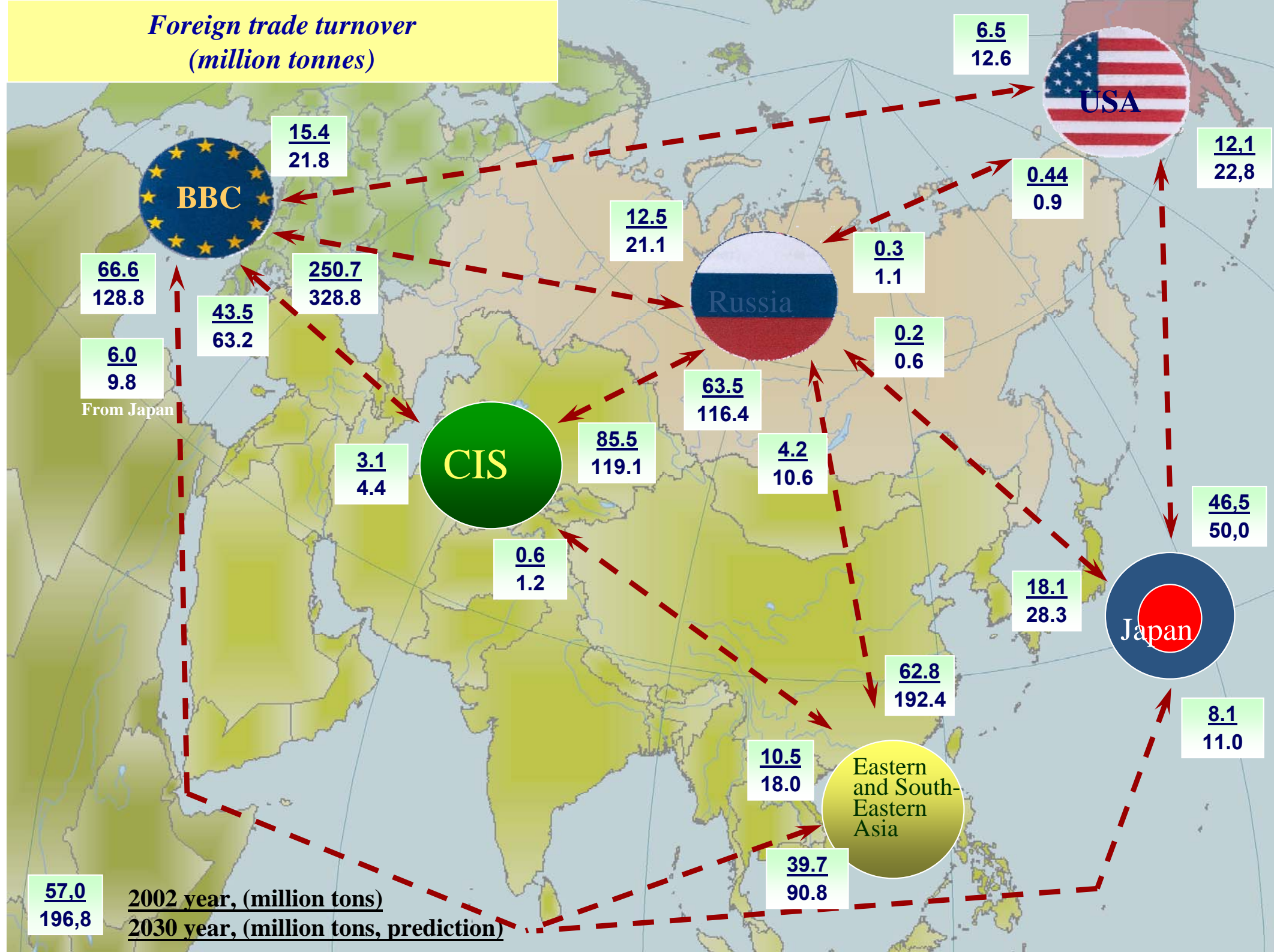


Russian underwater tunnels in the system of international transportation ways

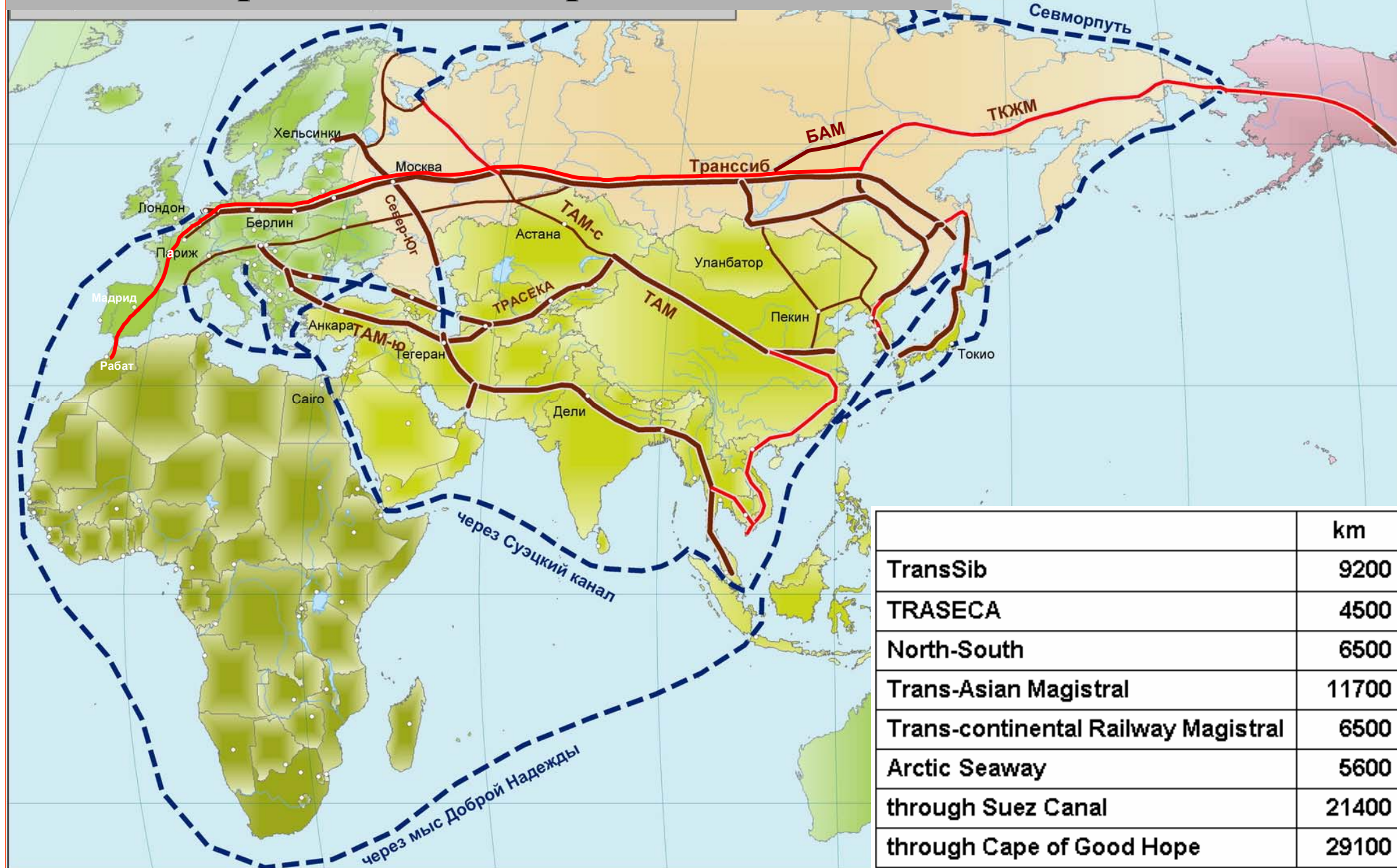
**V. Brezhnev, V. Abramson, A. Zemelman, S. Vlasov,
N. Koulaguin, V. Merkin, V. Razbeguin**

(Russian Tunnelling Association, Moscow, Russia)

*Foreign trade turnover
(million tonnes)*

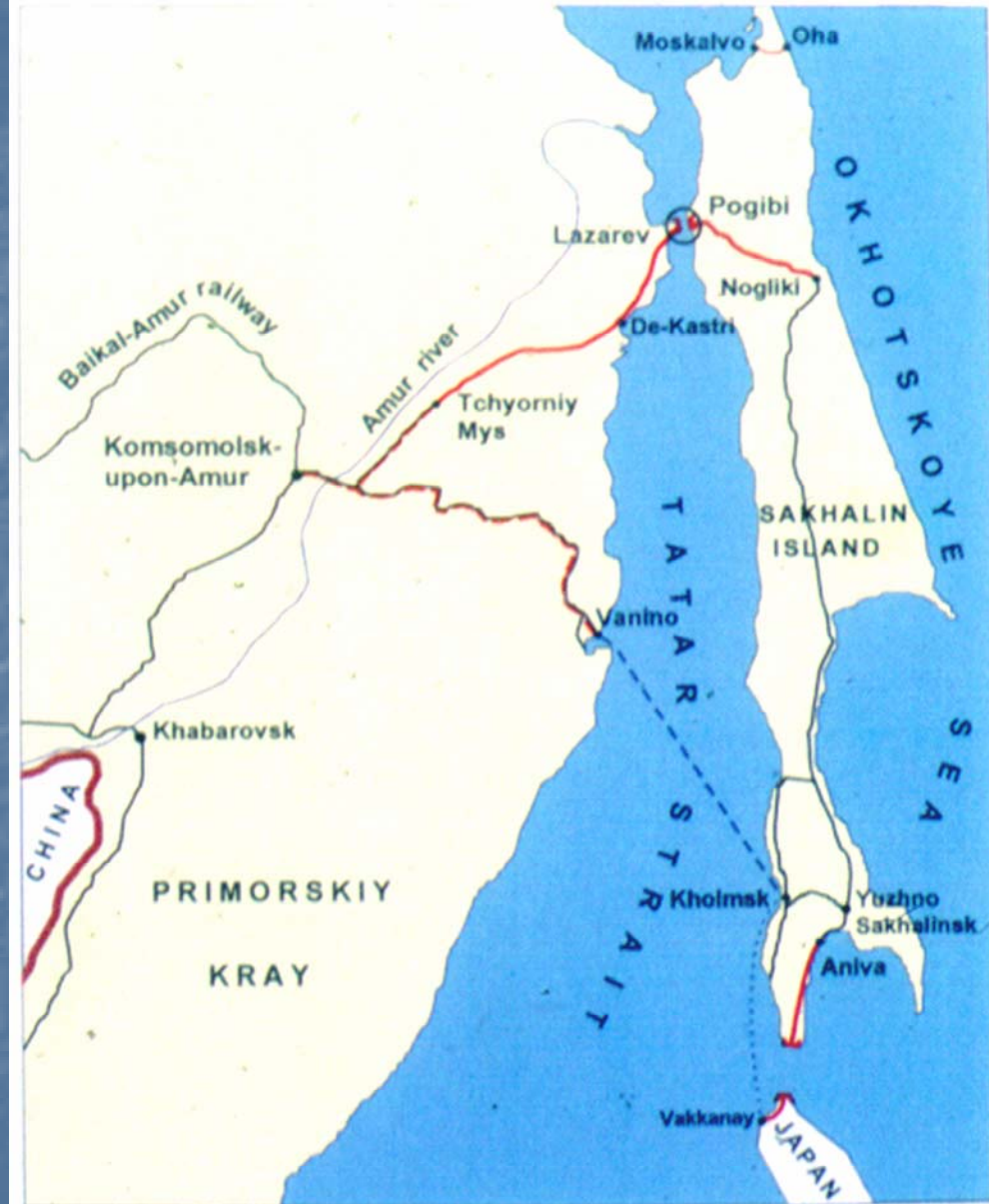


Main transport routes Europe–Asia–America

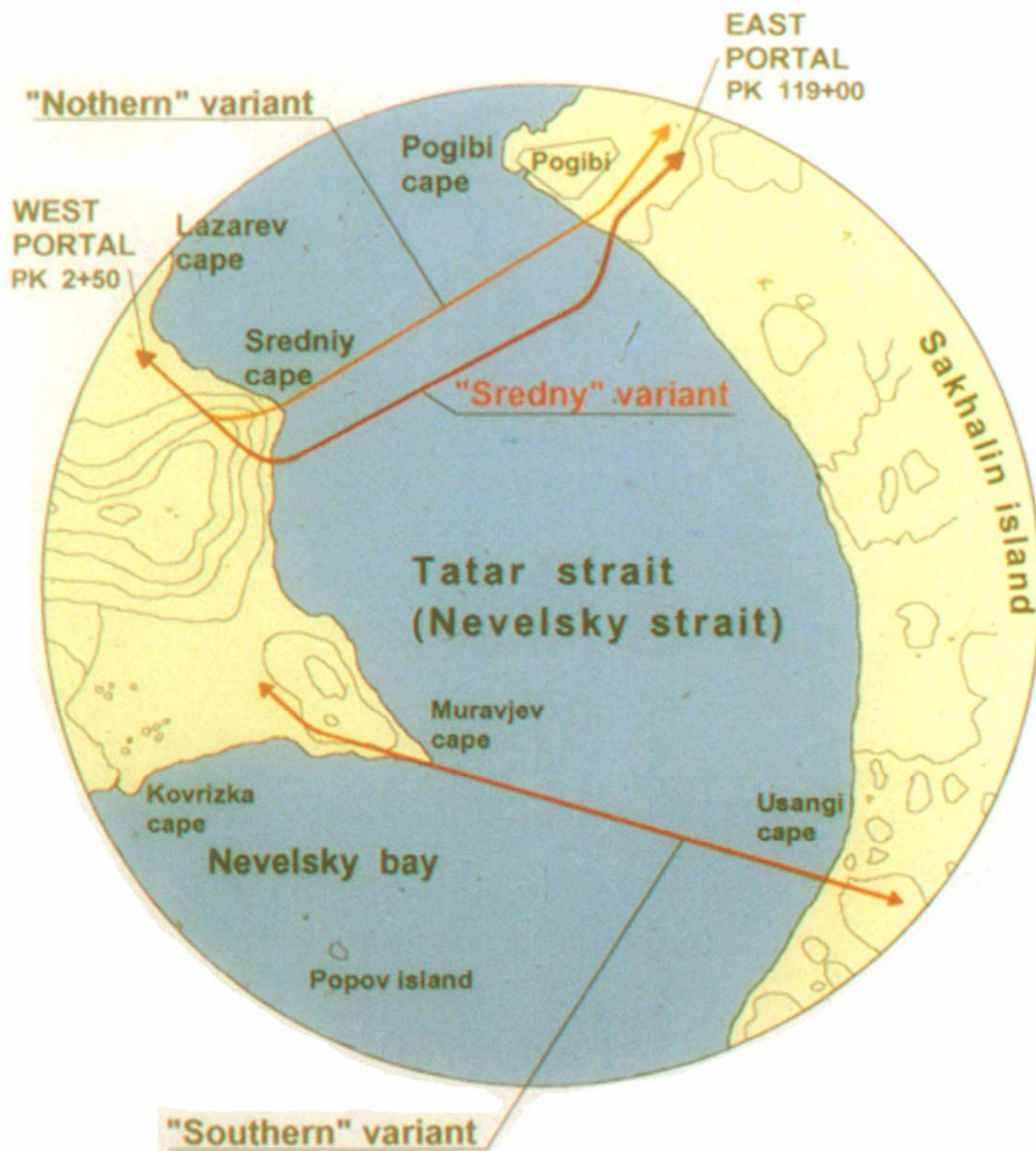


Variants of Single-track Railway Tunnel Route under Tatar Strait (Plan)

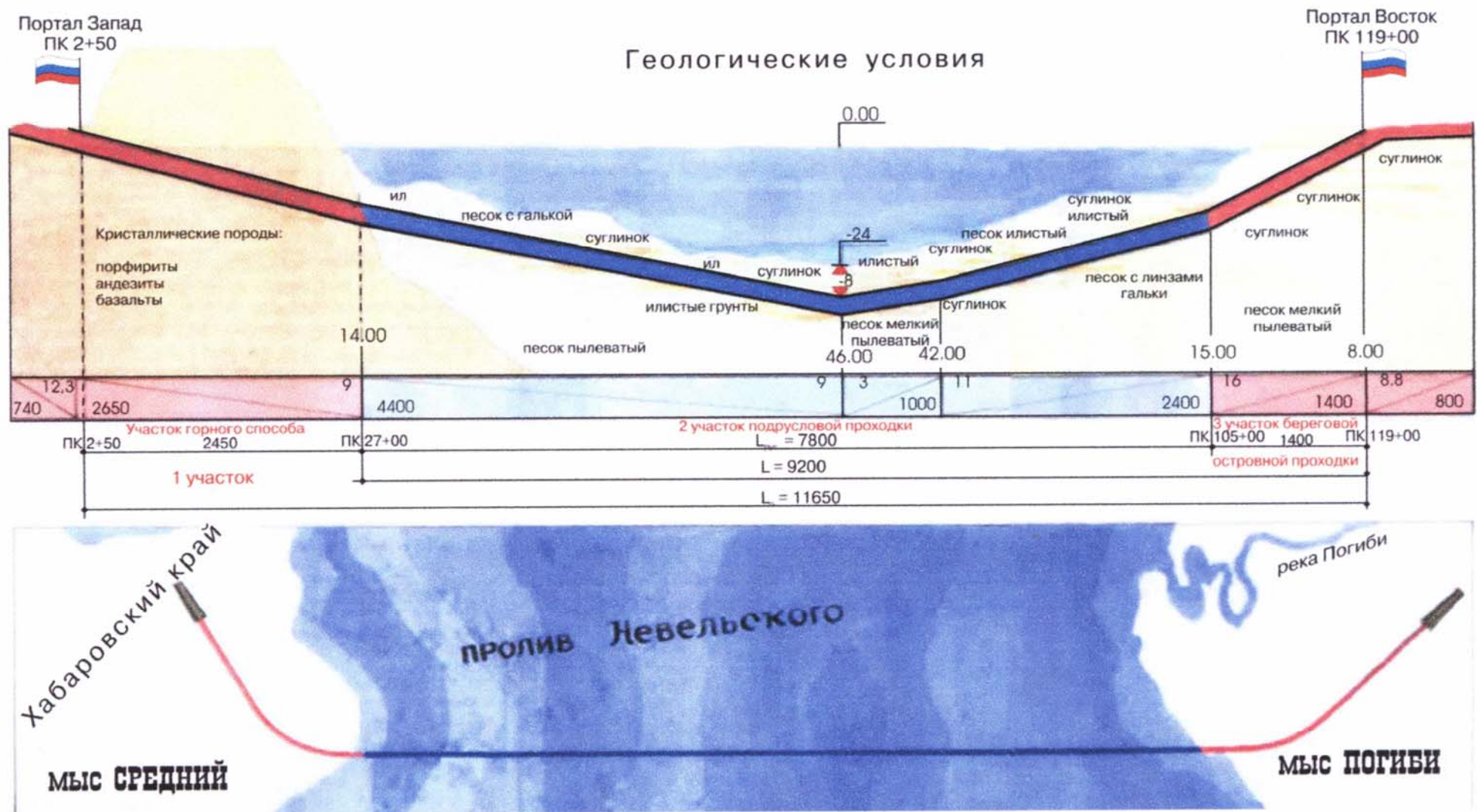
Variante des eingleisigen Eisenbahntunnels
unter der Tatarwasserstrasse



Railway lines:	— working;	Ferrying:	--- working;
	--- being reconstructed;	 being projected
	— being projected		
Eisenbahnlinien:	— wirkende	Fahrenueberfaerten:	--- wirkende
	--- umbauende	 planende
	— planende		



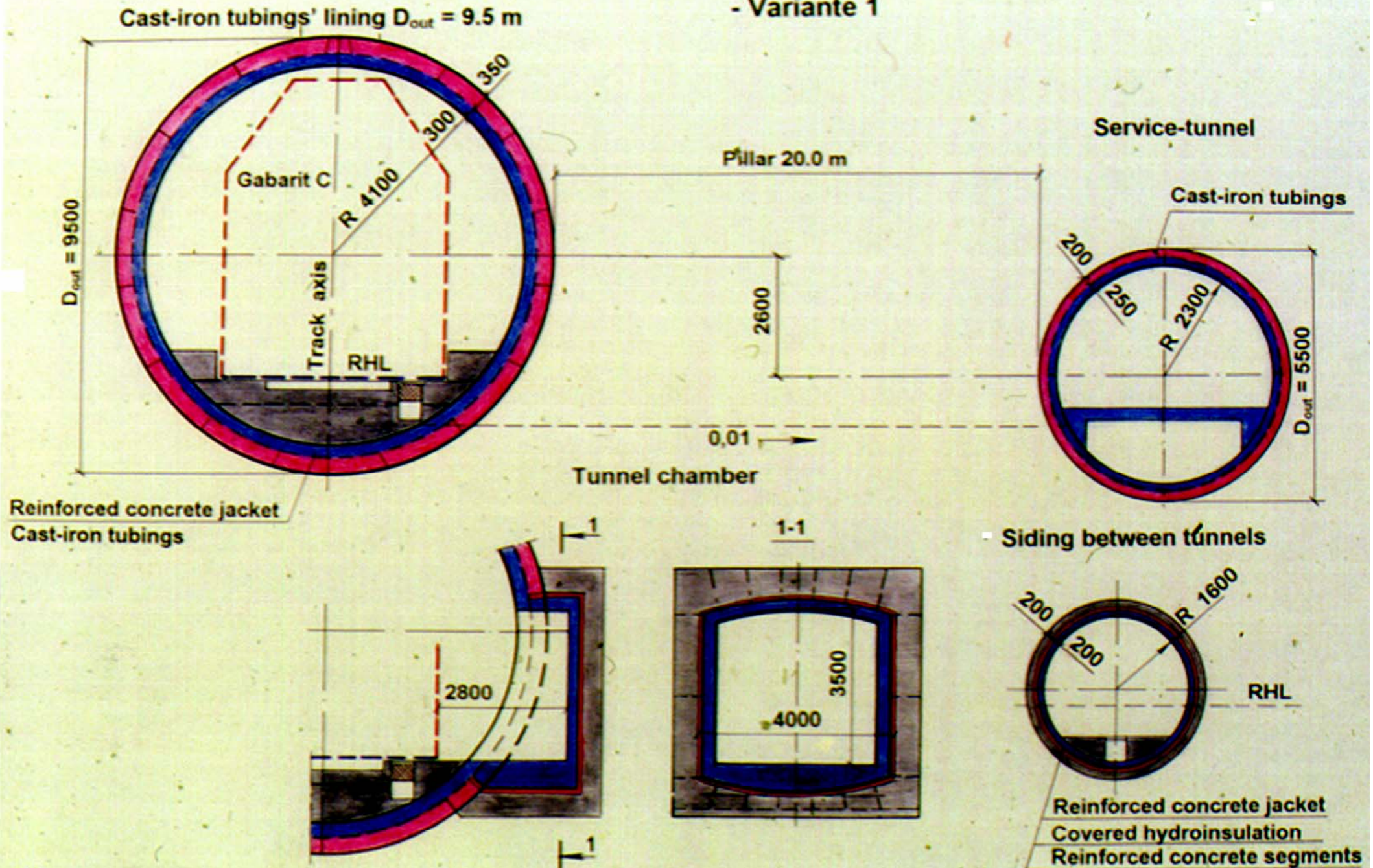
TUNNEL UNDER TATARSKY STRAIT



Single-track Railway Tunnel under Tatar Strait - Variant 1

Einglasiger Eisenbahntunnel unter der Tatarwasserstrasse

- Variante 1

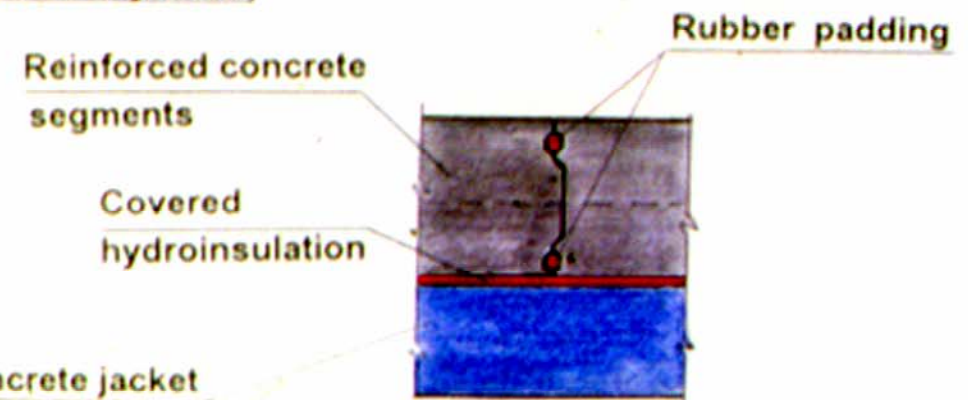
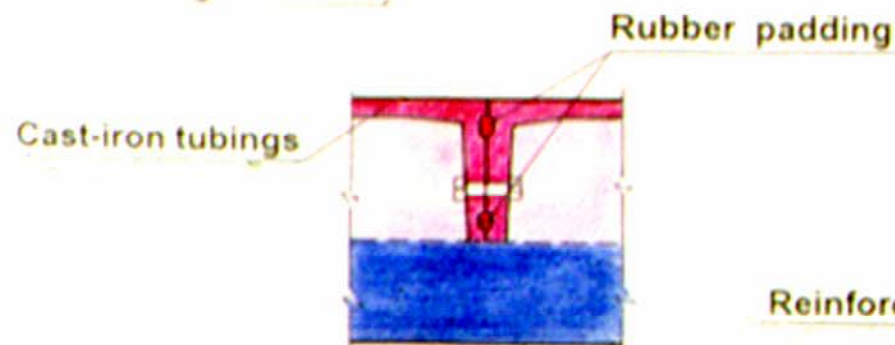
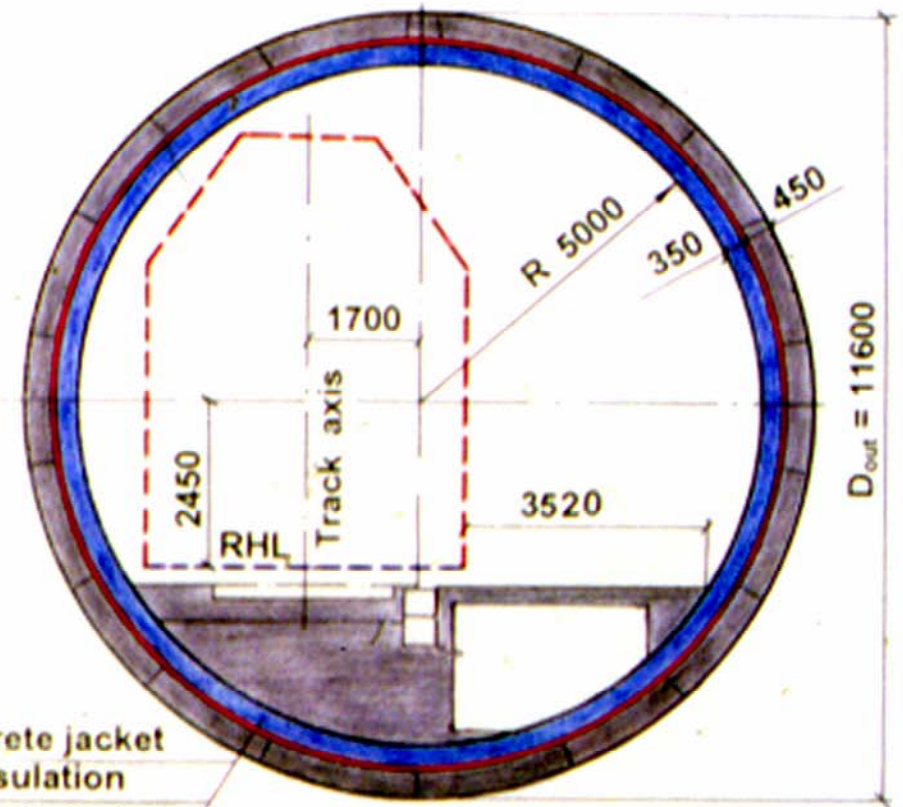
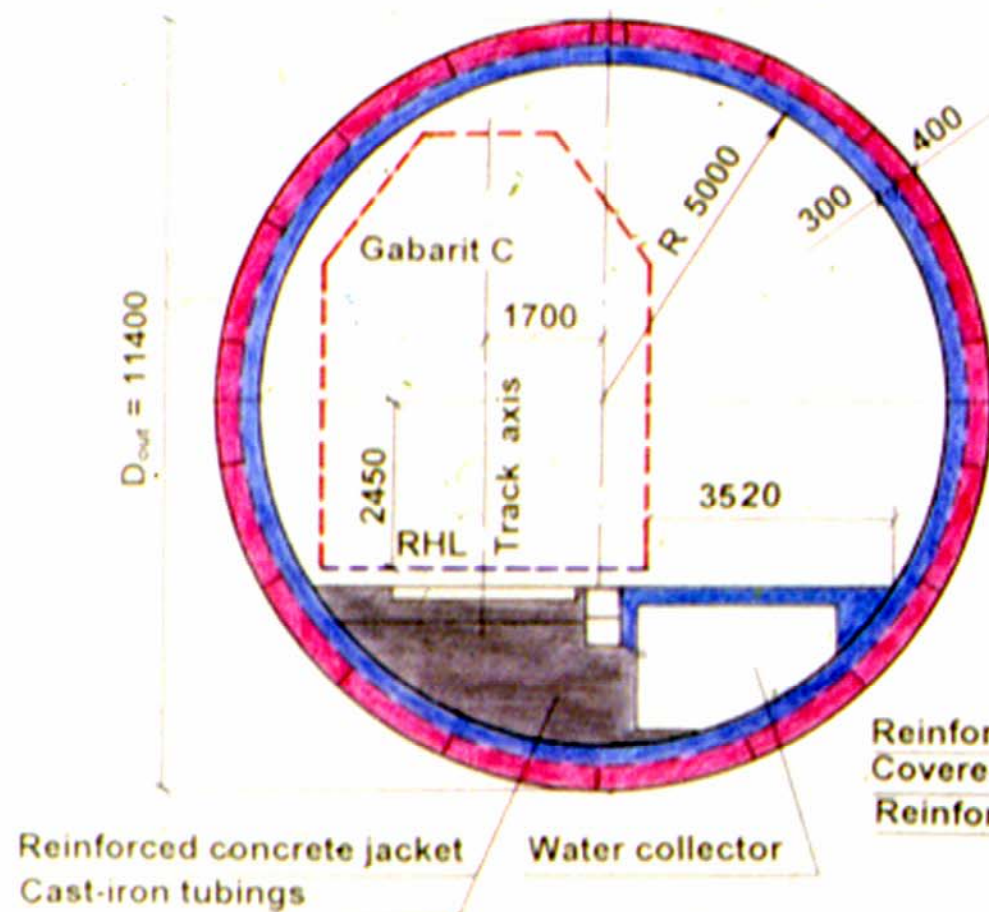


Single-track Railway Tunnel under Tatar Strait - Variant 2

Einglasiger Eisenbahntunnel unter der Tatarwasserstrasse - Variante 2

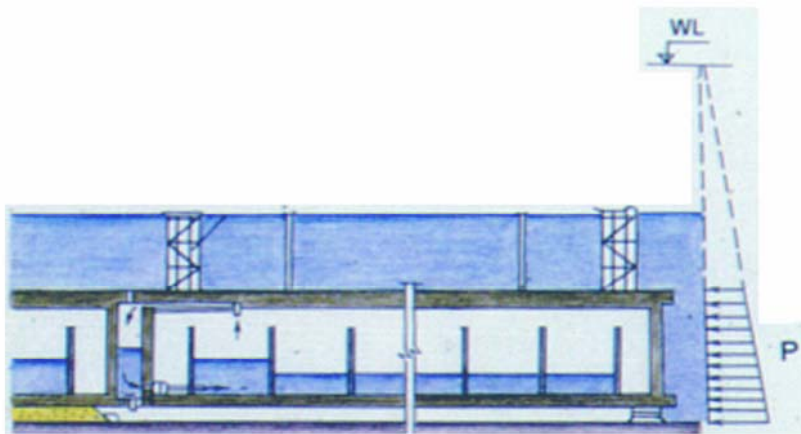
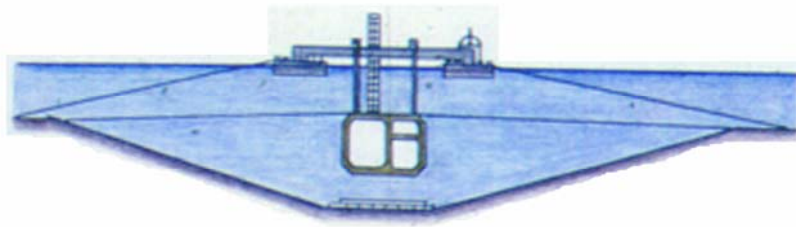
Cast-iron tubings' lining $D_{out} = 11.4$ m

Reinforced concrete segments' lining $D_{out} = 11.6$ m

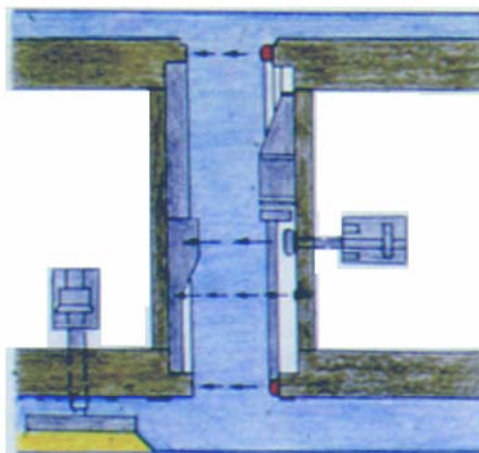


Scheme for Immersion and Jointing of Tunnel Sections onto Underwater Trench

Scheme der Senkung und Kopplung den Tunnelsektionen in die Unterwassergrube



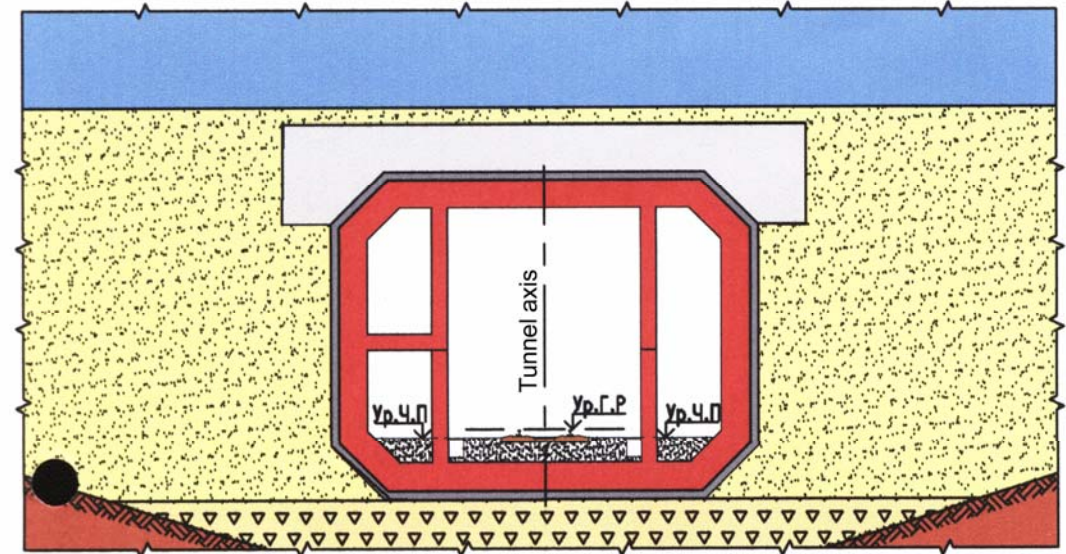
Jointing Detail
Zusammenkopplung (Detail)



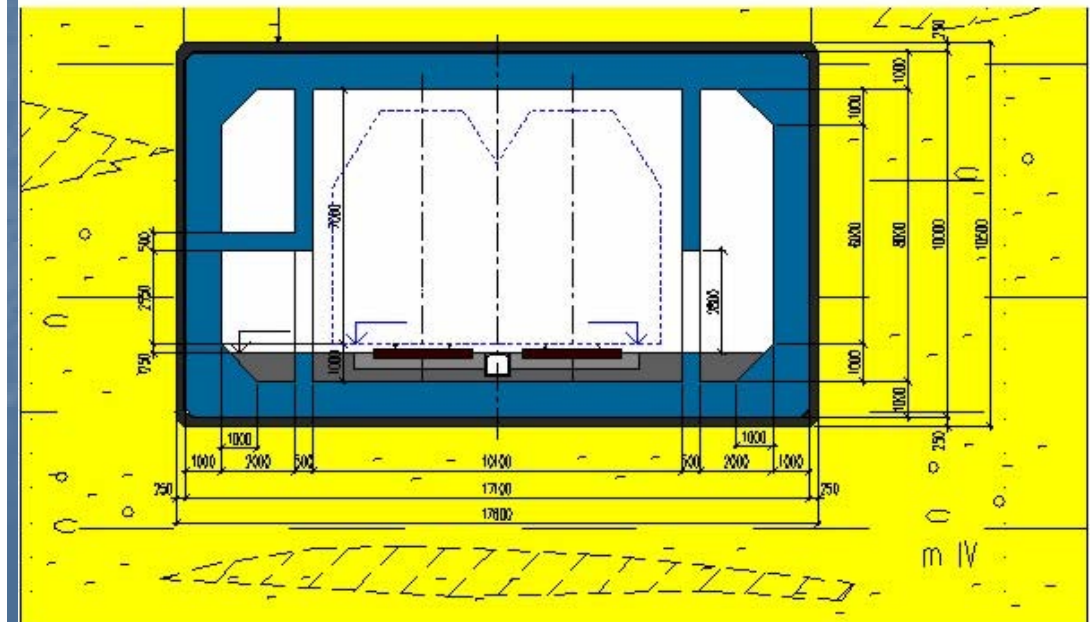
Stages for Seals
Tightening
Presstufen



SINGLE-TRACK TUNNEL

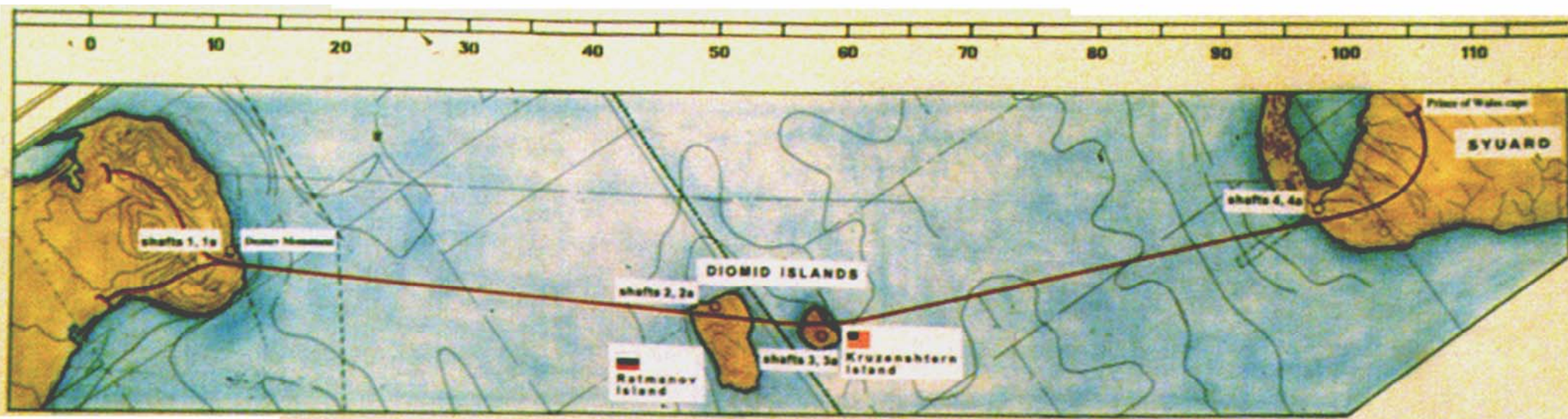


DOUBLE-TRACK TUNNEL
OPEN SECTION TUNNEL DESIGN





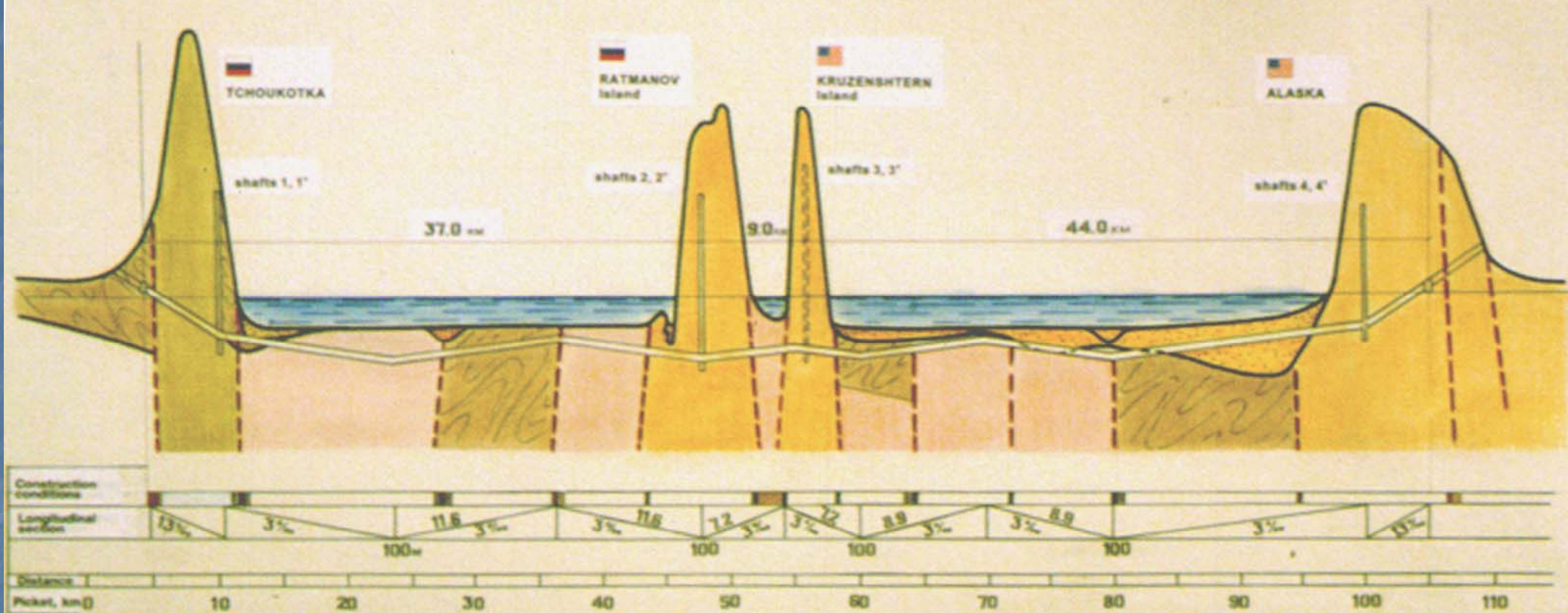
TUNNEL ROUTE PLAN



MAIN PARAMETERS OF ROUTE

Parameter	Length, km		Depth under bottom, m	Inclinations %		Min. radius, km		Shafts	
	general	under bottom		max	min	in plan	in profile	quantity	depth, m
Size	113	75	60 ... 120	13	3	2,5	10,0	8	100...400

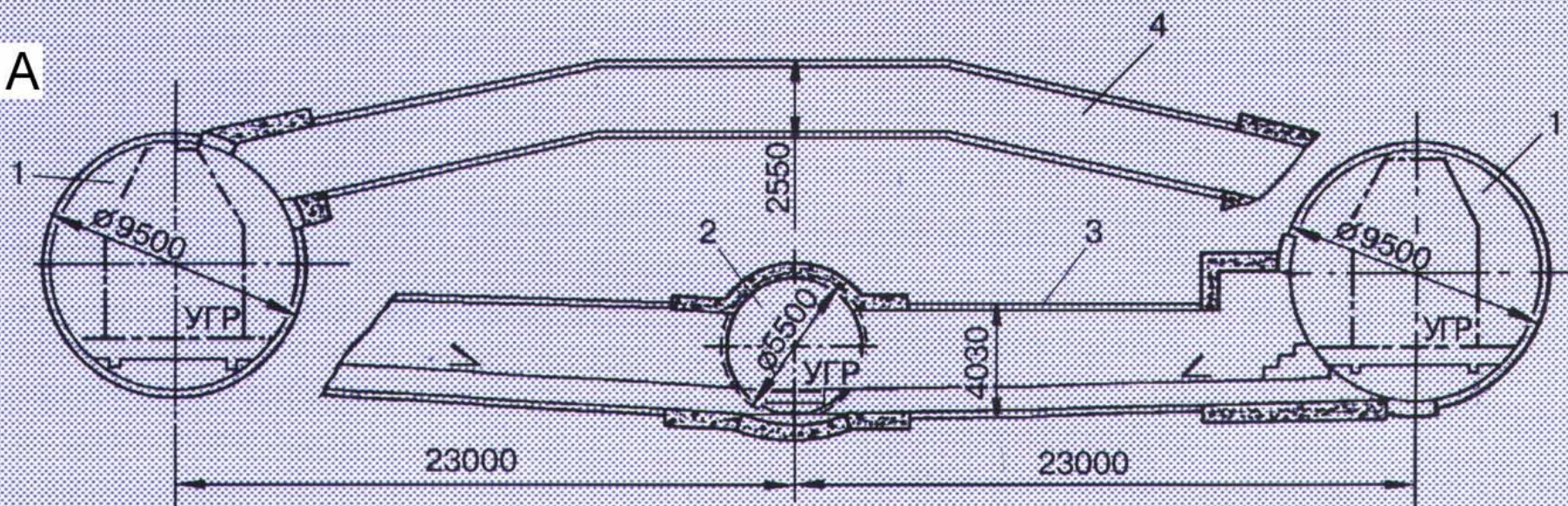
TUNNEL ROUTE WITH SHALLOW EMBEDDMENT



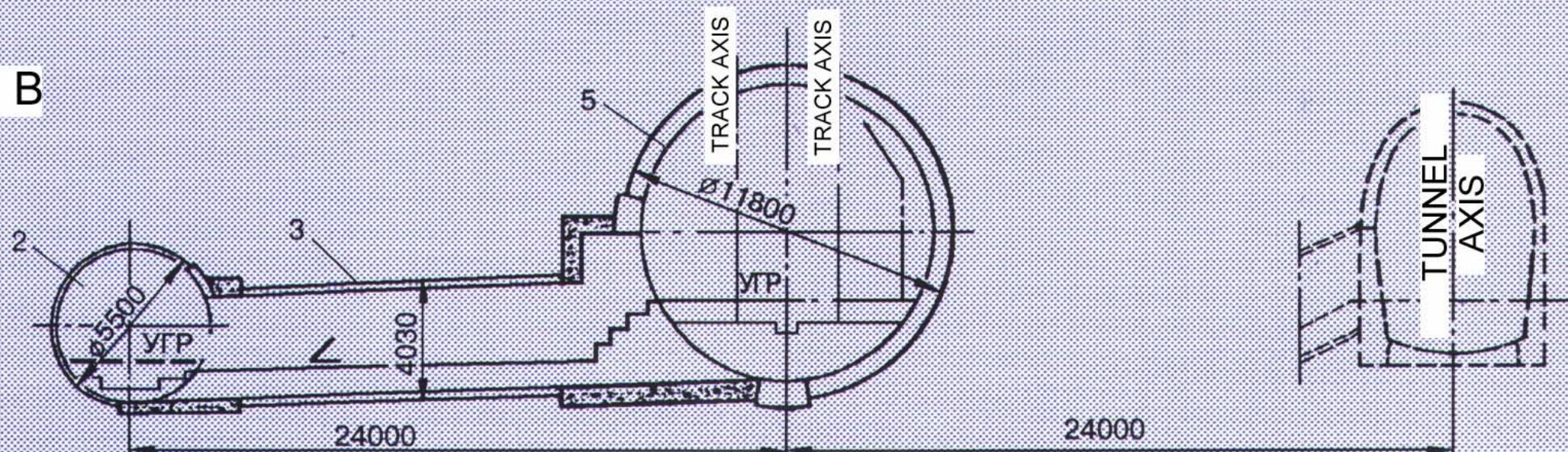
DISTRIBUTION OF CONSTRUCTION CONDITIONS ALONG THE TUNNEL LENGTH (L_t)

Evaluation of conditions	Part of L_t , %	C h a r a c t e r i s t i c s		
		Rocks	Water-ingress, m^3/h	Rock support
Good	75	Rock, solid stable $RQD (\%) \geq 75$	< 10	Not required up to 20-50 m Sometimes rock bolting
Satisfactory	15	Rock, middle-solid, fractured, possible break-downs $30 < RQD (\%) < 75$	Up to 100, sometimes up to 1000	Rock bolting with wire mesh, arches and shotcreting. Sometimes cementation
Poor	10	In structures: crushed up to clay, quite unstable $RQD (\%) \leq 30$	≥ 1000	Strengthened support with preliminary soil consolidation

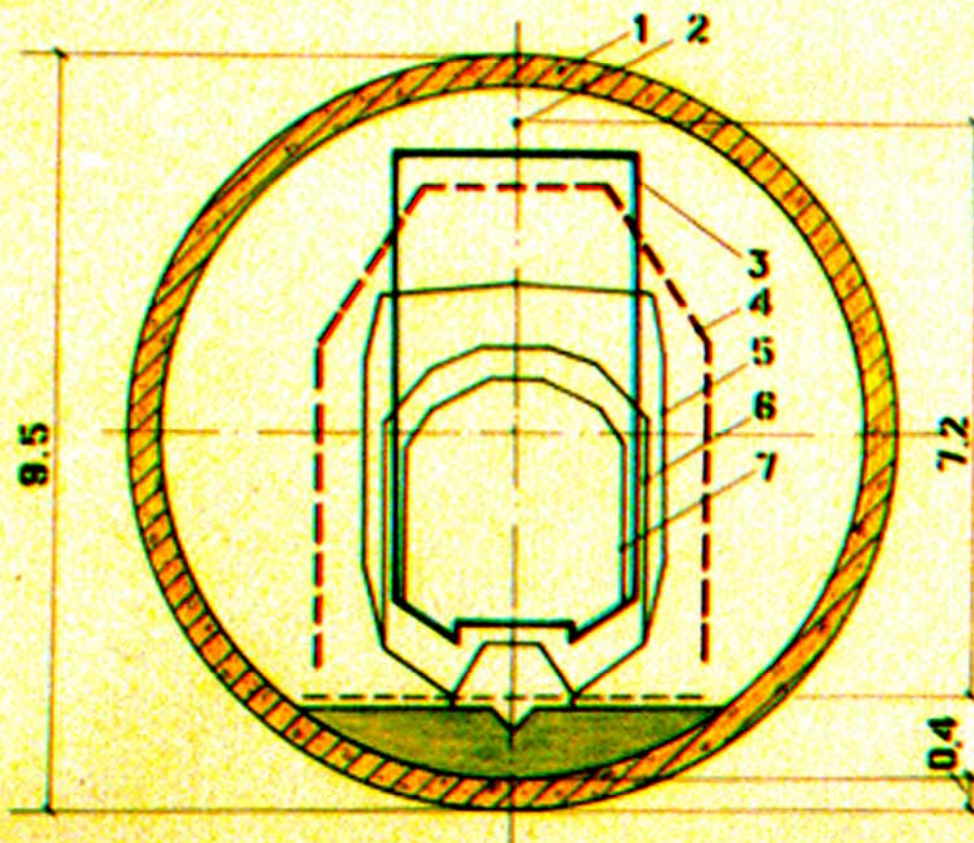
A



B



CROSS SECTION AND GABARIT IN TRANSPORT TUNNEL

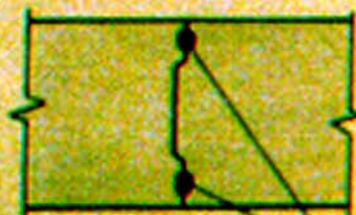


- 1 Lining
- 2 Contact wire
- 3 Standard container
- 4 Russian Railways "C" gabarit
- 5 La-Manche eurotunnel gabarit
- 6 Swiss Railways gabarit
- 7 British Railways gabarit

JOINT'S DETAIL IN SEGMENTAL LINING

of reinforced concrete

of cast iron



Rubber paddings