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Neuron Zagreb doo

Design Concept and Financing of the Light Rail Zagreb Project



References D.Kolić

- 1992 Metro Washington Columbia stat. designer
- 1992 Metro Los Angeles Hollywood Stat. designer
- 1992 U-Bahn München Candidplatz St. designer
- 1993 Metro Pariz RER Lot 35 B lead designer
- 1994 Light rail Lille Ligne2, Sect.“F“ consulting
- 1995 Metro Taipeh Sect.258a lead designer
- 1996 Metro Seoul Cabletunnel lead designer
- 1997 Metro Singapore NE Line, C710 lead designer
- 1998-99 Metro Budapest 4th Line reviewer
- 1999 Metro New Delhi MC1B lead designer
- 1999 Subway San Juan,P.Rico Minillas Ext. consulting
- 2000 Light Rail Seattle 1st Line lead des. NATM
- 2001-02 U-Bahn Wien Kagranerplatz lead designer
- 2004-05 Metro Hong Kong Kowloon SouthLink consulting
- 2005-06 Metro Singapore Circle Line, C855 consulting



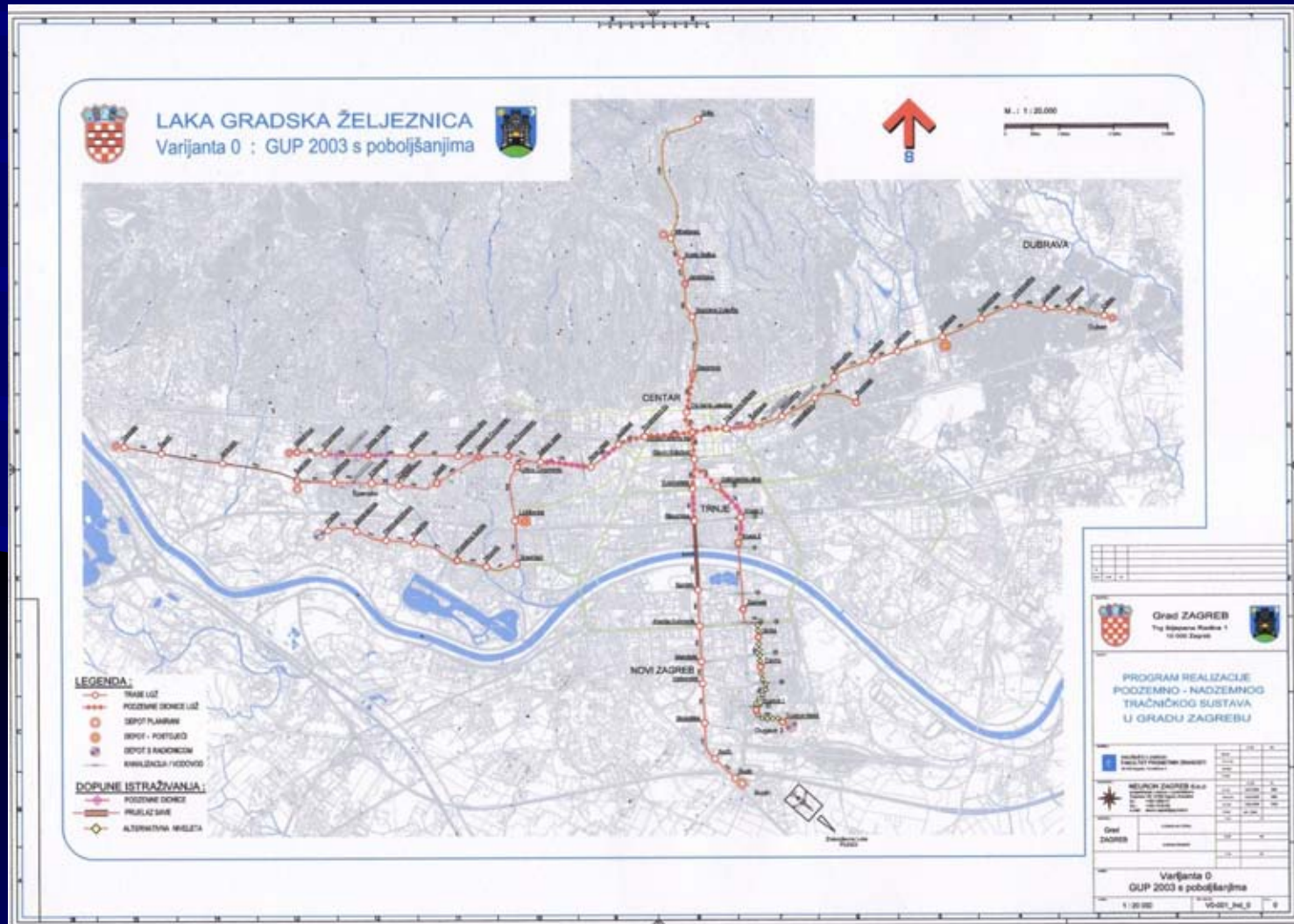
Content

- 1. Introduction : concept of development
- 2. Structures on light-rail lines
- 3. Bill of quantities and cost estimation
- 4. Construction time schedules
- 5. Financing models
- 6. Conclusions



1. Development of alignment variants

Variant 0 : GUP 2003 with improvements





1. Development of alignment variants

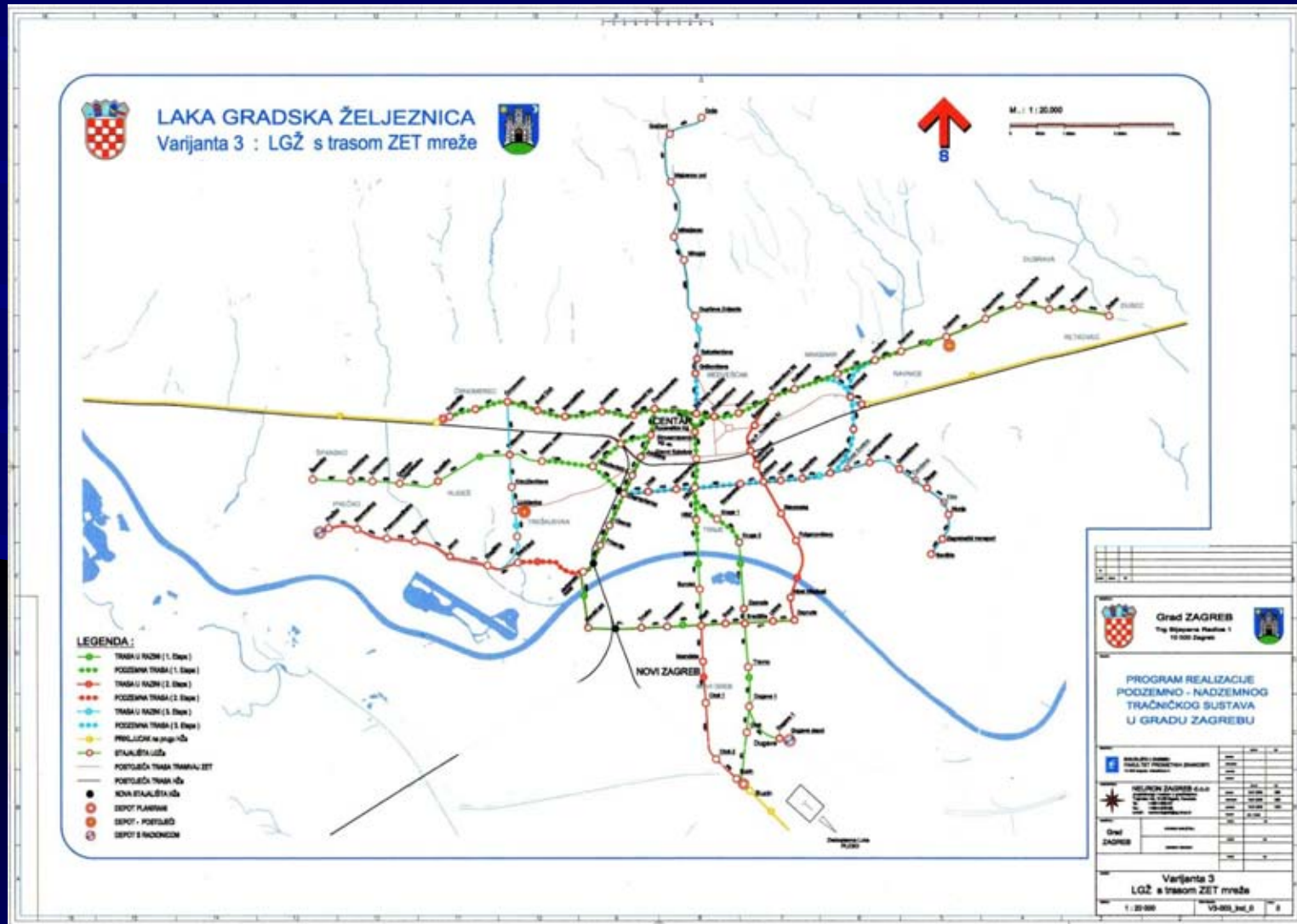
Variant 1.1 : Light rail with tramway connection





1. Development of alignment variants

Variant 3 : Light rail on basic tramway network

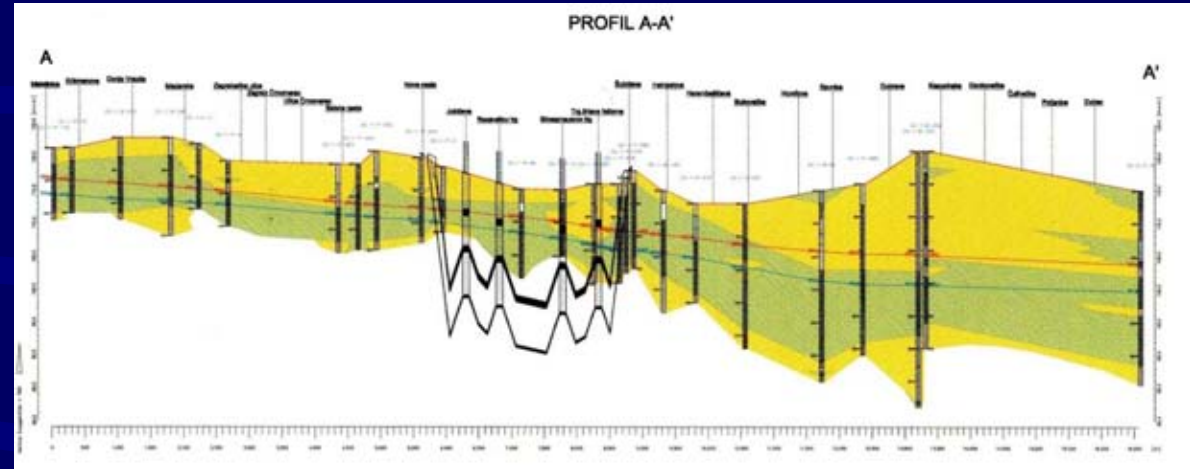




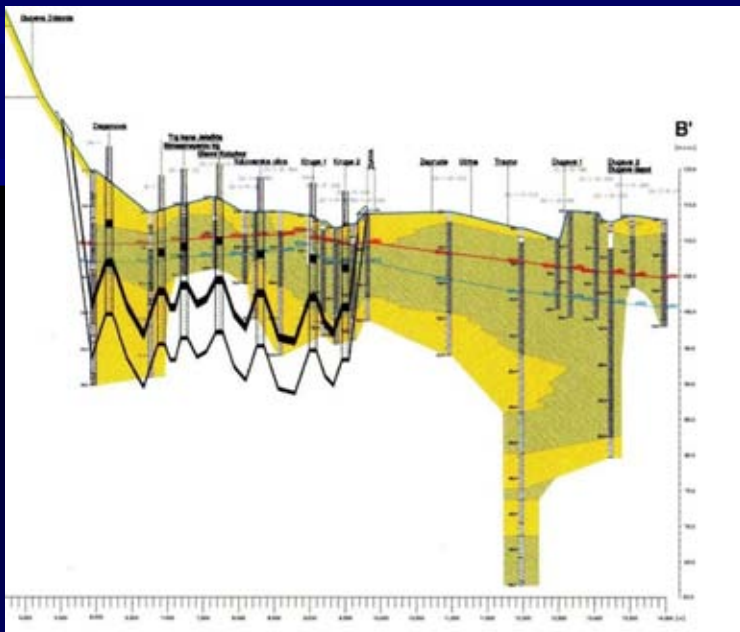
2. Structures on light rail lines

Hydro-geological longitudinal sections

East - West section



North – South section

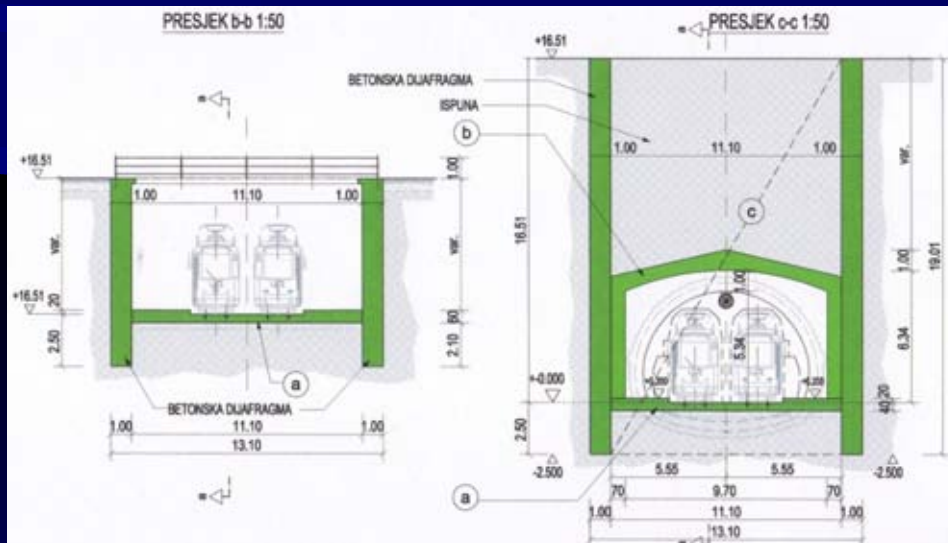
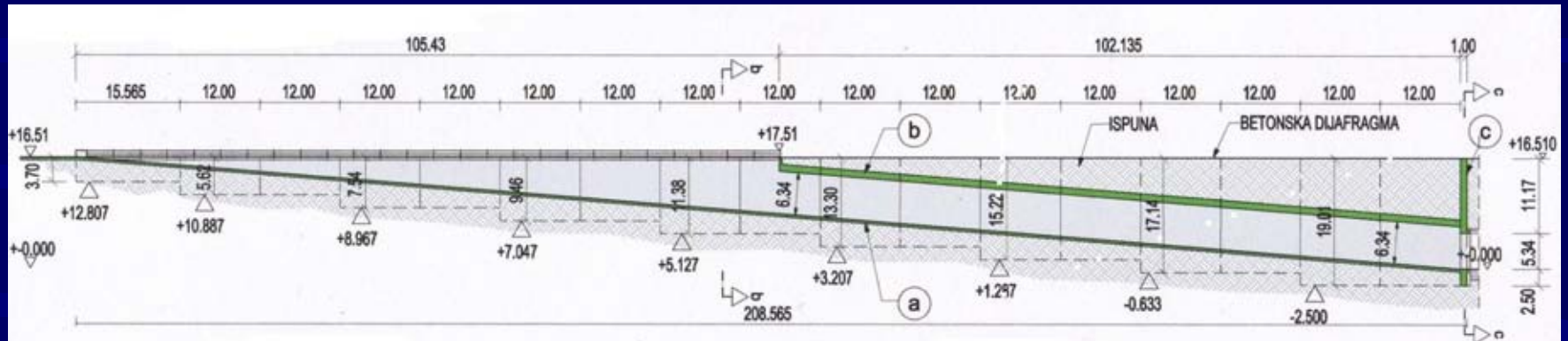


Required additional investigation works and deep boreholes on underground parts of the alignment.



2. Structures on light rail lines

Ramp to go underground



Ramp longitudinal section

Ramp cross section

Construction costs :

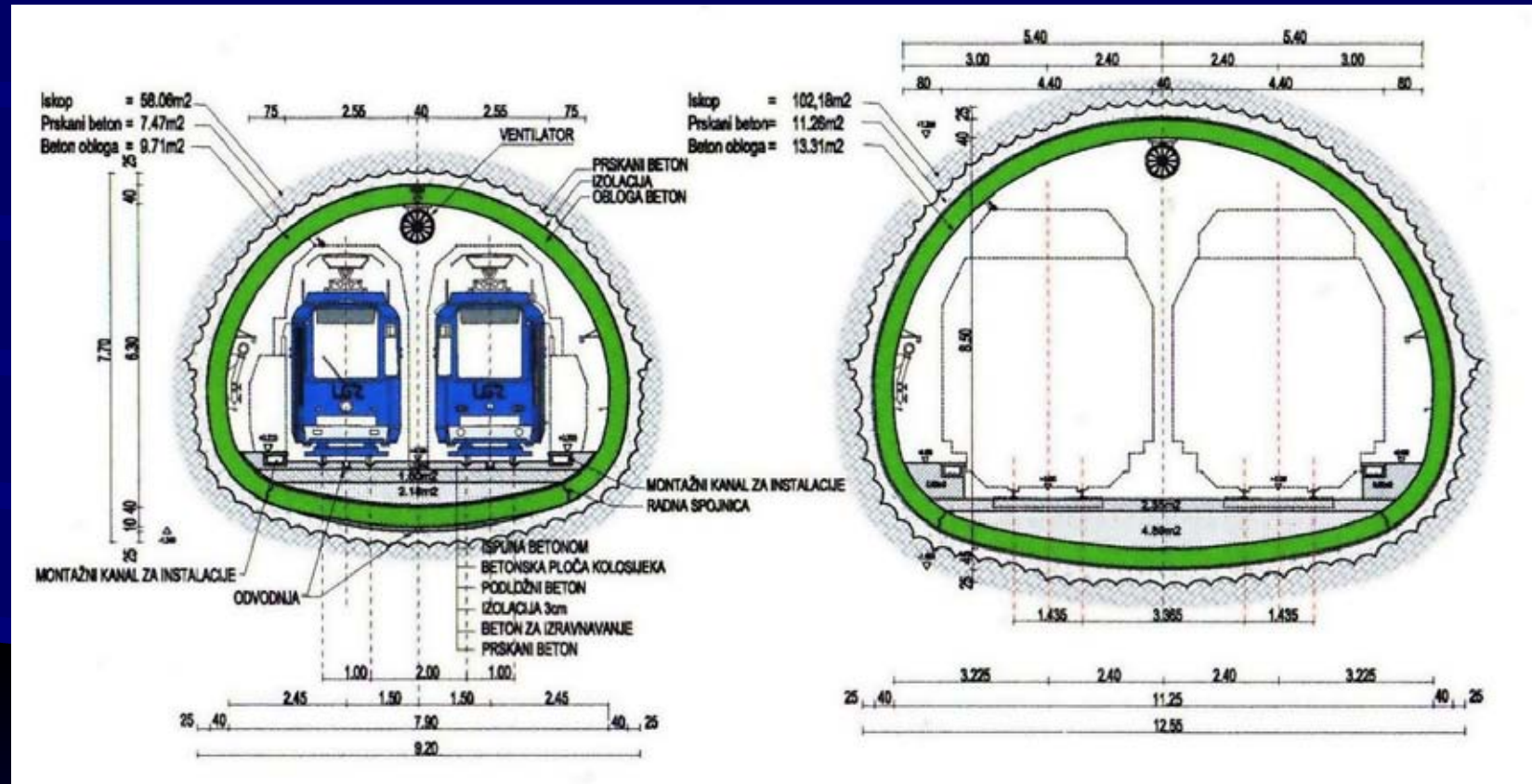
1 ramp = 4.500.000 €

= 32 000 000 KN



2. Structures on light rail lines

Tunnels for underground parts of line



Double-track tunnel, gauge 1000 mm

Excavation area = 58 m²

Construction costs = 29.500 € / m

Double-track tunnel, gauge 1435 mm

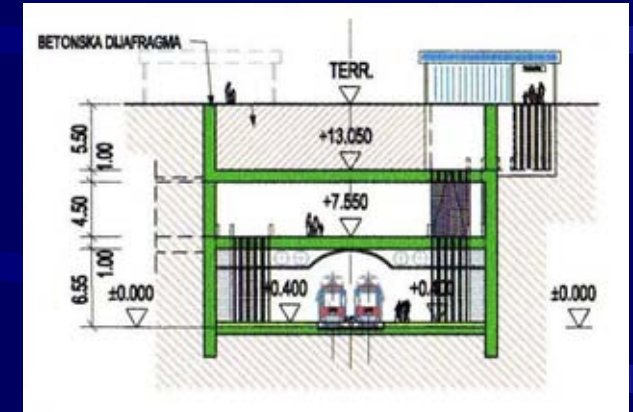
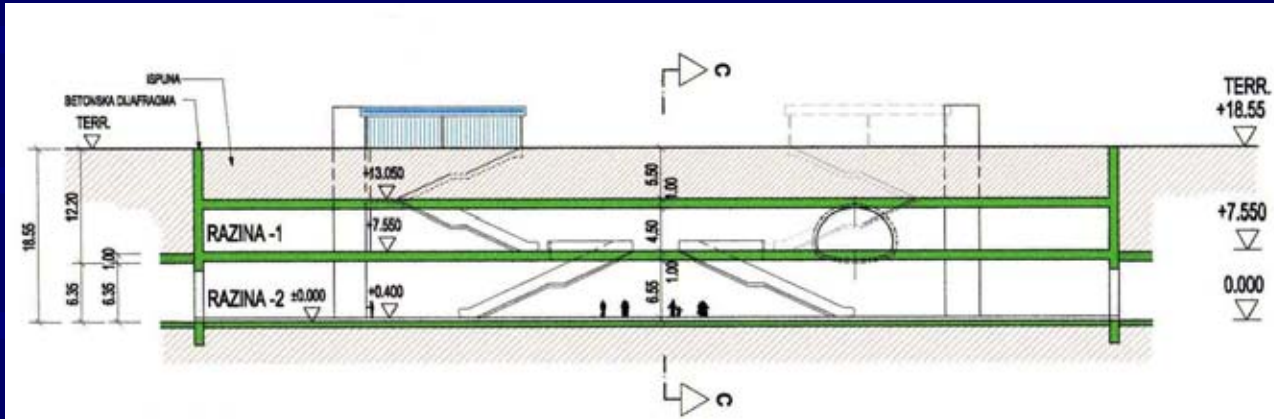
Excavation area = 102 m²

Construction costs = 47.500 € / m



2. Structures on light rail lines

Underground station : Main square Zagreb



Sections through station

Pedestrian tunnel

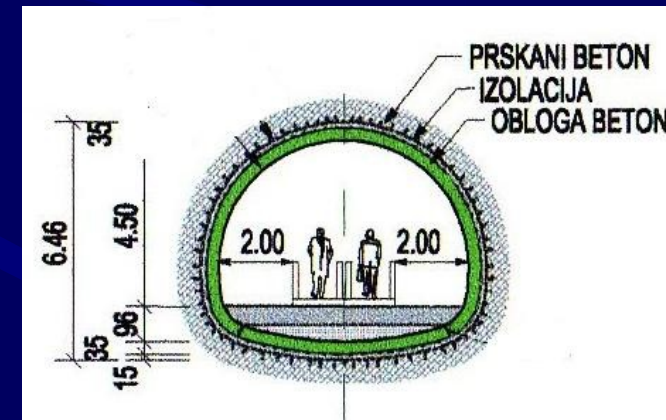


location :

Cesarčeva-Getaldićeva

Construction costs = 5.500.000 €

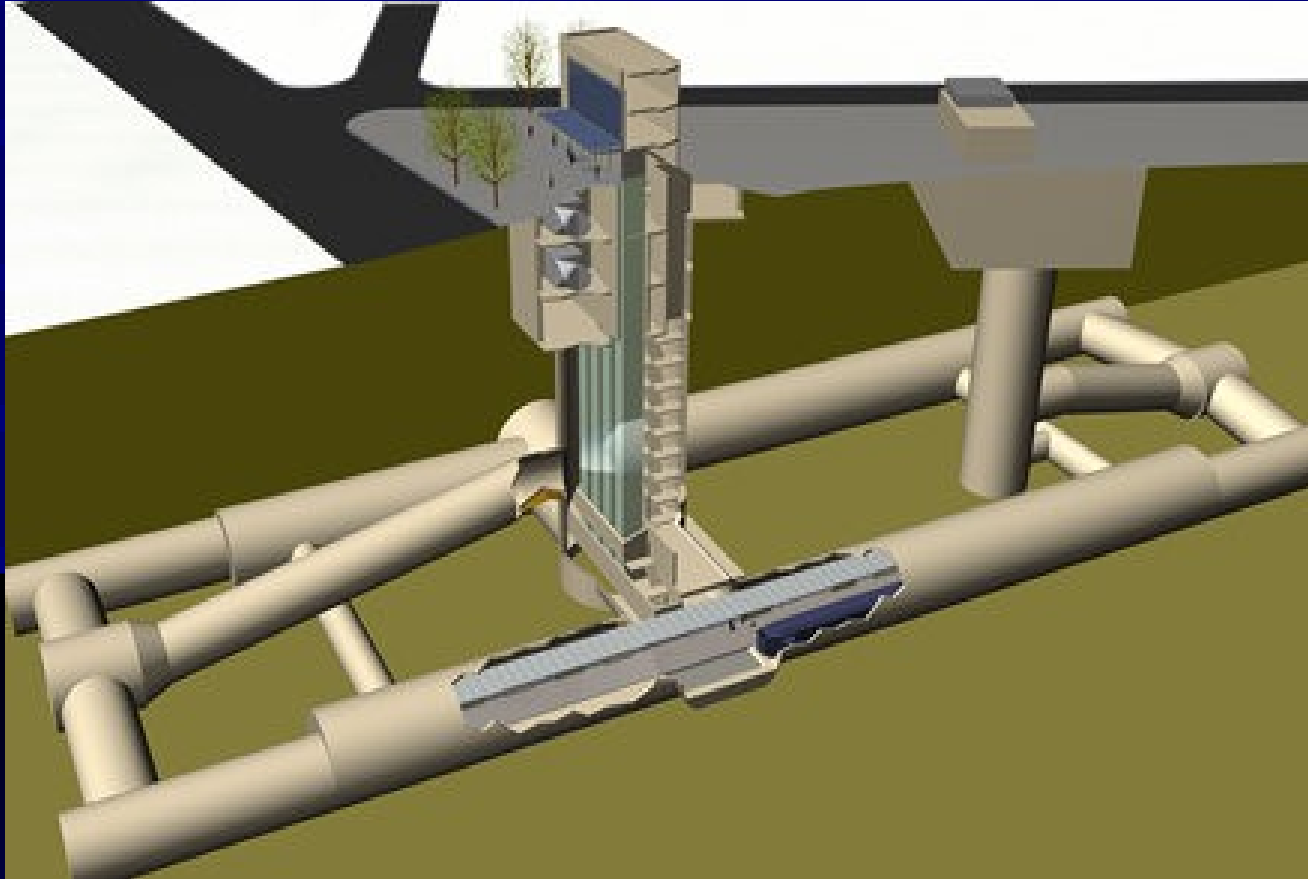
= 41.000.000 KN





2. Structures on light rail lines

Underground station : Main railway station



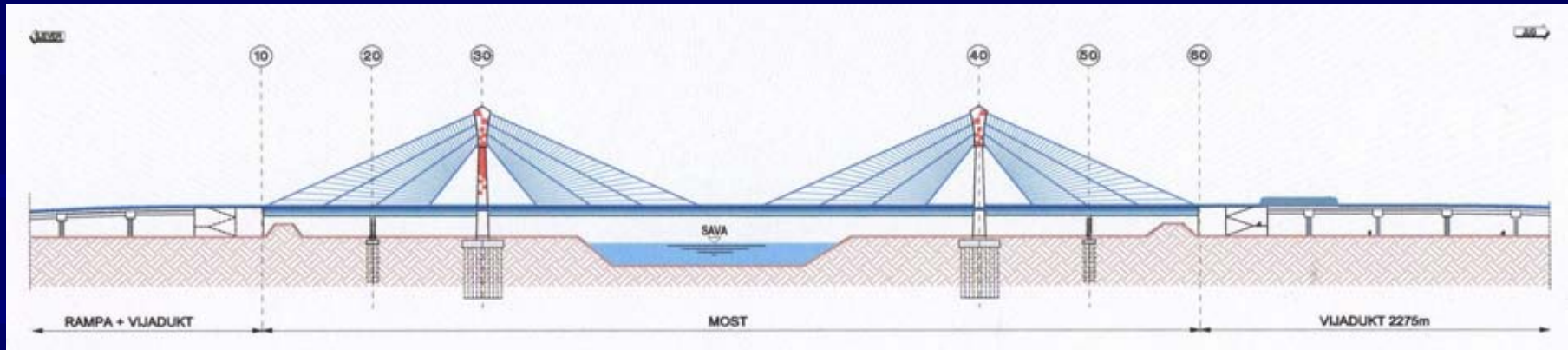
Example of
underground station
constructed using
tunnelling techniques

Cost estimation
relation:
top-down vs.
tunnelling station :
Range 1:2 – 1:5

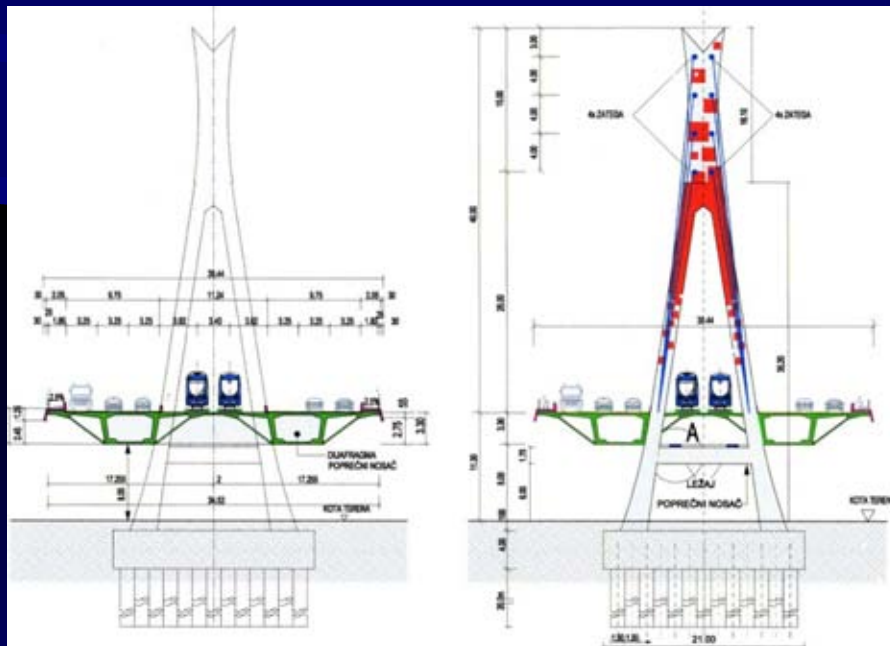


2. Structures on light rail lines

River Save crossing : Avenue of FR Germany



Longitudinal section L = 340 m



Cross section :

Main span and at the pylon

Construction time : 24 – 30 months



2. Structures on light rail lines

River Save crossing : Avenue of FR Germany



Cost estimation :
 $1.450 \text{ € / m}^2 = 17.500.000 \text{ €}$
 $= 130.000.000 \text{ KN}$



3. BoQ and Cost estimation

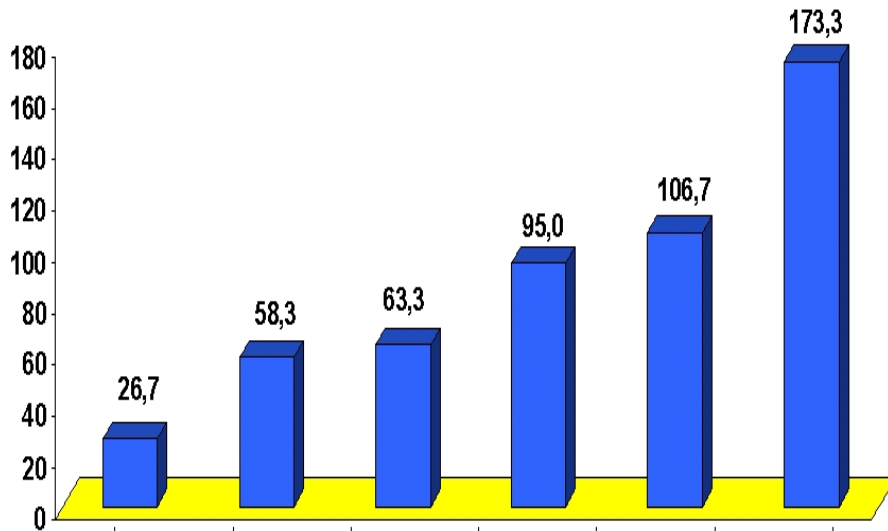
VIENNA SUBWAY (1995)

Contract Type: ClientDesign-Bid-Build

COST OVERVIEW

excluding design, trackwork, E & M

Cost per m
[USD x 1000]



Section Name	Kagran U1/11 and U1/12	Kardinal Nagl Platz U3/4	Vivenotgasse U6/3	Herrengasse U3/9	Volkstheater U3/10	Westbahnhof U3/13
	Elevated Structure	Cut & Cover Structure	Cut & Cover Station	Mined Station	Mined Station	Mined Station
			Mined Tunnel	Mined Tunnel	Mined Tunnel	Mined Tunnel
				Crossing with 2 lines	Crossing with 2 lines	Crossing with 3 lines

Light rail Zagreb 2006 (with equip.) :

Double track, 1000 mm, on surface :
5.500 € / m1

Double track, 1000 mm, on viaduct:
15.000 € / m1

Double track, 1000 mm, in tunnel:
29.500 € / m1

Underground stations (top-down / tunnel):

5.500 000 -11.000.000 € / kom 1

River Save bridge :

17.500.000 € / 1 pcs.



4. Construction time schedule: east-west



1. phase: 2.6 km - 116.7 mill.€ - 24 mo..

2a phase: 2.7 km - 15.2 mill.€ - 8 mo.

2b phase: 2.4 km - 98.9 mill.€ - 24 mo.

3a phase: 3.5 km – 22.3 mill.€ - 10 mo.

depot Špansko : 20.000.000 €

3b phase : 2.3 km – 15.5 mill.€ - 7 mo.



4. Construction time schedule : north - south



2. phase: 3.3 km – 136.4 mill.€ - 30 mo.

3a phase: 1.8 km – 41.0 mill.€ - 24 mo.

3b phase : 2.1 km – 26.0 mill.€ - 12 mo.

depot Dugave : 20.000.000 €



5. Financing models

- For public infrastructure projects : from private or public financial sources
- Involvement of public institutions is required : city, region, state or state companies
- **„Traditional“ public financing**
- Loans from international financing institutions (IBRD, EBRD, EIB) or banks
- Better conditions, lower interest rates, grace period, long contracting period
- State guarantees needed, Croatian foreign debt of 82.9 % of BNP
- **Private financing by concession (BOT : “build-operate-transfer”)**
- “Private financial resources” from banks
- Public partner is the owner after concession period (20 or more years)
- Concession company returns investment during concession period
- **Private financing based on PPP models (public-private partnerships)**
- Financial feasibility to be investigated at very beginning
- Public partner is the owner during whole time period of the project
- Concession company = private partner = is paid by public partner



6. Conclusions

- **Further project development in phases**
- **Project documentation of 2nd phase**
 - Technical documentation, preliminary design
 - Environmental studies
 - Risk analysis for technical, environmental and economical parts
 - Feasibility study
 - Traffic studies for different project phases
 - Ownership and legal procedure matters on future corridors
 - Additional geotechnical investigations