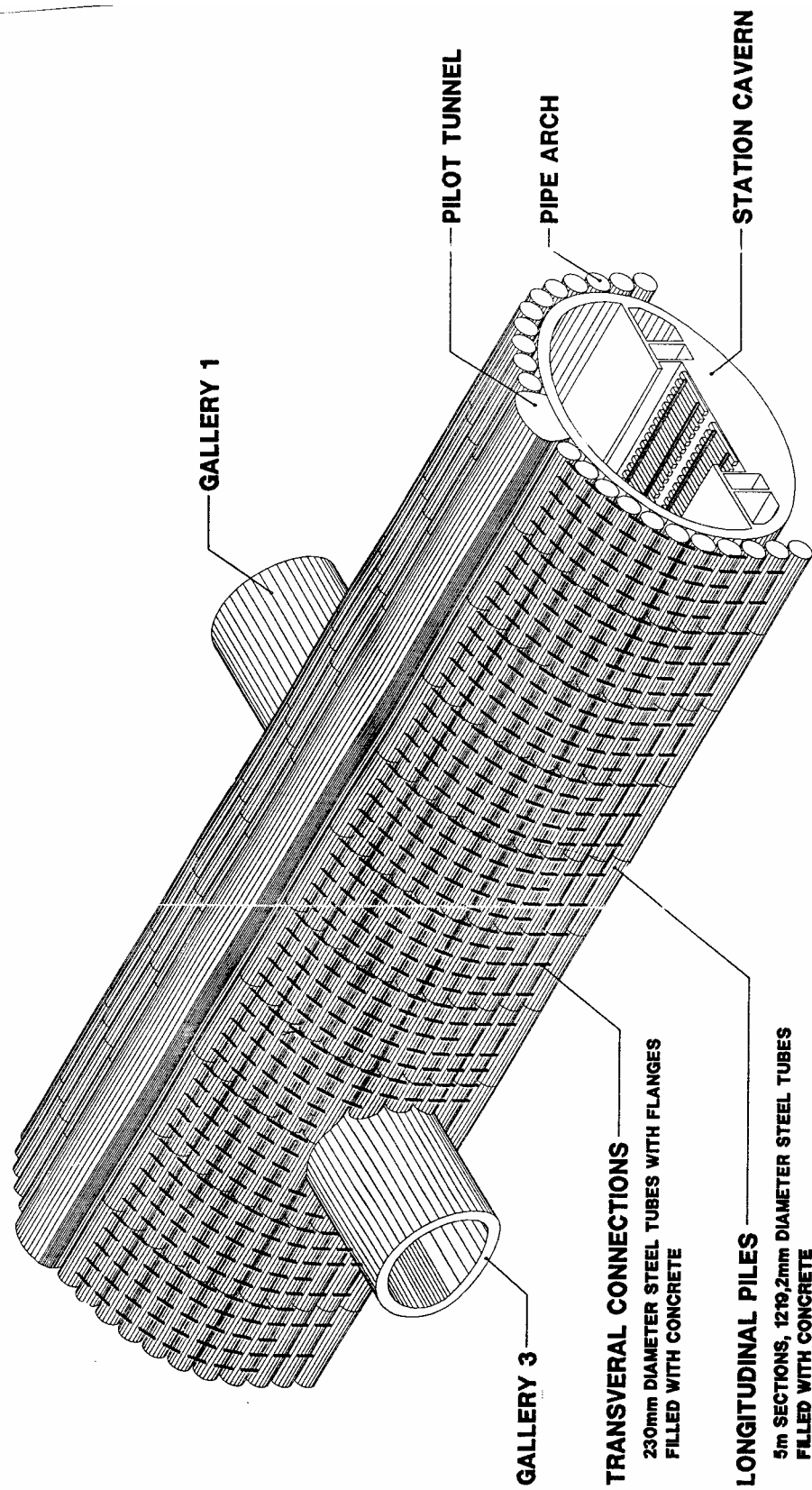
SOIL TYPE D
TYPICAL SECTION
RMR<20



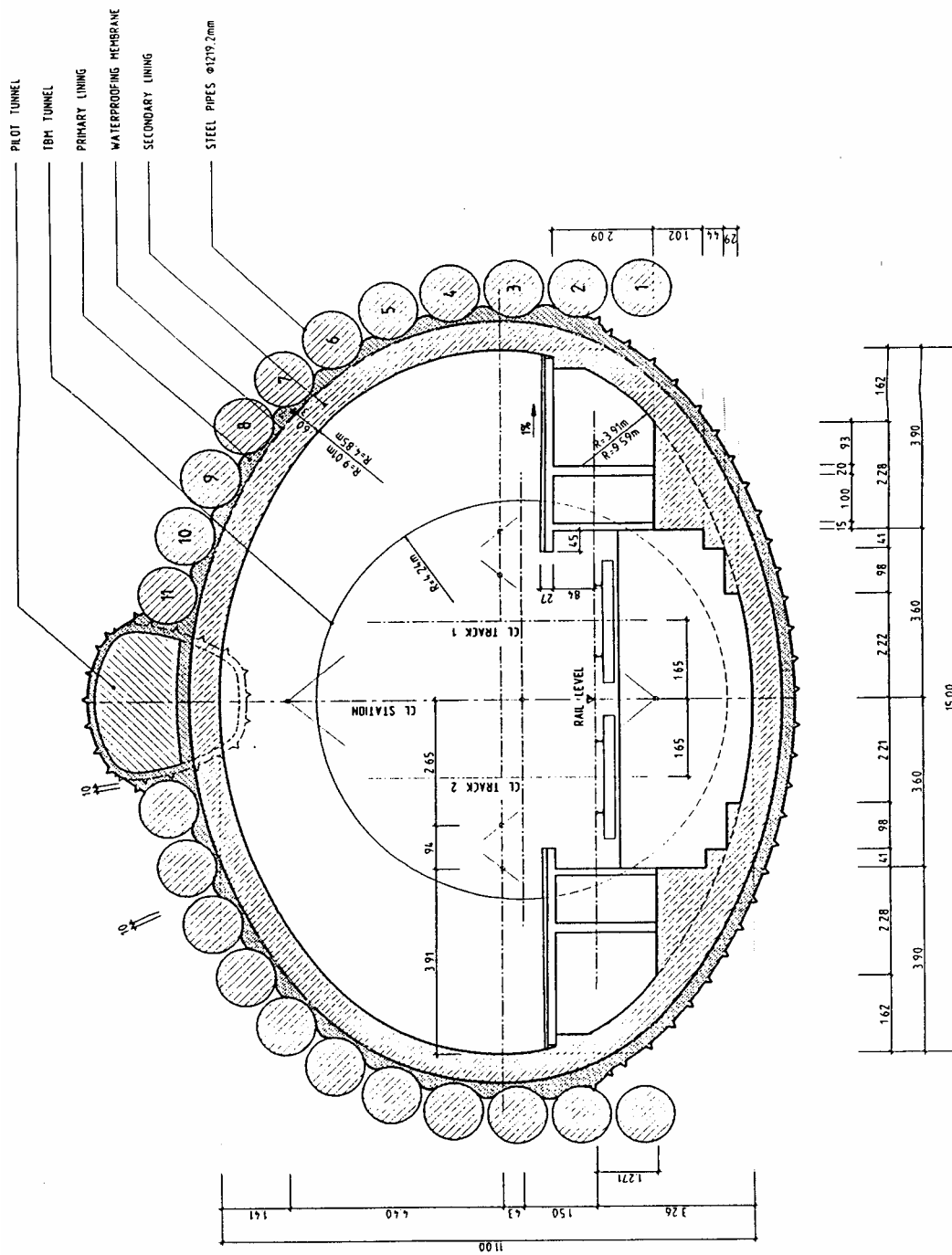
Σχήμα 16: Τυπική υποστήριξη σήραγγας με αγκύρια και εκτοξευόμενο σκυρόδεμα



Σχήμα 17: Υποστήριξη διατομής σήραγγας με δοκούς προτορείας και μικροπασσάλους στις βάσεις του τόξου



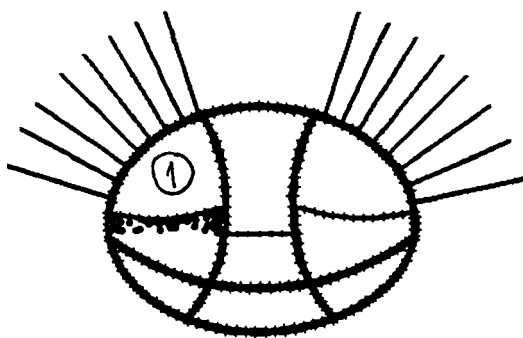
Σχήμα 18: Εκσκαφή σταθμού στο Μοναστηράκι με προστασία διαμήκων σωλήνων πληρωμένων με σκυρόδεμα



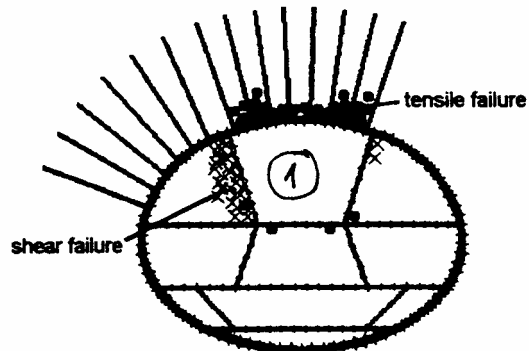
Σχήμα 19: Τυπική διατομή εκσκαφής σταθμού στο Μοναστηράκι με προστασία διαμήκων σωλήνων πληρωμένων με σκυρόδεμα

COMPARISON OF METHODS:

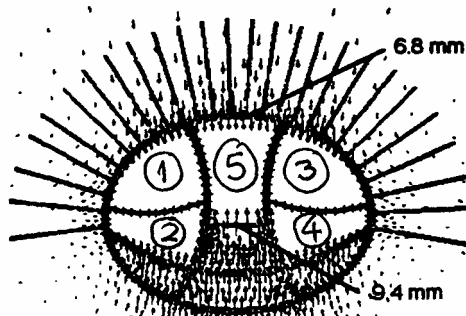
1. TWO-SIDE-WALLS + CENTRAL PILLAR,
2. MULTI-PHASE HEADING-BENCH-INVERT



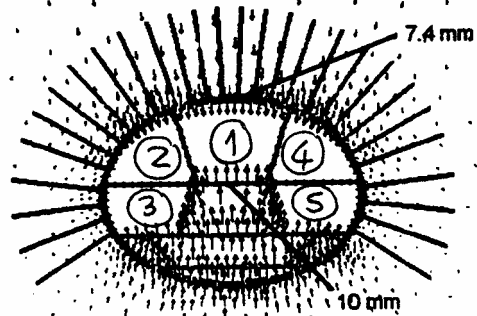
Stage 1 excavation: yield zones



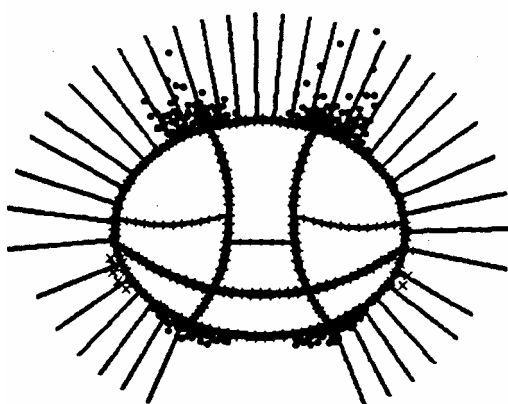
Stage 1 excavation: yield zones



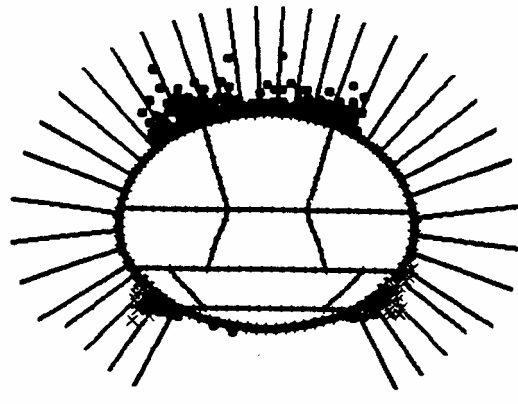
Stage 5 excavation: displacements



Stage 5 excavation: displacements



Completed excavation: yield points



Completed excavation: yield points

Σχήμα 20: Σύγκριση διάνοιξης σταθμού του Μετρό Αθηνών με την μέθοδο των διπλών πλευρικών στοών και την μέθοδο μετώπου-βαθμίδος