15. Arterial Road Improvement Projects

15.1 Kamel Sidky St. Improvement Project

15.1.1 Introduction

The project aims at widening of the existing Kamel Sidky st. starting from Gomhouria st. at Ramses sq. along the Old Cairo Wall, crossing the streets of Port Said, Gueish, and Salah Salem, and ending at Autostrade. The project street runs through an area of the city having a large number of old buildings. The right of way ordinance in Cairo Governorate regulates a road width of 30 m along this route, and 35 m for the road parallel with Kamel Sidky st. The distance between the two roads ranges from 50 m to 70 m. Since the distance from the edge of the existing Kamel Sidky st. to the Old Cairo Wall is about 40 m, a 40 m ROW improvement is planned as the study base to avoid having a narrow strip remain between the new road edge and the Old Cairo Wall.

15.1.2 Building Use along the Route

Of the total 5.1 km route, the existing 26 m wide street will be widened in the 1.2 km section between Manssoureya st. and Salah Salem st. A 2.7 km section of the route passes through a cemetery area between Salah Salem st. and Autostrade, and the remaining 1.3 km section passes through dense building area.

The present building use and condition are described below by sections of:

Section 1 : Ramses sq. to Port Said st.
Section 2 : Port Said st. to Manssoureya st.
Section 3 : Manssoureya st. to Autostrade

1) Floor Height

Fig. 15.1.1 shows the distribution of the floor heights by section. In sections 1 and 2, the share of buildings with more than 4 stories are 83% and 87% respectively. The average number of floors are 3.0, 2.7 and 1.3 in sections 1, 2 and 3 respectively. Half of section 2, from Bab Al Nasr to Manssoureya st. and 2/3rd of section 3 from Salah Salem st. to Autostrade are cemetery areas, therefore the floor height in these sections is low.

Fig. 15.1.2 shows the location of the buildings with more than 5 stories. They are mainly concentrated in and around Ramses sq.

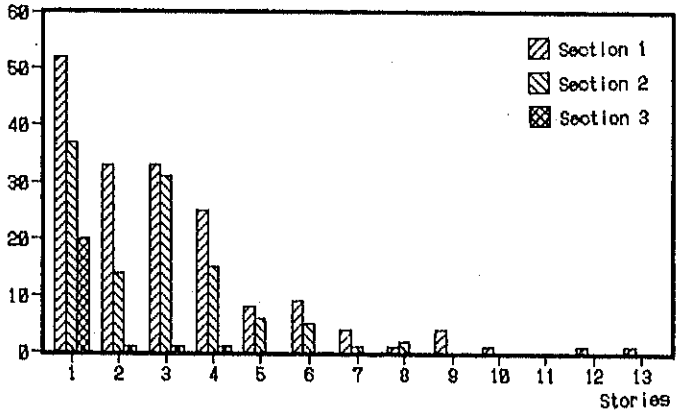


Fig. 15.1.1 Floor Height by Section

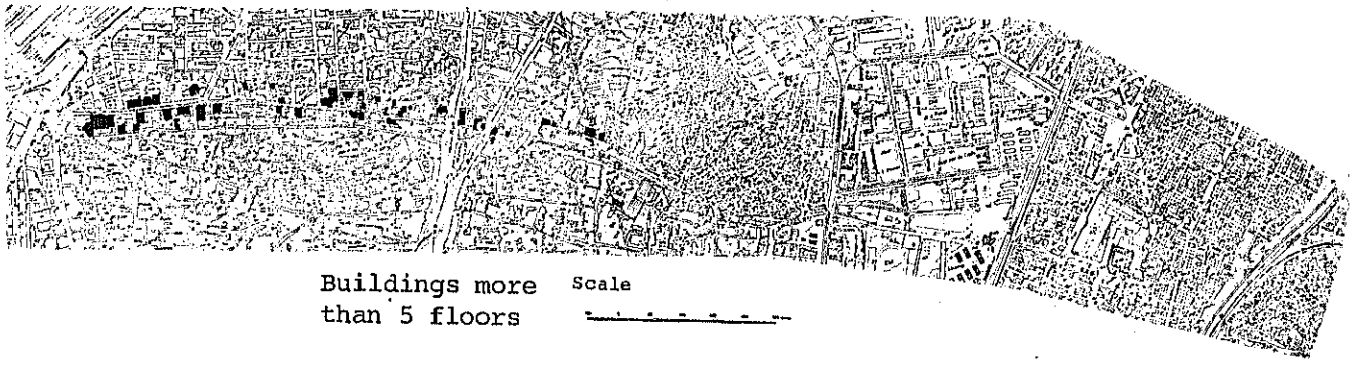


Fig. 15.1.2 Location of Buildings with more than 5 Stories

2) Classification of Buildings

Fig. 15.1.3 shows the building number by class and by section. The percentage of medium to high class buildings is 47% in section 1, however it reduces to 31% in section 2. Fig. 15.1.4 shows the location of the medium to high class buildings. The high class buildings are concentrated again in and around Ramses sq. Middle class buildings are scattered between Ramses sq. and Gueish st.

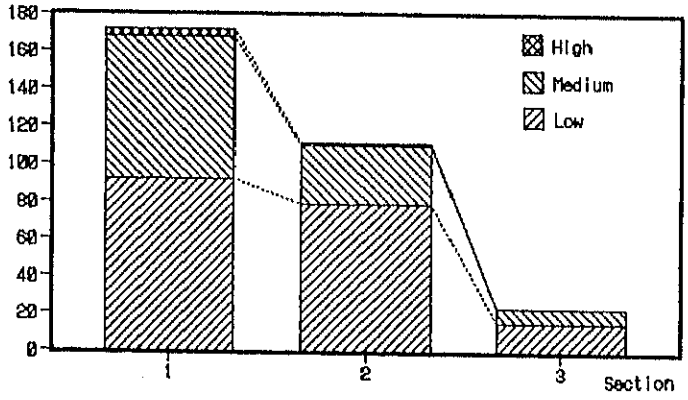


Fig. 15.1.3 Building Number by Classification and Section

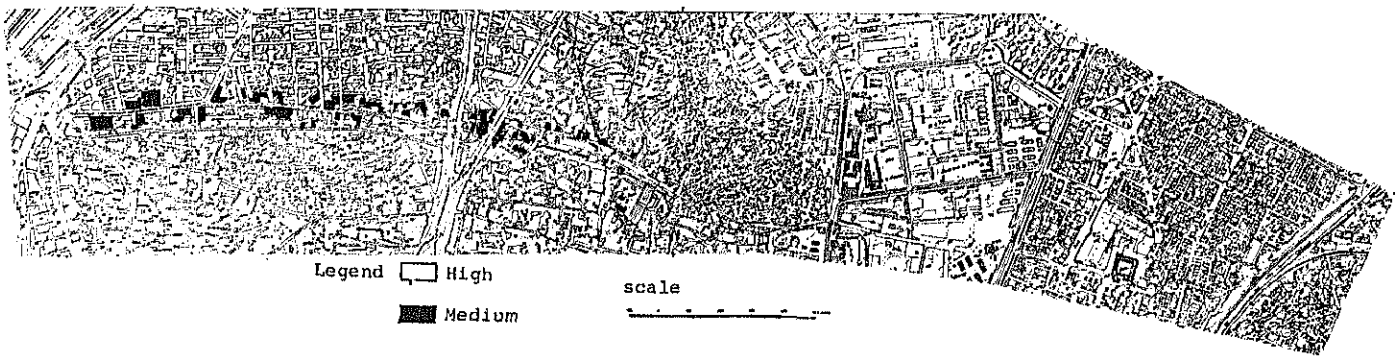


Fig. 15.1.4 Location of Medium - High Class Buildings

3) Floor Area by Purposes

(1) Total Floor Area

Fig. 15.1.5 shows the floor area distribution by purpose and by section. The percentage of residential purpose is the highest at 58.4% in section 1, followed by 15.1% and 11.4% for commercial and service purposes respectively.

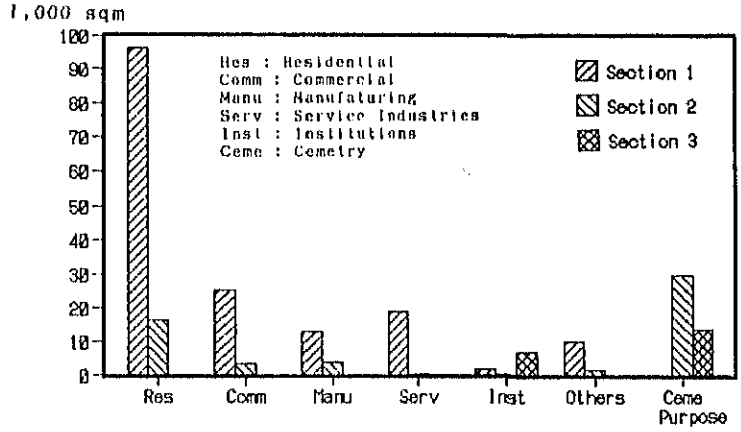


Fig. 15.1.5 Total Floor Area by Purpose and Section

In section 2, cemetery occupies the highest share at 53.7% followed by 29.9% for residential purpose. In section 3, institutional area occupies 32% and the rest is occupied by cemetery.

(2) Ground Floor Area

Fig. 15.1.6 shows the ground floor area distribution by purpose and by section. In section 1, the percentage of commercial purpose increase to the highest at 47.8%, followed by 24.4% for manufacturing and 10.1% for other purposes. In section 2, the percentage occupied by the cemetery increases to 73% followed by 9.0% for manufacturing and 7.8% for commercial.

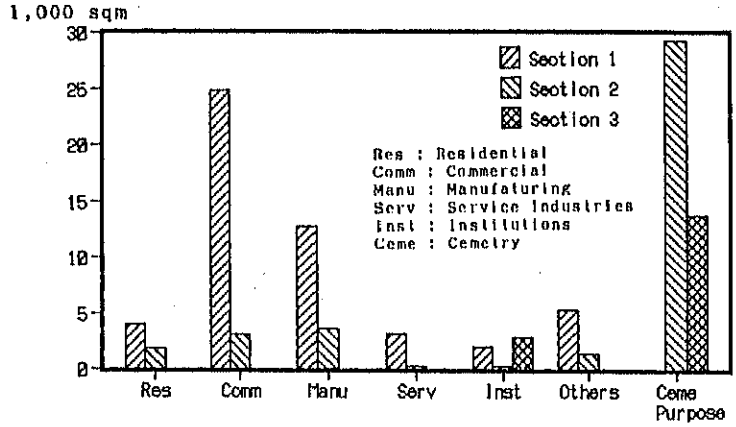


Fig. 15.1.6 Ground Floor Area by Purpose and Section

The results of this analysis indicate that the ground floor area is generally used for the commercial, manufacturing and service industries, and the upper floors are used for the residence.

4) Special Purpose Buildings

Fig. 15.1.7 shows the location of such special purpose buildings as hotel, bank, mosque, church, educational facilities, and institutions. Hotels are concentrated in and around Ramses sq. Mosques and churches are scattered along the route. The section between Manssoureya st. and Salah Salem st. is occupied by military installations and offices of the Cairo Governorate Traffic Police.

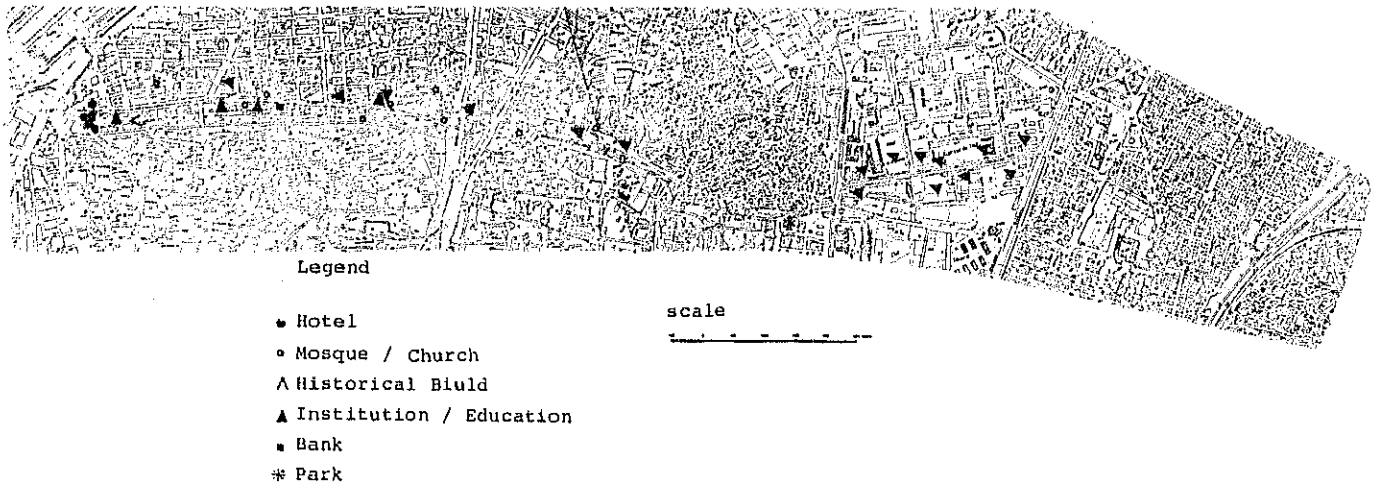


Fig. 15.1.7 Location of Specialized Purpose Buildings

15.1.3 Highway Planning

1) Number and Floor Area to be Acquired

To study the influence of land acquisition for the improvement of Kamel Sidky st., the following three cases are examined:

a. ROW 26 m 4 lane case
b. ROW 40 m 6 lane case
c. The case where the area between Kamel Sidky st. and the street parallel with Kamel Sidky st. is to be acquired.

The typical cross sections for 4 lane and 6 lane streets are shown in Fig. 15.1.8. In these cases, all the building floor is measured when a part of the building is subject to acquisition.

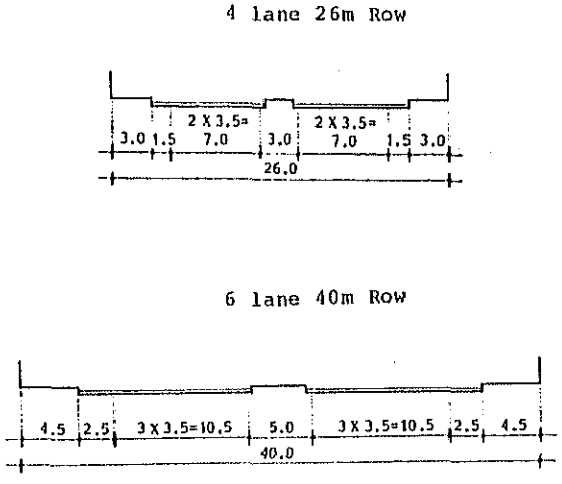
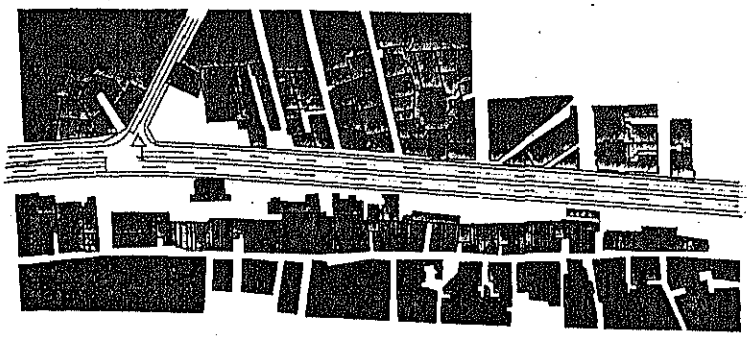


Fig. 15.1.8 Typical Cross Sections of Kamel Sidky St.

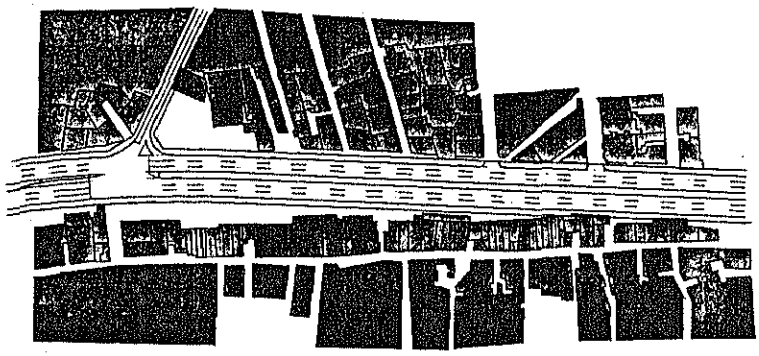
The improvement images of these three cases are shown in Fig. 15.1.9. In case C, area other than the roadway, is planned as a park for the conservation of the Old Cairo Wall and buildings.

The floor areas to be acquired are shown in Table 15.1.1. The increment of the acquired floor area between case A and case B in section 1 is only 17%, while that between cases B and C is 50.9%. In section 3, it is planned to widen the existing 20 m street, therefore the floor area to be acquired in case B increase by twice that in the case A. In section 2, 52.9% of the increment between cases A and B corresponds to the increment of the lane number.

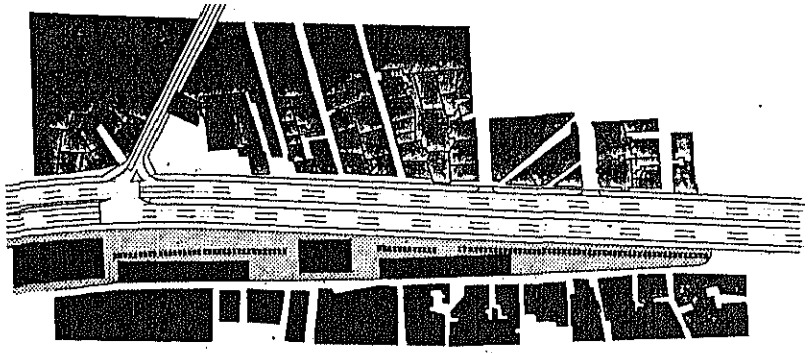
The building numbers to be acquired are shown in Table 15.1.2 by case and by section. The total building numbers are 150, 215 and 306 in cases A, B and C respectively.



(1) 26m, 4 Lane Improvement



(2) 40m, 6 Lane Improvement



(3) 40m + Road Side Development,
6 Lane Improvement

Fig. 15.1.9 Concept of Kamel Sidky St. Improvement Alternatives

Table 15.1.1 Floor Area to be acquired by Section and Alternative

(unit: sq.m)

Section	Alternatives			Total
	1	2	3	
1	93,369	15,943	55,657	164,969
2	28,516	15,093	11,068	54,677
3	6,858	13,407		20,265
Total	128,743	44,443	66,725	239,911
Accum.	128,743	173,186	239,911	
Index	1.00	1.35	1.86	

Table 15.1.2 Building Number to be acquired by Section and Alternative

Section	Alternative 1	2	3	Total
1	69	19	84	172
2	69	35	7	111
3	12	11	--	23
Total	150	65	91	306
Accum.	150	215	306	

2) Acquisition Cost

The acquisition rates for buildings based on the survey are estimated at 200 - 500 LE/sq.m depending on the building classification. The rate for land is estimated at 800 LE/sq.m. In addition to these rates, the adjustment factors of 0.5 for the floor use of others to 1.5 for service industries are included. The estimation results are shown in Table 15.1.3 by case and by section.

Table 15.1.3 Building and Land Acquisition Cost by Section and Alternative

(unit: 1,000 LE)

Section	Alternative 1	2	3	Total
1	50,086	9,333	30,768	90,187
2	19,624	12,089	9,708	41,421
3	6,478	11,149	--	17,627
Total	76,188	32,571	40,476	149,235
Accum.	76,188	108,759	149,235	
Index	1.00	1.43	1.96	

An area of 4.3 ha other than the area for the roadway, can be secured in case C. If this area is utilized as park space for the conservation of the Old Cairo Wall and construction of 13 story high office and residential buildings, keeping the building area to a total area of 30% in order to maintain a relaxed environment, are implemented and sold or rented, then additional land acquisition costs from case C can be covered.

15.1.4 Traffic Demand Forecast

The future average traffic demand in the year 2000 for the two cases of 4 lanes and 6 lanes is shown in Table 15.1.4. Traffic demand on Kamel Sidky st. will increase in accordance with the increase in lane number and therefore the burden on the other nearby streets is expected to drop by increasing the lane number on the project road.

Table 15.1.4 Future Traffic Demand on Kamel Sidky St. (Year 2000)

(unit: 1000 pcu/day)

	4 Lanes	6 Lanes
1 Ramses - Port Said	98	156
2 Port Said - Manssoureya	68	107
3 Manssoureya - Salah Salem	103	141
4 Salah Salem - Autostrade	69	87

15.1.5 Construction Cost Estimate

The estimated construction costs including land acquisition cost are shown in Table 15.1.5 by case. The land acquisition costs occupy 80% - 85% of the total in all the cases.

Table 15.1.5 Construction Cost Estimate for Kamel Sidky St. Improvement Project

Description	Alt-1 4 Lane			Alt-2 6 Lane			Alt-3 6 Lane		
	Financial Cost		Economic Cost	Financial Cost		Economic Cost	Financial Cost		Economic Cost
	Foreign (1000US$)	Local (1000LE)	(1000LE)	Foreign (1000US$)	Local (1000LE)	(1000LE)	Foreign (1000US$)	Local (1000LE)	(1000LE)
1 Road									
Sec 1 (1.19Km)	790	1,377	3,308	1,201	2,078	5,013	1,201	2,078	5,013
Sec 2 (1.22Km)	810	1,412	3,392	1,231	2,130	5,140	1,231	2,130	5,140
Sec 3 (2.70Km)	1,793	3,124	7,506	2,724	4,714	11,375	2,724	4,714	11,375
sub-total	3,393	5,912	14,206	5,156	8,922	21,528	5,156	8,922	21,528
2 Bridge									
Quarry Line (100m)	955	1,023	3,480	1,432	1,535	5,219	1,432	1,535	5,219
3 Land		76,188	76,188		108,759	108,759		149,235	149,235
Total	4,348	83,124	93,873	6,588	119,216	135,507	6,588	159,692	175,983

15.1.6 Economic Evaluation

Economic evaluation indices for the three cases are shown in Table 15.1.6. The EIRR at 39.9% in the 4 lane case and 33.3% in the 6 lane case is high, therefore the economic return on the investment is considered to be highly favorable.

The benefit in Table 15.1.6 was incurred from the VOC saving and, other benefits such as that resulting from the improvement of the urban environment along the road, or the conservation of historic monument, are not included. The table shows that the alternative with 40 m ROW and land acquisition along the road, has the lowest EIRR among the three, however this alternative will have more benefit when the other benefits are considered.

Table 15.1.6 Economic Evaluation Indices for Kamel Sidky St. Improvement Project

Alternatives	Economic Cost (M.LE)	B/C 12%	NPV 12% (MLE)	EIRR (%)
1 26m 4 Lane	93.9	5.8	208.3	39.9
2 40m 6 Lane	135.5	4.2	200.3	33.3
3 40m 6 Lane + Land alongside Route	176.0	3.2	182.0	28.2

15.1.7 Recommendation

About 80% of the total initial investment shall be used for land acquisition and compensation payments. Land acquisition is expected to be difficult because the route passes through highly dense residential area and the demolition of many buildings shall be needed.

However, since the area along the route is located adjacent to Ramses sq. which is situated in the city center of GCR, and has high potentiality for business and commercial activities, this project should be implemented in association with a redevelopment plan (see Chapter 12) for the surrounding area and therefore the alternative having 6 lanes and land acquisition of the road side area will be recommendable. This alternative can also provide an opportunity for the conservation of the Old Cairo Wall.

It is advisable that further studies on the following items shall be continued in order to examine the magnitude of the influence by land acquisition.

a. land ownership
b. resident attribute (income level, occupation, work place, etc.)
c. dwelling rights of land owners and tenants, and rents
d. demand for and expected price of land along the route

After reaching some agreement with the residents, land acquisition should be started during the second half of the 1990's with construction to be completed by the year 2000.

15.2 Inner Ring Road Northern Package

15.2.1 Introduction

Inner Ring Road Northern Package consists of;

a. Sekket Al Wayli st. from Rod Al Farag br. to Salah Salem st. via Corniche st.
b. Rod Al Farag br.
c. RodAl Farag br. western approach from Sudan st. to the bridge.

The main objectives of the Study for section a is to review and to adjust the 1984 study results with the changes that took place after the study, and to make a comparative study of an elevated road alternative over the ENR yard and the 1984 study proposal for an open cut and tunnel alternative.

Section b; Rod Al Farag br. is under construction at present. The idea for section c has been proposed in former studies, however so far no study has been made.

The Study aims to evaluate the effect of the packaged projects as a part of the Inner Ring road.

15.2.2 Highway Planning

1) Sekket Al Wayli St.

(1) Outline of the 1984 Study

a. Design Standards

The design standards applied in the 1984 study were;

Design Speed : 65 km/h
Lane Number : 6 lanes
ROW : 27 m - 32 m

b. Route and Length

The route and length is shown in Table 15.2.1. The total length, including the pavement improvement on Corniche and Farangy streets is 8.87 km..

c. Major Structures

The major structures proposed in the 1984 study were;
i Underpass structure below Ahmed Helmi st., ENR Cairo - Alexandria Main Line and ENR yard.
ii Underpass structure of Regional Metro Al Marg Line below Sekket Al Wayli st.
iii Widening of the existing bridge over Heliopolis Metro Line.
iv Underpass structure of Khalifah Al Mamoun st. below Sekket Al Wayli st.

Table 15.2.1 1984 Study Proposal for Sekket Al Wayli St. Improvement Project

Section	Length (Km)	Contents
1 Corniche St.	1.90	Pavement Improvement
2 Corniche St. - Ahmed Helmi St.	1.38	Widening
3 Ahmed Helmi St. - ENR Yard	1.09	New Construction
4 ENR Yard - Port Said St.	0.94	Improvement
5 Port Said St. - Kobba Palace	1.50	Pavement Improvement
6 Kobba Palace - Khalifah Al Mamoun St.	0.68	Widening and New Construction
7 Khalifah Al Mamoun St. - Salah Salem St.	1.38	Pavement Improvement
Total	8.87	

d. Estimated Cost

The cost was estimated at 30.8 million LE in 1984 price (Table 15.2.2), of which the cost of the 4 major structures occupied 20.9 million LE or 67.9% of the total and the cost of land acquisition was 5.4 million LE or 17.5%.

Table 15.2.2 Estimated Cost for Sekket Al Wayli St. Improvement Project in 1984 (Price in 1984)

Description	1984 Cost Unit	Qty	Total (MLE)
1 Road			
1 New Construction	Km	2.32	0.700
2 Patching	Km	3.56	0.495
3 Sidewalk and Median	Km	4.02	0.036
4 Curb	Km	6.07	0.210
5 Light	Km	4.02	0.400
6 Gulley	LS	1	0.020
7 Contingency	%	10	0.186
subtotal			2.047
2 Utility	LS	1	2.494
3 Structure			
1 Ahmed Helmi Tunnel	LS	1	15.640
2 Al Marg Line Br.	LS	1	0.500
3 HCHD Br.	LS	1	0.100
4 Khalifah Al Mamoun Tunnel	LS	1	4.610
subtotal			20.850
4 Land	Km	2.32	5.409
Total			30.801

(2) Adjustment to Present Conditions

Regarding the route, there is basically no change from that described in the 1984 study, however currently an elevated road is under construction from Kobba Palace and extending beyond the Khalifah Al Mamoun st. intersection. Therefore the three major structures; the underpass of Regional Metro Line, the bridge on Heliopolis Metro Line, and the underpass of Khalifah Al Mamoun st. are to be excluded from the project.

The cost in 1984 price was adjusted to that in 1988 price by the following procedures;

a. The costs were divided into foreign and local currency portions by items.
b. The local currency portion was adjusted into the cost in 1988 price applying the average annual inflation rate of 13.0%. The adjustment factor coincides with the GNP deflator of 1988 and 1984 of about 1.6.
c. The foreign currency portion was converted from the cost in 1984 LE to that in 1984 US$ applying the exchange rate of 1.0 US$ = 0.7 LE in 1984. Then the cost in US$ was adjusted to that in US$ 1988 applying the average annual inflation rate of 5.0%.
d. The total of the foreign and local currency portions in 1988 in terms of LE was calculated applying the exchange rate of 1.0 US$ = 2.3 LE in 1988.

Table 15.2.3 Adjusted Cost of Sekket Al Wayli St. Improvement Project for 1988 Price

Description	Unit	Qty	1988 Cost Total (MLE)	Foreign (MUS$)	Local (MLE)
1 Road					
1 New Construction	Km	2.32	1.472	0.243	0.913
2 Patching	Km	3.56	1.041	0.172	0.646
3 Sidewalk and Median	Km	4.02	0.076	0.013	0.047
4 Curb	Km	6.07	0.442	0.073	0.274
5 Light	Km	4.02	0.841	0.139	0.522
6 Gulley	LS	1	0.042	0.007	0.026
7 Contingency	%	10	0.391	0.065	0.243
subtotal			4.305	0.711	2.670
2 Utility	LS	1	7.217	2.314	1.894
3 Structure					
1 Ahmed Helmi Tunnel	LS	1	47.678	16.295	10.200
2 Al Marg Line Br.	LS	1	1.524	0.521	0.326
3 HCHD Br.	LS	1	0.305	0.104	0.065
4 Khalifah Al Mamoun Tunnel	LS	1	14.053	4.803	3.007
subtotal			63.561	21.723	13.598
4 Land	Km	2.32	8.819		8.819
Total			83.902	24.748	26.981

Accordingly the 1984 cost of 30.8 million LE was calculated at 83.9 million LE in 1988 price or about 2.7 times of the 1984 cost including the cost for 4 major structures, and 66.3 million LE when the cost for 3 major structures out of 4 are excluded (Table 15.2.3).

(3) ENR Yard Crossing Alternative

The 1984 study proposed consecutive open cut and tunnel structures for the crossings of Ahmed Helmi st., ENR Alexandria Main Line and ENR yard as shown in Table 15.2.4. The vertical clearance within the tunnel was 5.5 m, the depth of the top slab of the tunnel culvert was 1.0 m, and the approach gradient was 4.0%. The total cost for the open cut and tunnel structures was estimated at 15.64 million LE in 1984 price and is calculated at 47.68 million LE in 1988 price.

Table 15.2.4 Proposed ENR Yard Structures in 1984 Study

Section	Length (m)	Structure Type
1 Western Approach	221.0	Open Cut Underpass
2 Under Ahmed Helmi St.	35.0	Culvert
3 Intermediate Section	10.0	Open Cut Underpass
4 Under Alexandria Line	10.0	Culvert
5 Intermediate Section	21.0	Open Cut Underpass
6 Under Existing Street	16.0	Culvert
7 Intermediate Section	271.0	Open Cut Underpass
8 Under ENR Yard	291.0	Culvert
9 Eastern Approach	210.0	Open Cut Underpass
Total	1,085.0	

The points to be discussed to select a bridge type over the ENR yard are summarized below:

a. The possibility to locate bridge piers within the ENR yard is small.
b. The construction works may be limited by the rail operation in the yard in the cases of tunnel or standard bridge alternatives. Special temporary works to support rail tracks to avoid the disturbance on the rail operation should be planned together with the planning of the structure itself.
c. The axis of Sekket Al Wayli st. and that of the ENR yard intersect at a small angle of about 35 degree, therefore the length of the crossing structure will change largely depending on the route location.

To avoid these problems, a bridge type that can cover a span length of more than 100 m and requires no staging work under the bridge girder during construction is required. Post tension PC cantilever type in concrete bridges, or cable staying or suspension types in steel bridges can meet these requirements, and the concrete bridge is considered economically favorable.

The standard viaduct with a span of 30 m can be applied and will reduce the cost, if agreement can be reached with ENR on the following conditions:

a. The bridge piers can be located within ENR yard.
b. The rail operation can be modified or partially closed to allow the installation of temporary support to underpin the bearings during the excavation for bridge piers, the installation of temporary stagings or the erection of girders from the railway yard.

The temporary detour or closure of rail operation was also assumed in the tunnel alternative in the 1984 study, however the cantilever bridge alternative was selected in this Study as the base case in view of the small possibility on the railway operation change.

Fig. 15.2.1 shows the alternative routes to cross the ENR yard. The center span in route A, which was proposed in the 1984 study, will be 180 m, taking into consideration the pier locations and the skew angle. Route C has the least center span of 100 m because the route intersects the ENR yard at a right angle, however the detour route is needed east of the yard and accordingly additional land acquisition is needed. Therefore the route should be selected between routes A and B.

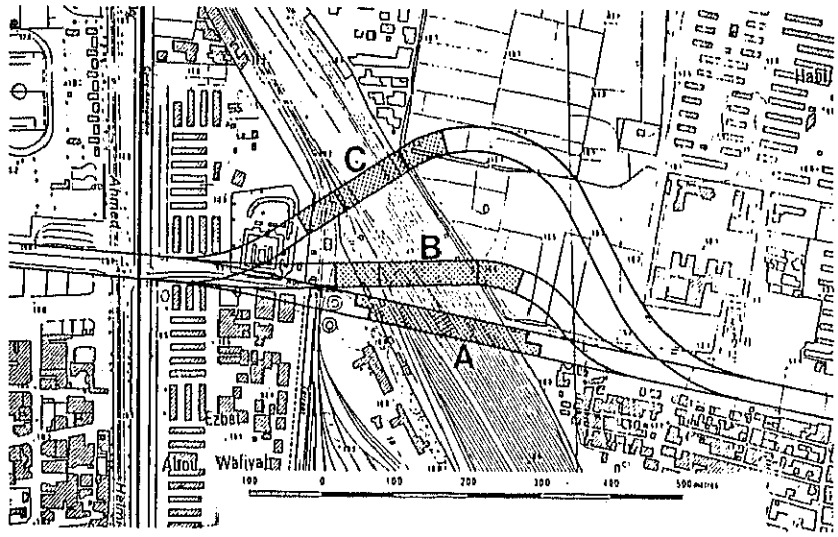


Fig. 15.2.1 Route Alternatives for ENR Yard Crossing

Fig. 15.2.2 shows the relationship between the center span length and the bridge cost per meter in the case of cantilever type bridge. The cost per meter does not change until the span reaches to 125 m, however it increases sharply afterwards.

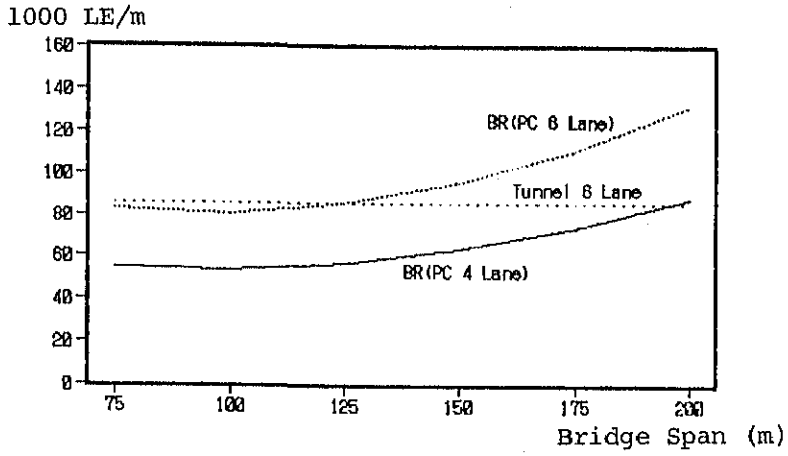


Fig. 15.2.2 Bridge Cost per Meter (PC Post-Tension Type)

Route B, where the center span was 130 m and no additional land acquisition was needed, was finally selected. The girder height at the pier was calculated at 7 m, and 3.5 m at the span center. A vertical gradient of 5.0%, 1.0% steeper than that in 1984 study on the ramps to connect with Ahmed Helmi st. is needed for this alternative.

The whole structures consist of;

a. approach slope	:	161 m
b. approach viaduct	:	376 m
c. cantilever bridge	:	270 m
d. approach viaduct	:	150 m
e. approach slope	:	146 m
Total	:	1,103 m

The cost of the whole structures was estimated at 52.5 million LE, which was 10% higher than 47.7 million LE in 1984 study, while the cost of cantilever bridge at 85.3 thousand LE/m is cheaper than the tunnel cost at 99.7 thousand LE/m. The discrepancy was incurred mainly from the costs of the approach viaducts.

The cost will decrease to 44.3 million LE, which is 10% cheaper than that in the 1984 study, when a standard viaduct with 30 m span instead of the cantilever bridge is applied.

2) Rod Al Farag Br. Western Approach

(1) Design Standard

The design standard of Sekket Al Wayli st. shall also be applied for Rod Al Farag br. Western Approach, although Sudan st., to which it will be connected, is a 25 m wide 4 lane road at present.

(2) Route Location

The 1.4 km Wehda st. which directly connects to Rod Al Farag br. has a secured ROW of 40 m. The 1.8 km Bouhi st., which connects to Wehda st. has also almost secured ROW of 50 m, although some buildings exist within that ROW. Therefore both streets shall be used as the project roads.

The specialized buildings located from Bouhi st. to Sudan st. are shown in Fig. 15.2.3. CTA bus depot is located around the intersection with Sudan st. and one primary school is located within the ROW of Bouhi st.

Fig. 15.2.3 Location of Specialized Buildings along Western Approach

Two alternatives are provided for the crossing of the ENR tracks to connect with Sudan st.; Alternative A north of the tracks, and alternative B south of the tracks (Fig. 15.2.4). In the case of Alternative B, the 30 m width between existing buildings and the tracks will create some land acquisition problems, however on the other hand there is the advantage that the buildings in the way are old and land acquisition may not be so difficult. In case of Alternative A, two railway crossing structures are necessary; one over the main tracks, and the second over the single silo line tracks. Large scale structures shall be required for the crossing with the main tracks because of the small skew angle. Therefore Alternative B is considered the better of the two.

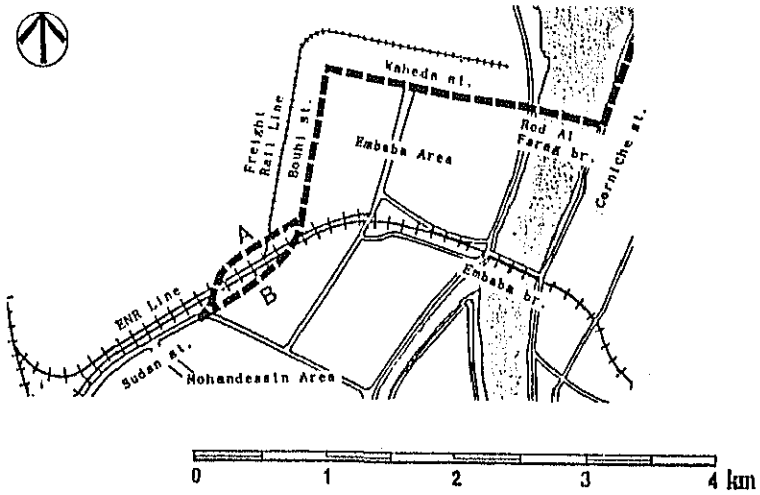


Fig. 15.2.4 Route Alternative of Western Approach at ENR Crossing

In alternative B, a culvert was planned to cross the tracks because the ENR tracks run on a level of about 3m higher than the adjacent ground. The lengths of the planned culverts are 100 m for the north bound lane and 140 m for the south bound. A 200 m approach slope north of the track and 160 m approach south of it are planned.

15.2.3 Traffic Demand Forecast

Traffic demand forecast was made for the following three alternatives;

a. The case where Sekket Al Wayli st. is constructed,
b. the case where Western Approach is constructed, and
c. the case where both Sekket Al Wayli st. and Western Approach are constructed.

In all the cases, Rod Al Farag br. was assumed to be completed. In the case of the 6 lanes facility, the average daily traffic demand in the year 2000 by section and case are shown in Table 15.2.5. In the case where all the sections are executed,

the demand is the highest. Furthermore in all the three cases, the demand along Sekket Al Wayli st. is the highest at about 120,000 pcu/day, while the demand on the western approach is in the level of 65,000 pcu/day.

Table 15.2.5 Future Traffic Demand for Inner Ring Road Northern Package Project

(unit: 1000 pcu/day)

Case	WA	RAF br.	SW
1 RAF br. + SW	--	88	118
2 RAF br. + WA	63	89	--
3 SW + RAF br. + WA	67	93	121

Note: WA : Western Approach
RAF br. : Rod Al Farag Br.
SW : Sekket Al Wayli

Table 15.2.6 Construction Cost Estimate for Inner Ring Road Northern Package

Description	Unit	Qty	Foreign (MUS$)	Local		Total	
				Financial (MLE)	Economic (MLE)	Financial (MLE)	Economic (MLE)
(1) Sekket Al Wayli St.							
1 Road							
1 New Construction	Km	2.82	0.30	1.11	0.89	1.79	1.70
2-Patching	Km	3.56	0.17	0.65	0.52	1.04	0.99
3 Sidewalk and Median	Km	4.02	0.01	0.05	0.04	0.08	0.07
4 Curb	Km	4.02	0.03	0.12	0.10	0.19	0.18
5 Light	Km	4.02	0.14	0.52	0.42	0.84	0.80
6 Gulley	LS	1	0.01	0.03	0.02	0.04	0.04
7 Contingency	%	10	0.07	0.25	0.20	0.40	0.38
subtotal			0.72	2.72	2.17	4.38	4.17
2 Utility	LS	1	1.69	2.23	1.79	6.13	6.46
3 Structure							
1 ENR Br.	LS	1	15.49	16.90	13.43	52.52	56.17
2 Al Marg Line Br.	LS						
3 HCHD Br.	LS						
4 Khalifah Al Mamoun Tunnel	LS						
subtotal			15.49	16.90	13.43	52.52	56.17
4 Land	Km	2.47		9.39	9.39	9.39	9.39
Total			17.90	31.19	26.78	72.37	76.19
(2) Western Approach							
1 Wehda St. Section	Km	1.40	1.52	2.66	2.11	6.14	6.30
2 Bouhi St. Section	Km	1.82	1.84	3.18	2.60	7.40	7.67
3 North App.	LS	1	0.29	0.36	0.54	1.03	1.34
4 ENR Culvert	LS	1	1.55	2.86	3.69	6.44	7.98
5 South App.	LS	1	0.36	0.45	0.68	1.28	1.67
6 ENR - Sudan St. Section	Km	1.30	1.21	2.10	1.73	4.87	5.06
7 Land	Ha	0.61	0.00	6.06	6.06	6.06	6.06
Total			6.77	17.67	17.41	33.23	36.08
Grand Total			24.67	48.86	44.19	105.60	112.27

15.2.4 Construction Cost Estimate

The construction cost was estimated at 105.6 million LE in total (Table 15.2.6), of which 53.7% or 24.7 million US$ is foreign currency portion and 46.3% or 48.9 million LE is local currency. The cost for Sekket Al Wayli st. occupies 68.5% and for Western Approach 31.5%. Of the total 72.4 million LE for Sekket Al Wayli st., the ENR yard br. cost is 72.6% or 52.5 million LE.

15.2.5 Economic Evaluation

The economic evaluation was made including the cost of Rod Al Farag br., which amounts to a total of 47.0 million LE; 30.0 million LE in 1988 and 17.0 in 1989, since the bridge will seriously affect the traffic demand on Western Approach and is considered one of the components of Inner Ring Road Northern Package.

Table 15.2.7 EIRR of Inner Ring Road Northern Package Project

Case	B/C 12%	NPV 12% (MLE)	EIRR (%)
1 Whole Route with 6 Lanes Operated Simultaneously	5.0	391.9	37.1
2 Sekket Al Wayli st. + Rod Al Farag br.	4.4	270.3	34.4
3 Rod Al Farag br. + Western Approach	1.4	23.6	15.6

Since the total package obtained a high EIRR of 37% and far exceeded the capital opportunity cost of 12%, the project is judged to be economically viable. If each component is evaluated individually, the total return will decrease. The total effect of the components when constructed together is larger than when each component is constructed individually, as shown in Table 15.2.7.

15.2.6 Recommendation

Initial investment cost of the three components is relatively small, at 105.6 million LE in 1988 price. On the other hand, the traffic demand and economic return are large, therefore it is recommended to construct the 6 lane Sekket Al Wayli st. and Western Approach in the first half of the 1990's.

The cantilever type bridge is recommended over the ENR yard. Cost of the tunnel and open cut alternative was proved to be cheaper than the bridge alternative, however the tunnel alternative can not be implemented as long as the possibility to reach an agreement with ENR is small, while on the other hand the bridge alternative will not affect the rail operation.

It is recommended to maintain contact with ENR on the yard crossing structure and construction process. The railway yard is one of the important facilities for the rail operation, however it divides the northern part of GCR into two areas for an extension of 4.5 km. This situation causes the concentration of the traffic into Ramses st. in the south and Ismailia Canal Road in the north, and therefore a high EIRR was calculated by the construction of Sekket Al Wayli St. The modification of the rail arrangement within the yard should be planned together with the introduction of ENR commuter service between Shubra Al Kheima and Cairo Central Stations.

The study proved the existence of sufficient traffic demand for 6 lane Sekket Al Wayli st. improvement, however a 4 lane structure at the limited section over ENR yard can be applied in view of the fact that a 4 lane flyover at Kobba Palace over the Regional Metro and Heliopolis Metro is currently under construction despite the 1984 study 6 lane structure proposal.

16. Upgrading of Heliopolis Metro, New Ramses Nozha line

16.1 Demand

1) Demand in 1989

The number of passengers were surveyed on station to station basis in February 1989. Fig 16.1.1 shows the actual passenger flow calculated from that survey. The largest flow is seen in the section between Koliet Al Tarbia and Al Demerdash, where the traffic volume shows 76 thousand passengers per day at the most crowded section.

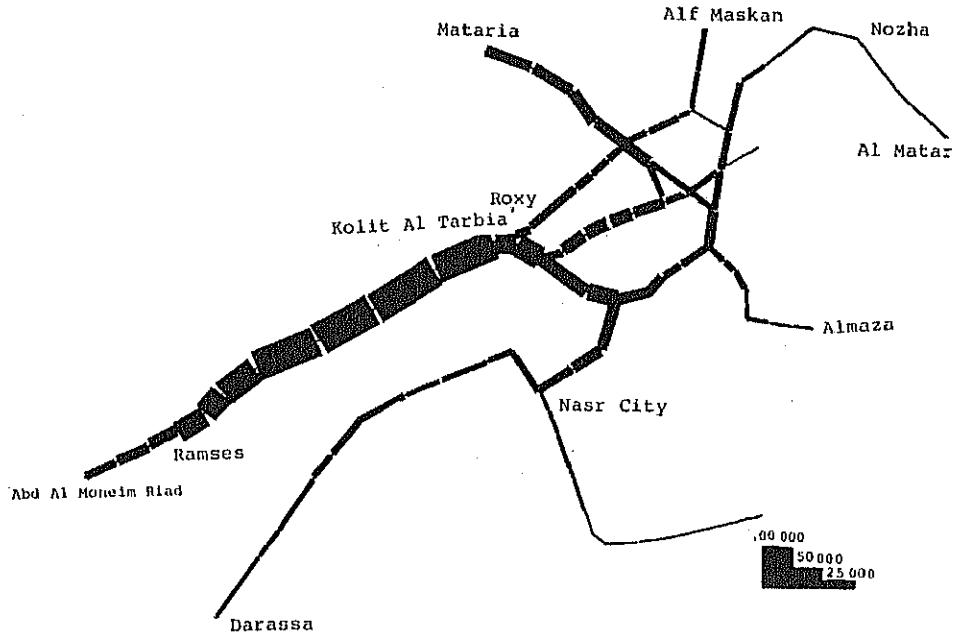


Fig. 16.1.1 Passenger Flow in 1989

The large passenger flow coming from the Ramses direction branches into three directions; first in the Koliet Al Banat direction, second in Cinema Al Horreiya direction, and third in the Merryland direction. The major share of passenger flow is in the first two directions. Another large flow can be observed along Al Mataria line in the Al Mataria - Haroun Al Rashid section.

The largest ten stations where passengers get on or off the metro are shown in Table 16.1.1.

2) Demand in 2000

The tracks to be upgraded are from Ramses (Kobri Al Lymon) via Merryland, Mostashfa Heliopolis, Al Hegaz up to Al Nozha. Along this line, the section between Mostashfa Heliopolis and Al Hegaz is planned to be newly constructed.

Table 16.1.1 The Largest Ten Stations

	Getting on		Getting off	
	Name	Passenger No./day	Name	Passenger No./day
1	Abdel Moneim Riad	17990	Abdel Moneim Riad	13192
2	Ramses	11631	Ramses	11165
3	Ain Shams Univ.	11179	Kobri Al Lymon	9968
4	Koliet Al Tarbia	11122	Ghamra	9102
5	Roxi	10333	Demerdash	8884
6	Al Mahkama	9672	Ain Shams Univ.	8414
7	Alf Maskan	8045	Manshiet Al Bakry	7863
8	Koliet Al Banat	7391	Koliet Al Tarbia	7620
9	Omar Ibn Al Khattab	7121	Roxi	7021
10	Mataria	7062	Mataria	6447

Source: HCHD and Study Team Joint Survey

Needless to mention, the demand is highly dependent on tariff rate under the conditions of competitive transport modes. From the financial point of view, complicated discussions shall be done on tariff rate to be applied to the updated line. However, in this section, the existing tariff rate (in 1988 constant price) is applied to all the Heliopolis Metro lines for convenience to compare with existing demand (Fig. 16.1.1). Demand in the year 2000 is illustrated in Fig. 16.1.2, which shows that the new main line shall become a trunk line.

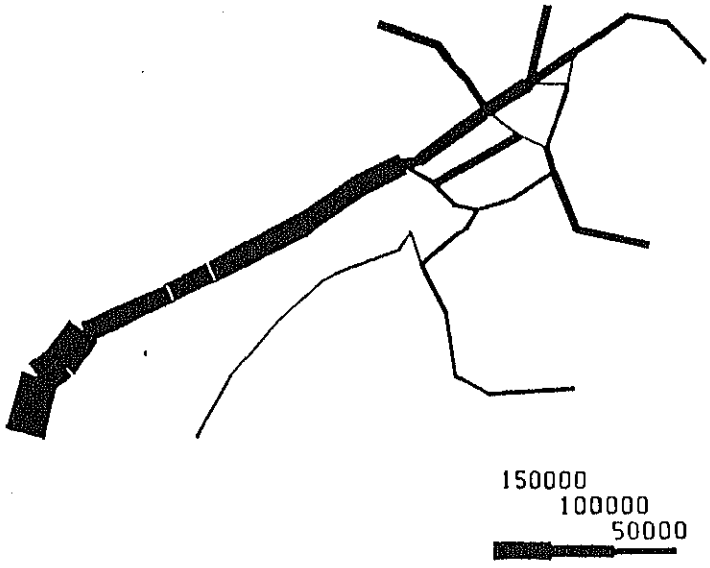


Fig. 16.1.2 Passenger Flow in 2000

The daily total volume transported is 2,248 thousand person kilometer or 47.5 thousand person/km. Maximum hourly transports are seen at the section between Koliet Al Tarbia and Al Demerdash, at 28 thousand persons/hr.

16.2 Basic Plan

1) Overall Route Subject to Upgrading

Starting point: Ramses
Ending point : Al Nozha
Route : The route of the existing tramway will be used wherever possible (Fig. 16.2.1).

a. The Ramses - Roxi section will be left as is, and will share tracks with other tram lines.

b. The Roxi - Mostashfa Heliopolis section will follow the route of the Alf Maskan line.

c. The Mostashfa Heliopolis - Hegaz sq. section (800 meters) is to be newly constructed.

d. The Hegaz sq. - Al Nozha section will follow the route of the Nozha line.

Total extension: 15 kilometers

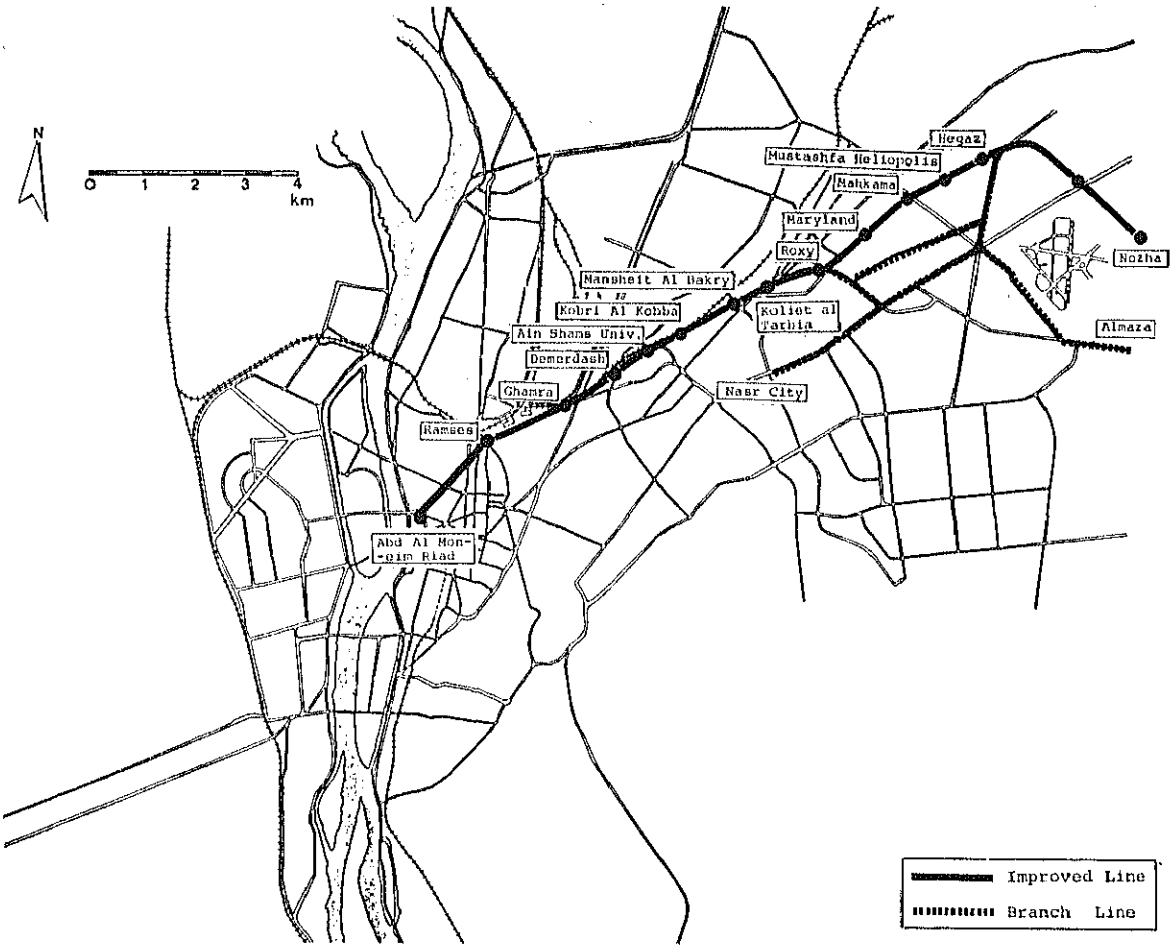


Fig. 16.2.1 Plan of Heliopolis Line Improvement and Extension

2) Construction Standards

Construction standards are established under the assumption that the rolling stock currently in use on the Heliopolis line will be used. Details are shown in Table 16.2.1. The construction gauge is as given in Fig. 16.2.2.

Table 16.2.1 Construction Standards

Item		Dimension
Gauge		1000 mm
The minimum radius of curvature	Main track	150 m
	Along the platform	200 m
	Side track	50 m
The maximum cant		100 mm
The steepest grade	Main track	30 %
	Along the platform	10 %
	Side track	2 %
The minimum vertical curve		1500 m
Ballast depth (from sleeper bottom to ballast formation)	Gravel made	250 mm
Rail unit weight	main track	54 kg/m
	side track	40 kg/m
Distance between track centers	main track	3.5 m
	side track	3.5 m
Platform	Effective length	110 m
	Width	
	* island form	5 m
	* separate form	4 m
	Height from rail top	450 mm
	Distance from track center to form end.	1.300 mm
	Distance from form end to column or wall surface on the form.	1.000 mm
Formation width		8.5 m
Electric rail car line system	ground surface	double compound catenary
Railway signaling equipment	Blocking and signaling system	automatic blocking, way side signal

3) Rolling Stock

An outline description of the rolling stock assumed in accordance with the construction standards is given in Fig. 5.2.6 of Chapter 5. Principal particulars of car are listed in Table 16.2.2.

Table 16.2.2 Principal Particulars of Cars

Items	Heliopolis
Train Formations	Mc-M-T2-T2-M-Mc
Track Gauge (mm)	1,000
Electric Power Supply	600V DC overhead contact system
Tare Weight (t)	Mc:21.62, M:21.6, T:18.0
No. of Passengers	(Seating) (Standing)
Driving Car	40 145
Middle Car	64 116
Acceleration (m/s2)	
High	0.90
Normal	0.60
Low	0.37
Retardation (m/s2)	1.12
Maximum Speed with Full Load (km/h)	62.50
Dimensions of Car Body (LxHxW) (mm)	
Driving Car	15,800x3,290x2,400
Middle Car	16,320x3,290x2,400
Bogie Center Distance (mm)	
Driving Car	8,400
Middle Car	9,800
Wheel Base (mm)	1,900
Bogie	KINKI type cylindrical axle box guide system bogie
Coupler	Bar type coupler with rubber draft gear
Traction Motor	Direct current, series wound with interpoles 1h:70 Hp-300 V-196A 1,100rpm.F.F.
Gear Ratio	73/16=4.56
Wheel Diameter (new) (mm)	660
Traction Control System	Multi-notch, automatic acceleration, camshaft and cam contactors system driven by a pilot motor with emergency rheostatic brake Series running step :11 Parallel running step : 6 Braking step :10
Braking System	SME straight air brake with emergency rheostatic brake
Current Collector	Pantograph
Auxiliary Power Supply System	DC 1kw MG (for Mc, M car) M:2p-2.2kw-600V-4A-3600 rpm G: 2p-1kw-110V DC-9.1A DC 100V-20Ah battery
Lighting	
Passenger Room	DC 600V-30W fluorescent lamp Driving car :10 Middle car :12
Head Light	DC 100V-60Wx2
Tail Light	DC 100V-40Wx2

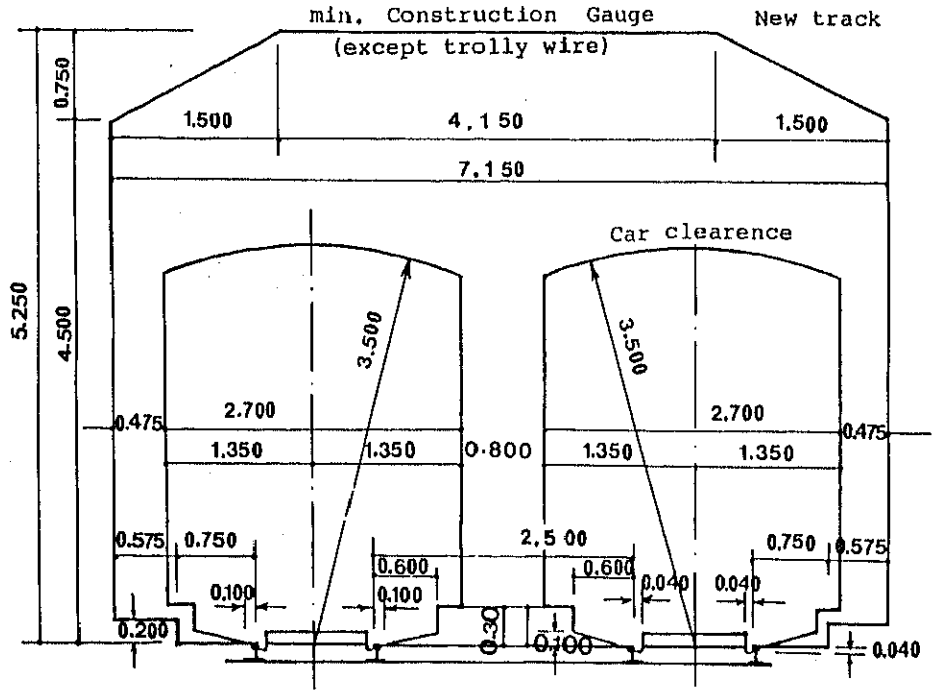


Fig. 16.2.2 Heliopolis Metro (Construction Gauge and Car Clearance)

4) Route Plan

The profile of the route plan is shown in Fig. 16.2.3. The route plan can be described as follows:

a. In the Ramses - Roxi section, the existing tracks will be used (6.8 kilometers).

b. There is an at-grade crossing of the Al Mataria and Alf Maskan lines in the Roxi - Al Hegaz section. In addition, street intersections near both squares have heavy traffic, and a grade-separated crossing is desirable at these points to avoid creating bottlenecks. In view of these factors, the section will be grade separated (4.5 kilometers).

c. In the Al Hegaz - Nozha section, the existing tracks will be used (3.7 kilometers).

d. Open Cut or Elevated Method

Two types of grade separation structures are considered. One is the elevated type and the other is open cut type structure. The difference in construction costs of both methods is considered to be small, however the exact costs can not be estimated without detailed engineering data. Nevertheless, the elevated type structure is recommended because adopting the open cut method would create the following problems:

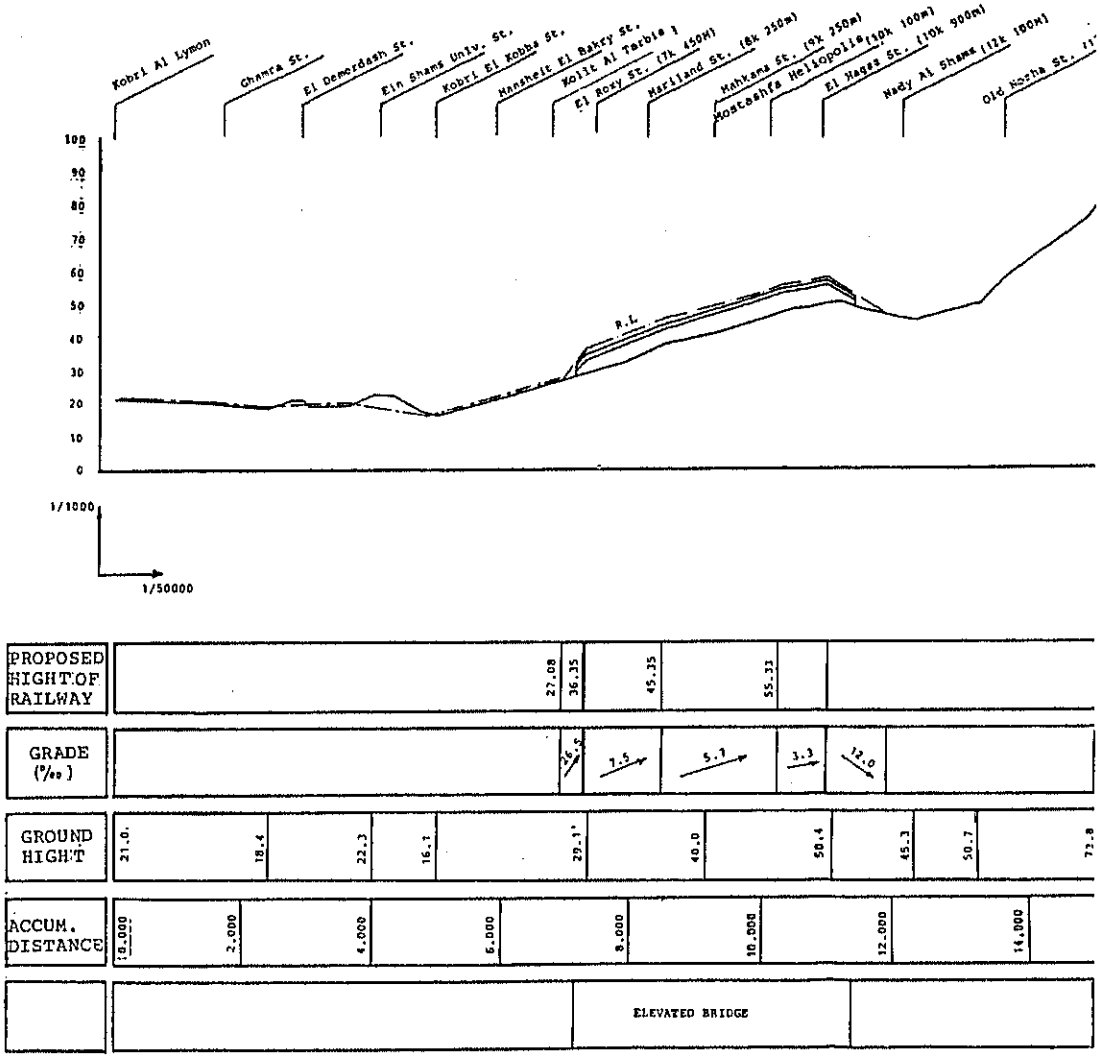


Fig. 16.2.3 Profile of Heliopolis Line

- Traffic on street along the construction section is restricted, especially at the section of station construction.
- Additional costs for works to support tram tracks crossing constructed section are required.
- Sheet pile driving works are required along the operating tramway. Because not enough separation is available between the sheet pile driving place and tramway tracks, there is some possibility of accidents occurring.

Needless to say, these problems may be overcome if tramway operation between Roxi sta. to Mostashfa Heliopolis sta. is suspended during the construction period and the line may be temporarily operated between Al Mataria and Mahkama.

The selection of the grade separation method requires consideration of various issues; not only technical aspects but also social, psychological, and environmental aspects. Discussions on these points must be thorough and comprehensive because once such a structure is constructed, it will remain for several decades.

Fortunately, the difference in construction cost between both structures is estimated to be not so much, therefore the final decision on type of structure will be decided in the feasibility study stage. At this pre-feasibility study stage the conventional elevated type structure is adopted to examine the project.

16.3 Operation Plan

1) Specifications of Train Operation

Specifications are established as follows in line with the basic plan described above.

a. Maximum speed: 60 km/hr for all sections
b. Schedule speed: 30 km/hr target
c. Headway:
   Ramses - Roxi section : Minimum 2 minutes
   Roxi - Al Nozha section : Minimum 4 minutes
d. Train formation: 6 cars, same type as those used at present
e. Planned number of passengers (with full load):
   Main line : 180 pax. x 6 cars = 1,080 pax.
   Branch line : 180 pax. x 4 cars = 720 pax.
f. Type of service: Local train service only
g. Target travel time (between Ramses and Nozha): 30 minutes

2) Number of Trains Required and Operation Schedule

The maximum transport demand per peak hour in the sections surrounding Roxi is calculated as follows (peak ratio 18%):

a. Main line past Koliet Al Tarbia
   (142,000 pax. x 0.18)/2 = 12,780 pax./hr (one direction)

b. Branch line past Koliet Al Tarbia
   (17,000 pax. x 0.18)/2 = 1,530 pax./hr (one direction)

The number of trains required per hour to deal with the maximum transport demand is as follows:

a. Main line : 12,780/1,080 = 11.8 = 12 trains
b. Branch line: 1,530/720 = 2.2 = 3 trains

Fig. 16.3.1 shows the operating conditions during the peak hour.

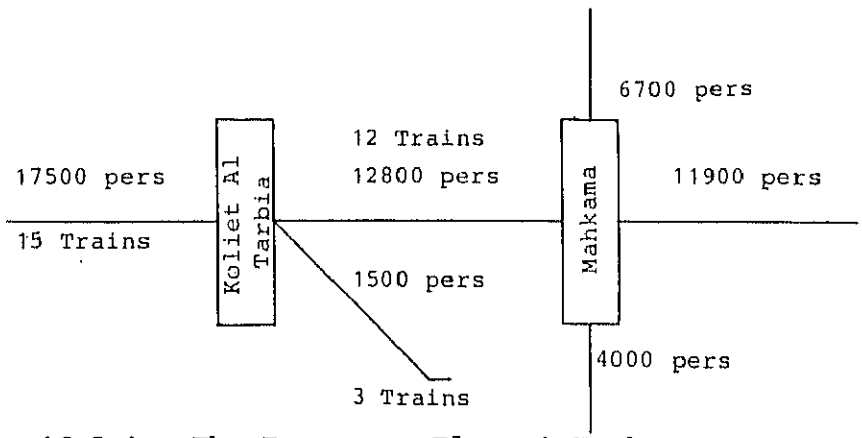


Fig. 16.3.1 The Passenger Flow at Each Cross Section (Single way pers/hr)

Since the main line is operated at 5-minute intervals, there are 12 free slots in an hour during which a branch-line tram can use the track shared with the main line. Of the 12 available free slots, the branch line will actually use three of the slots, as it is operated at 20-minute intervals.

The Koliet Al Tarbia to Ramses section of the main line has 17,500 passengers in the peak hour. Twelve trains of six car formation and three trains of four car formation can provide capacity of 15,120 passengers. Consequently a congestion rate of 115% (demand/capacity) is anticipated.

Fig. 16.3.2 shows the track layout determined in accordance with the foregoing.

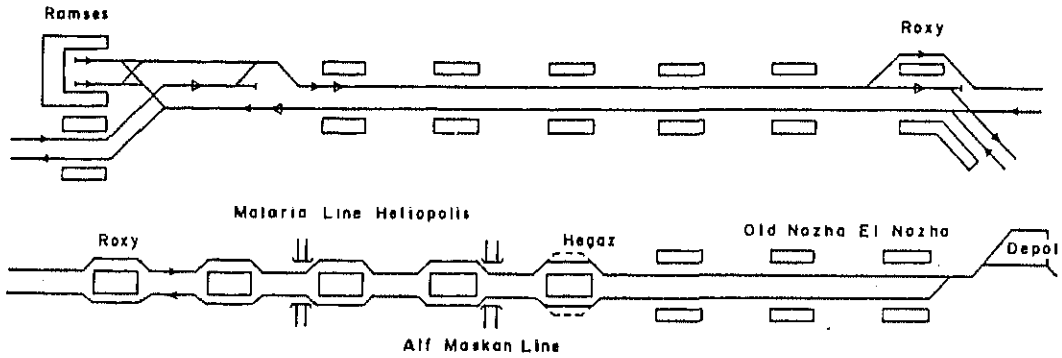


Fig. 16.3.2 Track Layout Sketch

3) Number of Cars Required

The number of cars required is determined on the basis of the above-mentioned track layout and operation plan, and the train diagrams are shown in Fig. 16.3.3. The results are as follows:

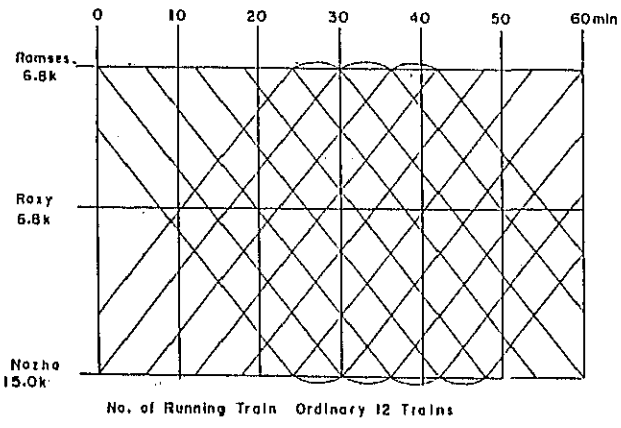


Fig. 16.3.3 Train Diagram at the Set Up Time

15 trains + 3 reserve = 18 trains of the same type as those used at present

Number of cars required:

Main line	6 cars x 15 =	90	cars
Branch line	4 cars x 3 =	12	cars
Total		102	cars

4) Schedule Speed

Travel times were calculated by using the mean value of the acceleration and deceleration speeds given in Table 16.2.2 and the characteristic curve of the train motor. The results, summarized below, are shown in Table 16.3.1. The train diagrams indicate that there is adequate leeway.

Travel time from end to end: 28 min. 35 sec.
Schedule speed : 31.5 km/hr

Table 16.3.1 Necessary Driving Time (Regular Service)

	Station Name	Distance Between Stations (km)	Driving Time (sec)	Staying Time at Station (sec)	Remark
1	Ramses				
		1.30	115		
2	Ghamra			20	
		1.10	105		
3	Al Demerdash			20	
		1.20	110		
4	Al Gamaa			20	
		0.80	85		
5	Kobri Al Kobba			20	
		1.50	135		
6	Manshiet Al Bakry			20	
		0.90	90		
7	Koliet Al Tarbia			30	
		0.65	85		
8	Roxi			20	
		0.80	90		
9	Merryland			20	
		1.00	100		
10	Mahkama			20	
		0.85	85		
11	Mostashfa Heliopolis			20	
		0.80	85		
12	Al Hegaz			20	
		1.20	105		
13	Nady Al Shams			20	
		1.50	120		R=300m
14	Old Nozha			20	Limited V=75km/h
		1.40	135		
15	Nozha				
Total		15.00	1,445.00	270.00	

16.4 Facilities Plan

1) Land

a. Land for Ramses station will be leased from the ENR.
b. Remaining land will be obtained without payment of compensation.

2) Civil Engineering

a. Between Ramses (Kobri Al Lymon) and Koliet Al Tarbia stations, the existing roadbed will be used after improving the drainage facilities (6.8 kilometers).

b. The Roxi - Al Hegaz section will be built as a dual single-track elevated bridge (Fig. 16.4.1). Construction work will be implemented after temporarily re-locating the existing tracks.

c. Between Al Hegaz and Nozha (the current terminus), the existing roadbed will be used. Protective fencing and grade crossings will be newly provided.

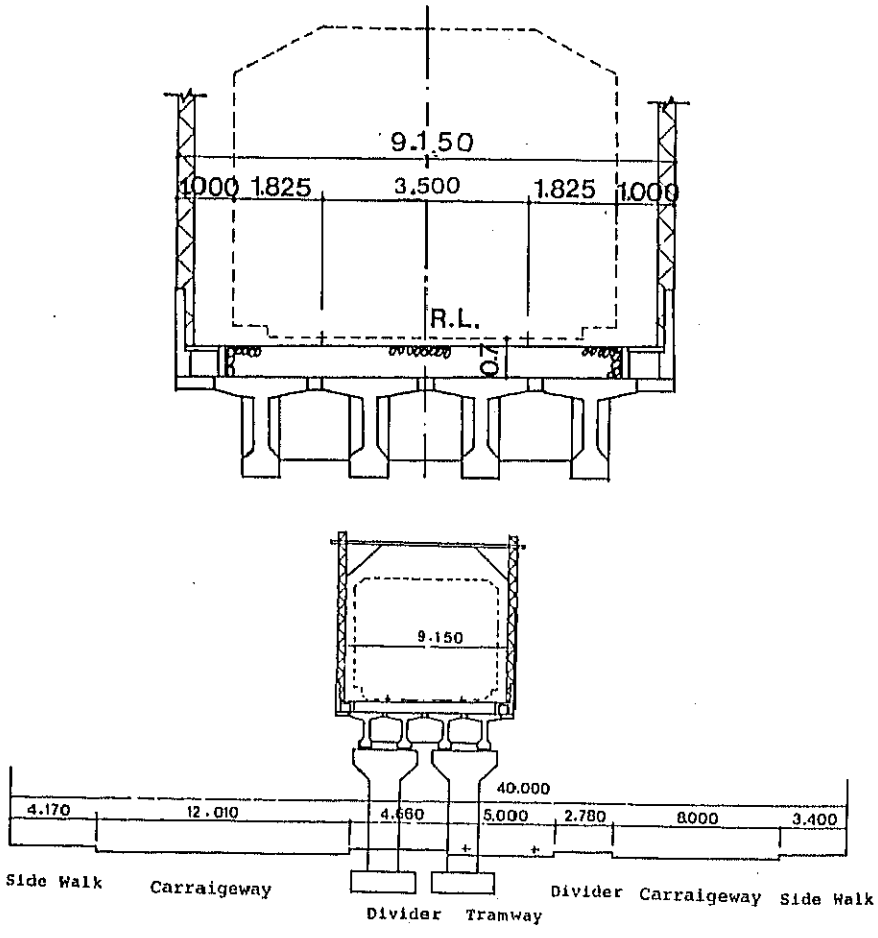


Fig. 16.4.1 Cross Section of Elevated Structure

3) Stations and Tracks

a. Track layout will be rearranged, taking advantage of the former site of ENR's Kobri Al Lymon sta.

b. The Koliet Al Tarbia junction station will be built at ground level. Track layout will be rearranged using existing land as much as possible. In conjunction with the rearrangement, obstructive structures will be re-located.

c. Stations along the elevated route will have island platforms in consideration of the roadway width and to facilitate construction work (Fig. 16.4.2).

d. The existing route will be relaid with 54-kilogram rails along its entire extension.

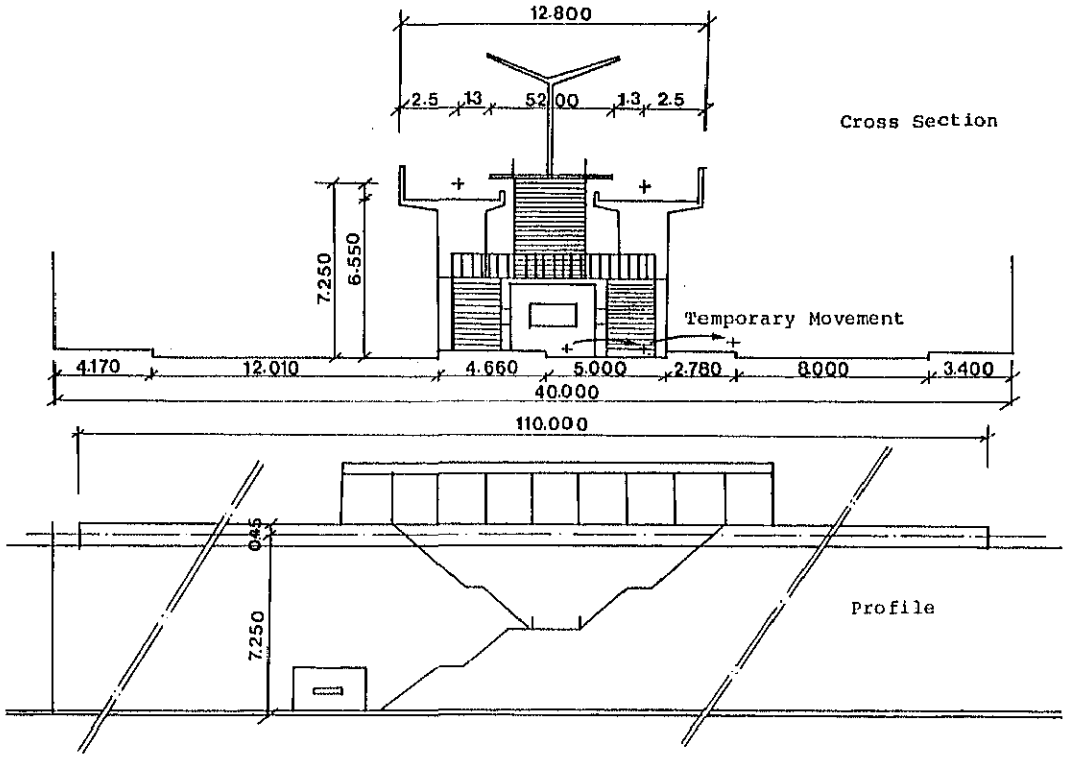


Fig. 16.4.2 Sketch of the Stations

4) Electric Equipment

a. Aerial trolley lines between Old Nozha and Nozha that are currently suspended directly will be provided with double compound catenaries as in other sections.

b. Necessary improvements to the power substations and feeder sectioning posts will be effected.

c. The entire route will be connected to a CTC system by installing way side double-track automatic signals and full relay interlocking devices.

Sections shared with other tram lines will be provided with automatic train stoppers (ATS) and train identifiers in order to operate the turnouts automatically (Figures 16.4.3, 16.4.4).

d. Operating personnel will be assigned to the following stations: Ramses, Koliet Al Tarbia and Nozha. Telephone system will be installed for the use of the operating personnel.

5) **Grade-Crossing**

All crossings will be provided with crossing alarms, and major crossing barriers. At all ground level stations, crossing facilities for passengers will be provided within the station yard.

6) **Rolling Stock**

Cars currently in use in connection with the subject line will be used.

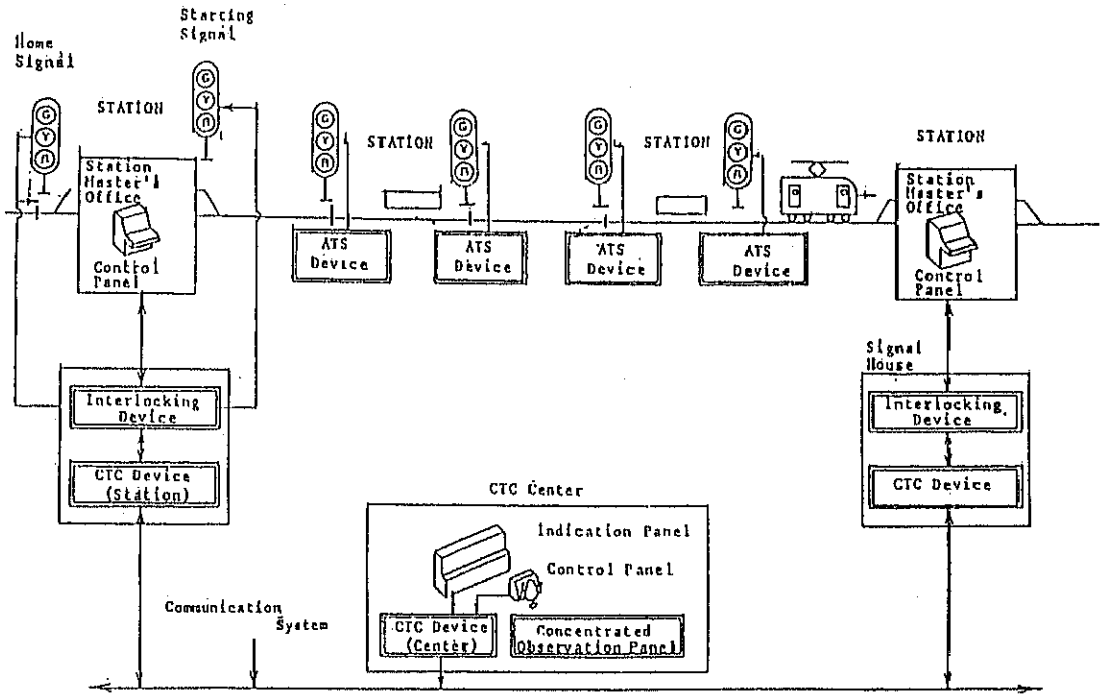


Fig. 16.4.3 Signal Equipment Composition

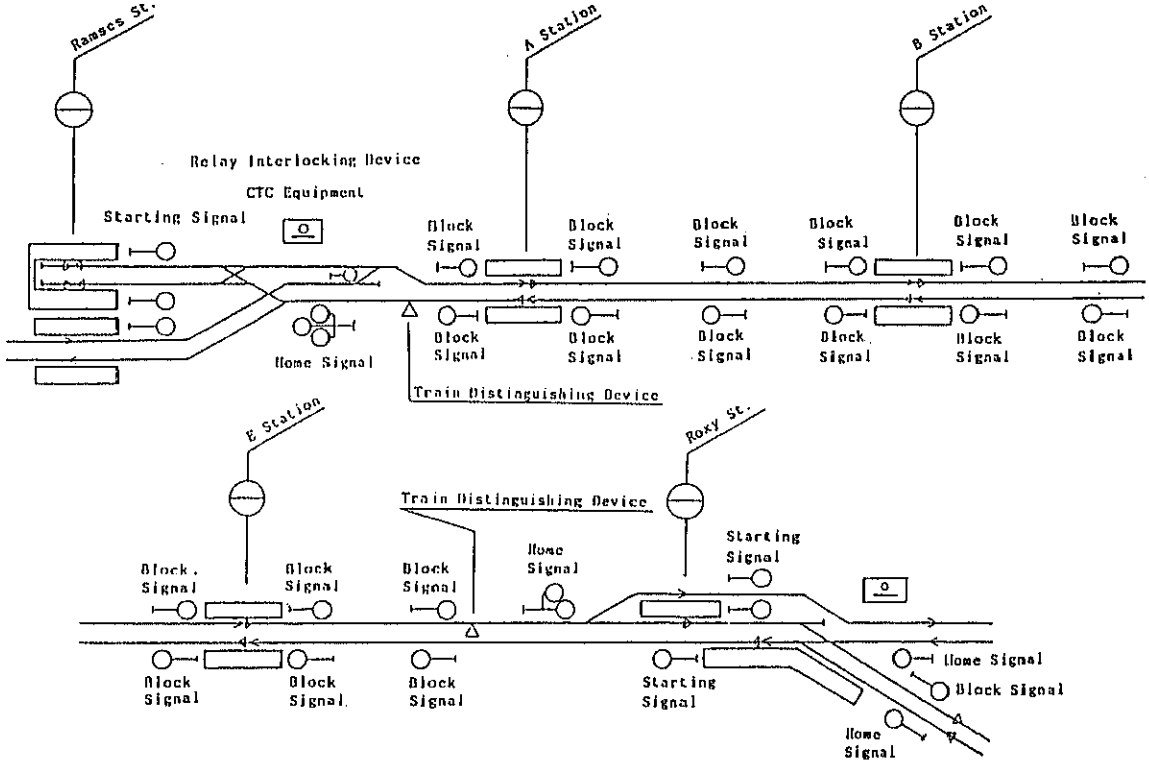


Fig. 16.4.4 Signal Installation and Track Layout

16.5 Upgrading Cost

1) Preconditions

a. Labor cost, the cost of materials (including equipment), and miscellaneous expenses will be calculated individually for each work component in order to estimate the construction cost.

b. Calculations will be made in 1988 prices, and no consideration will be given to price escalation.

c. Calculations will be made separately for domestic currency and foreign currency.

d. Imported materials and equipment subject to payment inforeign currency will be calculated in CIF prices (cost plus insurance and freight).

e. The foreign currency conversion rate shall be US$ 1= 2.3 LE.

f. Local prices will be applied to the unit price of labor and materials. For work components on which local prices are not directly available, unit price will be determined by referring to Japanese prices and adjusting them with Egyptian construction prices.

g. Labor cost for all work components will be in domestic currency. The domestic currency portion of materials cost will be determined in line with the supply situation in Egypt.

h. Contingency costs are given as 10% of the overall construction cost.

i. Rolling stock is not included in the project cost, since cars currently in operation will be used.

2) Cost

Upgrading cost is summarized in Table 16.5.1, and construction cost without elevated structures is tabulated in Table 16.5.2 for reference.

3) Construction Schedule and Annual Investment

The construction schedule for the new Nozha line improvement is shown in Fig. 6.5.1, which is prepared under the consideration that grade separation forms the critical path in this project.

Table 16.5.1 HCHD Elevated br. (R101)

Description	Unit	QTY	UNIT PRICE			PRICE			
			Financial Cost		Economic Cost	Financial Cost			Economic Cost
			Foreign (US$)	Local (LE)	(LE)	Foreign (1000US$)	Local (1000LE)	Total (1000LE)	(1000LE)
1 Civil Works									
1 Superstructure-1	LM	3400	3,446.67	2,005.57	10,730.42	11,718.7	6,818.9	33,771.9	36,483.4
Superstructure-2	LM	550	2,888.98	1,692.04	9,005.91	1,588.9	930.6	4,585.2	4,953.3
subtotal						13,307.6	7,749.5	38,357.1	41,436.7
2 Foundation-1	LM	3400	239.47	404.40	987.30	814.2	1,375.0	3,247.6	3,356.8
Foundation-2	LM	550	199.56	337.00	822.75	109.8	185.4	437.8	452.5
Piles	LM	8572	205.87	250.52	921.93	1,764.6	2,147.3	6,205.9	7,902.3
subtotal						2,688.6	3,707.6	9,891.3	11,711.7
4 Indirect Cost						3,671.1	8,443.5	16,886.9	18,601.9
5 Total						19,667.3	19,900.6	65,135.3	71,750.3
2 Building									
1 Elevated Sta.	EACH	5	210,000.00	1,127,000.00	1,481,200.00	1,050.0	5,635.0	8,050.0	7,406.0
2 Surface Sta. Imp.	EACH	8	49,565.22	266,000.00	349,600.00	396.5	2,128.0	3,040.0	2,796.8
3 Surface Sta. Const.	EACH	2	100,434.78	539,000.00	708,400.00	200.9	1,078.0	1,540.0	1,416.8
Total						1,647.4	8,841.0	12,630.0	11,619.6
3 Facilities									
1 Interior									
Elevated Sta.	EACH	5	45,217.39	416,000.00	457,600.00	226.1	2,080.0	2,600.0	2,288.0
Surface Sta.	EACH	9	20,869.57	192,000.00	211,200.00	187.8	1,728.0	2,160.0	1,900.8
2 Terminal	EACH	1	87,826.09	808,000.00	888,800.00	87.8	808.0	1,010.0	888.8
3 CTC Site Office	LS	1	121,739.13	1,120,000.00	1,232,000.00	121.7	1,120.0	1,400.0	1,232.0
Total						623.5	5,736.0	7,170.0	6,309.6
4 Track									
1 Imp. Rail	LM	22000	69.57	240.00	384.00	1,530.4	5,280.0	8,800.0	8,448.0
2 New Rail	LM	10000	106.52	105.00	378.00	1,065.2	1,050.0	3,500.0	3,780.0
3 Diamond Cross	EACH	3	23,434.78	23,100.00	83,160.00	70.3	69.3	231.0	249.5
4 Point	EACH	10	15,217.39	15,000.00	54,000.00	152.2	150.0	500.0	540.0
5 Relocation	LM	1000	69.57	240.00	384.00	69.6	240.0	400.0	384.0
6 Switching	LS	1	57.39	198.00	316.80	0.1	0.2	0.3	0.3
Total						2,887.8	6,789.5	13,431.0	13,401.8
5 Electric Works									
1 Signaling									
Signal system	Km	30	22,608.70	9,000.00	69,600.00	678.3	270.0	1,830.0	2,088.0
Interlocking Equip.	Set	4	153,260.87	17,500.00	437,000.00	613.0	70.0	1,480.0	1,748.0
CTC Equip.	Sta.	15	64,637.68	4,000.00	181,600.00	969.6	60.0	2,290.0	2,724.0
Block system	Km	30	26,086.96	8,000.00	78,400.00	782.6	240.0	2,040.0	2,352.0
Train Dstg. Equip.	Set	2	108,695.65	10,000.00	308,000.00	217.4	20.0	520.0	616.0
ATS Equip.	Km	30	11,304.35	12,333.33	41,066.67	339.1	370.0	1,150.0	1,232.0
Rail Cross Equip.	Set	11	26,086.96	6,363.64	77,090.91	287.0	70.0	730.0	848.0
Cable	Km	130	6,622.07	10,000.00	26,276.92	860.9	1,300.0	3,280.0	3,416.0
subtotal						4,747.8	2,400.0	13,320.0	15,024.0
2 Telecommunication									
Carrier Equip.	Set	4	107,608.70	2,500.00	299,000.00	430.4	10.0	1,000.0	1,196.0
Cable	Km	46	9,451.80	6,739.13	31,478.26	434.8	310.0	1,310.0	1,448.0
Train Dispatch Tel.	Set	1	56,521.74	10,000.00	164,000.00	56.5	10.0	140.0	164.0
Rail-side Tel.	Set	1	26,086.96	10,000.00	80,000.00	26.1	10.0	70.0	80.0
subtotal						947.8	340.0	2,520.0	2,888.0
3 Power Supply									
New Trolly Line	LM	10000	121.74	420.00	672.00	1,217.4	4,200.0	7,000.0	6,720.0
Imp. Trolly Line	LM	1400	71.30	246.00	393.60	99.8	344.4	574.0	551.0
Substation	Set	1	869,565.22	3,000,000.00	4,800,000.00	869.6	3,000.0	5,000.0	4,800.0
Sta. Power Supply	Sta	15	5,217.39	18,000.00	28,800.00	78.3	270.0	450.0	432.0
subtotal						2,265.0	7,814.4	13,024.0	12,503.0
Total						7,960.7	10,554.4	28,864.0	30,415.0
6 Grade Crossing									
1 At sta.	EACH	8	74,782.61	258,000.00	412,800.00	598.3	2,064.0	3,440.0	3,302.4
2 Inter sta.	EACH	8	92,173.91	318,000.00	508,800.00	737.4	2,544.0	4,240.0	4,070.4
Total						1,335.7	4,608.0	7,680.0	7,372.8
7 Total of 1 - 6						34,122.2	56,429.5	134,910.3	140,869.1
8 E/S Cost	LS					2,932.8	6,745.5	13,491.1	14,086.9
9 Contingency	%	10				3,705.5	6,317.5	14,840.2	15,495.6
Grand Total						40,760.6	69,492.6	163,241.6	170,451.6

Table 16.5.2 HCHD Ground Improvement (R101-R)

Description	Unit	QTY	UNIT PRICE			PRICE			
			Financial Cost		Economic Cost	Financial Cost			Economic Cost
			Foreign (US$)	Local (LE)	(LE)	Foreign (1000US$)	Local (1000LE)	Total (1000LE)	(1000LE)
1 Building									
1 Surface Sta. Imp.	EACH	13	49,565.22	266,000.00	349,600.00	644.3	3,458.0	4,940.0	4,544.8
2 Surface Sta. Const.	EACH	2	100,434.78	539,000.00	708,400.00	200.9	1,078.0	1,540.0	1,416.8
Total						845.2	4,536.0	6,480.0	5,961.6
2 Facilities									
1 Interior Surface Sta.	EACH	14	20,869.57	192,000.00	211,200.00	292.2	2,688.0	3,360.0	2,956.8
2 Terminal	EACH	1	87,826.09	808,000.00	888,800.00	87.8	808.0	1,010.0	888.8
3 CTC Site Office	LS	1	121,739.13	1,120,000.00	1,232,000.00	121.7	1,120.0	1,400.0	1,232.0
Total						501.7	4,616.0	5,770.0	5,077.6
3 Track									
1 Imp. Rail	LM	30200	69.57	240.00	384.00	2,100.9	7,248.0	12,080.0	11,596.8
2 New Rail	LM	1800	106.52	105.00	378.00	191.7	189.0	630.0	680.4
3 Diamond Cross	EACH	3	23,434.78	23,100.00	83,160.00	70.3	69.3	231.0	249.5
4 Point	EACH	10	15,217.39	15,000.00	54,000.00	152.2	150.0	500.0	540.0
Total						2,515.1	7,656.3	13,441.0	13,066.7
4 Electric Works									
1 Signaling									
Signal system	Km	30	22,608.70	9,000.00	69,600.00	678.3	270.0	1,830.0	2,088.0
Interlocking Eqip.	Set	4	153,260.87	17,500.00	437,000.00	613.0	70.0	1,480.0	1,748.0
CTC Equip.	Sta.	15	64,637.68	4,000.00	181,600.00	969.6	60.0	2,290.0	2,724.0
Block system	Km	30	26,086.96	8,000.00	78,400.00	782.6	240.0	2,040.0	2,352.0
Train Dstg. Equip.	Set	2	108,695.65	10,000.00	308,000.00	217.4	20.0	520.0	616.0
ATS Equip.	Km	30	11,304.35	12,333.33	41,066.67	339.1	370.0	1,150.0	1,232.0
Rail Cross Euip.	Set	22	13,043.48	3,181.82	38,545.45	287.0	70.0	730.0	848.0
Cable	Km	130	6,622.07	10,000.00	26,276.92	860.9	1,300.0	3,280.0	3,416.0
subtotal						4,747.8	2,400.0	13,320.0	15,024.0
2 Telecommunication									
Carrier Equip.	Set	4	107,608.70	2,500.00	299,000.00	430.4	10.0	1,000.0	1,196.0
Cable	Km	46	9,451.80	6,739.13	31,478.26	434.8	310.0	1,310.0	1,448.0
Train Dispatch Tel.	Set	1	56,521.74	10,000.00	164,000.00	56.5	10.0	140.0	164.0
Rail-side Tel.	Set	1	26,086.96	10,000.00	80,000.00	26.1	10.0	70.0	80.0
subtotal						947.8	340.0	2,520.0	2,888.0
3 Power Supply									
New Trolly Line	LM	10000	121.74	420.00	672.00	1,217.4	4,200.0	7,000.0	6,720.0
Imp. Trolly Line	LM	1400	71.30	246.00	393.60	99.8	344.4	574.0	551.0
Substation	Set	1	869,565.22	3,000,000.00	4,800,000.00	869.6	3,000.0	5,000.0	4,800.0
Sta. Power Supply	Sta	15	5,217.39	18,000.00	28,800.00	78.3	270.0	450.0	432.0
subtotal						2,265.0	7,814.4	13,024.0	12,503.0
Total						7,960.7	10,554.4	28,864.0	30,415.0
5 Grade Crossing									
1 At sta.	EACH	8	74,782.61	258,000.00	412,800.00	598.3	2,064.0	3,440.0	3,302.4
2 Inter sta.	EACH	22	92,173.91	318,000.00	508,800.00	2,027.8	6,996.0	11,660.0	11,193.6
Total						2,626.1	9,060.0	15,100.0	14,496.0
6 Total of 1 - 5						14,448.8	36,422.7	69,655.0	69,016.9
7 F/S Cost	LS					1,514.2	3,482.8	6,965.5	6,901.7
8 Contingency	%	10				1,596.3	3,990.5	7,662.1	7,591.9
Grand Total						17,559.4	43,896.0	84,282.6	83,510.5

Work Item	Year 1	2	3	4	Total
1 Viaduct between Stations	======	==========	======	======	
2 Viaduct at Stations		=========			
3 Erection of Girders			===	===	
4 Shift of Tracks	======				
5 New Track			===	===	
6 Removal of Obstacles	======				
7 Trolley Line		===	===	===	
8 Signal and Communication				======	
Local (M.LE)	4.7	24.2	27.1	13.5	69.5
Foreign (M.US$)	1.2	12.5	9.3	17.8	40.8
Total (M.LE)	7.4	63.0	48.5	54.4	163.3

Fig. 16.5.1 Construction Schedule and Annual Investment

16.6 Economic and Financial Evaluation

1) Economic Evaluation

(1) Data applied for Evaluation

a. Project Life

The construction cost is listed in the preceding section, and residual value of the project 25 years after its commencement is calculated using the following assumptions for the project life:

Civil works	50 years
Building	20
Facilities	20
Tracks	50
Electric works	15
Grade crossing	20
Engineering service	30
Contingency	30
Rolling stock	30

b. Operating Cost

The operating cost for the Economic Evaluation is induced from the actual accounting figures of HCHD, Transport Sector. The formula of Economic Rail Operating Cost has three variables; line length, car running length, and number of cars used.

The formula to calculate the Economic Rail Operating Cost is as follows:

Annual Operating Cost (LE/year) =
2.5538 x car.km/year + 20,940 x number of cars used in operation

The HCHD has 256 cars at present and so the total number of cars for use in operation does not exceed 256 cars. Therefore, in the economic evaluation the car price can be considered as a sunk cost. Consequently, the formula used for this evaluation is as follows:

AOC = 2.5538 car.km/year

For the economic evaluation the Vehicle Operating Cost (VOC) is also needed. The same VOC as that applied in the preceding chapter is used here.

c. Demand

The OD tables for 1995 and 2000 are prepared and assigned to the network. Demand after the year 2000 is extrapolated up to the year 2005, and after that is set flat at the year 2005 demand level to avoid increasing the error caused by extrapolation.

(2) Evaluation

a. Economic Internal Rate of Return (EIRR)

EIRR is calculated, as basic case for 20 pt flat fare at present constant prices. The calculation result is 24.1% (Table 16.6.1). This figure far exceeds the interest rate of the Capital Opportunity Cost customarily used in Egypt, 12%.

Table 16.6.1 Cost Benefit Flow (20 pt Case)

	Year	Benefit (MLE)	Cost (MLE)	B-C (MLE)
	1988			
	1989			
	1990			
1	1991		7.1	-7.1
2	1992		53.3	-53.3
3	1993		47.4	-47.4
4	1994		58.4	-58.4
5	1995	-1.0		-1.0
6	1996	10.8		10.8
7	1997	23.6		23.6
8	1998	37.3		37.3
9	1999	52.0		52.0
10	2000	67.8		67.8
11	2001	84.7		84.7
12	2002	102.8		102.8
13	2003	122.2		122.2
14	2004	142.9		142.9
15	2005	164.9		164.9
16	2006	164.9		164.9
17	2007	164.9		164.9
18	2008	164.9		164.9
19	2009	164.9		164.9
20	2010	164.9		164.9
21	2011	164.9		164.9
22	2012	164.9		164.9
23	2013	164.9		164.9
24	2014	164.9		164.9
25	2015	164.9	-54.0	218.9
NPV(12%)		270.2	82.9	187.3
B/C(12%)				3.3
IRR				24.1

Note : Benefit includes difference of Rail Operating Cost and Vehicle Operating Cost.
Source: Study Team

b. Sensitivity of EIRR

The sensitivity of the EIRR in relation to the change in construction cost is evaluated in the range of 20% of the change. In case the construction cost rises by 20%, the EIRR loses 2.1 percentage points, and on the other hand a decrease of 20% in the construction costs results in a gain of 2.8 percentage points for the EIRR. These results reflect the stability of the EIRR in

relation to the construction cost. This is very important since the cost estimation in the pre-feasibility stage may be rough and the actual costs may vary by 10 to 20%, a situation which would not adversely effect this strong EIRR.

The results of the Masterplan case in the year 2000 show that the bus operating cost is 3.19 pt.km/passenger against 4.24 pt.km/passenger for the tram operating cost. This fact means that the total operating costs of public transport increase when the ratio of bus user to tram user becomes larger, under the condition of disregarding the impact of bus fleet on road congestion.

In line with this discussion, the EIRR of this project has a very complicated nature. In general, a large number of bus users will accelerate road congestion, which in turn will induce an increase in VOC, and consequently result in a decrease in EIRR. On the contrary, in the case of this project a large number of upgraded Heliopolis Metro users will result in a decrease in the EIRR due to the comparatively high operating costs of the tram. The EIRR obtained has been synthesized.

In conclusion, even though the EIRR of this project behaves differently than usual, it nevertheless shows stability within the pragmatic range of fare changes.

2) Financial Evaluation

(1) Data applied for Evaluation

a. Tariff Rate

The revenue and the number of passengers transmitted in the last few years by HCHD is shown in Table 16.6.2. The table shows that the increase in the tariff rate was almost in line with the rise in rate of inflation after 1977. Therefore the tariff rate shall be expected to increase at the same rate of inflation.

Table 16.6.2 Past Tariff Rate

Year	Actual Rate	Index (1977=1.00)	
		Tariff	Inflation Rate
1964	1.5- 4.5 pt.	0.90	0.38
1977	1.5- 5.0	1.00	1.00
1986	10.0-15.0	3.00	2.50
1988	10.0-25.0	5.00	3.75

b. Operation and Maintenance Cost (OMC)

Operation and maintenance cost for the annual operation of Heliopolis Metro Line is calculated from the following formula:

OMC (LE/year)=
83,480 x Line Length (km) + 2.1342 car.km/year + 9,054 x car

The financial evaluation focuses on the difference in profit between the case of total Heliopolis Metro Line upgrading and that case with no upgrading. Therefore OMC is expected to differ for the following items:

- Car maintenance
- Operation costs of car

Conclusively, the calculation formula for the project can be modified as follows (Table 16.6.3):

OCM (LE/year) = 1.35 x car.km/year

Table 16.6.3 Components of Financial Operating Cost in 1987-88 Operation

Annual Operating Cost (in LE)	Line Length (LE/km)	Car.km (LE/km/yr)	No. of Cars (LE/unit)
Maintenance Cost			
- Line	35,750		
- Electric Facility	47,730		
- Car		0.5265	
Car Operation Costs			
- Power Cost		0.1042	
- Labor Cost		0.7188	
- Cost of Car			9,054
Overhead Cost			
- Personnel Cost		0.1239 *	
- Insurance		0.3308 *	
- Other Costs		0.3290 *	
- Capital Opportunity			8,493 *
Total	83,480	2.1332	17,547

Note : * is common in both the upgrade case and no-upgrade case
Source: HCHD

(2) Evaluation

The results of the analysis are poor. The Financial Internal Rate of Return (FIRR) shows a negative value of -8.9% in the case of a flat fare rate of 20 pt, at 1988 constant prices, and -13.0% in the case of a flat fare rate of 15 pt, at 1988 constant prices. These results mean that the balance of the new project can only be sustained by an annual subsidy of around 10% of the total investment cost.

In addition, the operating income (operating revenue - operating expenses) has a negative value in the year 1995, the first year of operation, and the deficit shows a fluctuating trend over the period. This implies that there is no possibility for the financial cost to be offset by the operating income. Needless to say, it is out of the question to resume the construction cost by the revenue after operation (Table 16.6.4).

Table 16.6.4 Operating Results of Heliopolis Company

(unit: 1000 LE)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Operating Revenue.....	15320	15320	15320	15320	15320	26811	26811	26811	26811	26811	47876	47876
Operating Expenses....	17450	19719	22282	25179	28452	32151	36330	41053	46390	52421	59236	66936
Operating Income.....	-2130	-4398	-6962	-9858	-13132	-5340	-9520	-14242	-19579	-25610	-11359	-19060
Operating Ratio	113.9%	128.7%	145.4%	164.3%	185.7%	119.9%	135.5%	153.1%	173.0%	195.5%	123.7%	139.8%

It may appear that the project is financially not viable. However the present operating ratio (operating expenses/operating revenue) is more than 400% and the net income is steadily continuing to show negative values, as seen in Table 16.6.5. Comparing the managerial status quo of HCHD, Transportation Sector, the proposed project will contribute to mitigating the serious financial situation of the Sector.

Table 16.6.5 Profit and Loss Statement for Elevated Bridge (20pt)

(unit: LE)

	Items	1979	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88
Expensec	Wages	2238982	2963641	4653605	5218288	6330371	7943214	8382524	9148679	9513695
	Commodities	839471	1200861	1292565	1583517	1764209	2052495	2390148	3018554	2903350
	Services	3015686	4954313	5106965	6926326	8968213	622484	325199	275559	340354
	Transferred Expenses						3410619	5720989	6411923	7545120
	Running Transfer						3229446	3435416	3831458	10906329
	General Expense						2854967	6130257	6253479	4000342
	Total	6094139	9118815	11053135	13728131	17062793	20113225	26384533	28939652	28939652
Revenues	Tickets	2010315	2344696	2729572	3507044	3710452	3927897	5344616	5633010	6182263
	Passes						158719	278618	297366	343308
	Reduced Card						7436	3361	403	
	Other Revenue	150593	160284	258717	358738	308825	1057365	1145521	699777	343347
	Total	2160908	2504980	2988289	3865782	4019277	5151417	6772116	6630556	6868918
Net Income		-3933231	-6613835	-8064846	-9862349	-1.3E+07	-1.5E+07	-2.0E+07	-22309096	-22070734
Expenses/Revenue Ratio		282.0%	364.0%	369.9%	355.1%	424.5%	390.4%	389.6%	436.5%	421.3%

16.7 Recommendation

The economic analysis of this project shows a high performance, in spite of the higher operating costs of the HCHD compared to the operating cost of buses. This indicates that the project contributes to lessen road congestion by reducing the number of buses, an advantage which far outweighs the disadvantage of the increase in operating cost due to the difference of bus VOC and tram ROC. This project is recommendable from the economic point of view.

On the other hand, the financial analysis shows poor results. Even though the project can mitigate the financial situation of the HCHD Transportation Sector, still financially it is not recommendable.

There are two ways to improve the low financial performance; one is to save construction costs, and the second is to collect higher fare.

The main objectives of this project are to increase speed and provide punctual service in order to attract mainly "to work" and "to school" passenger trips. The achievement of these objectives depends on the segregation of the tracks and control systems. Control systems are essential to maintain speed and safety. Concerning the segregation of tracks several alternatives exist. The basic plan proposes to construct an elevated structure in the Heliopolis city area. In order to save construction cost, use of the existing segregated rails shall be considered. On the ground level, the tram speed does not change much and punctuality can be maintained.

The low fare structure in the public transport system is common, and not only for this project. The fare setting policy may be discussed in another chapter of this report, but shall not be discussed to relieve one project in particular. One suggestion the Study Team can offer is to upgrade the first class car and collect higher fare.

In line with the above way of thinking, hereinafter the upgrading at ground level shall be examined as a promising alternative in order to realize this project.

The ground level upgrading project requires 84.3 million LE and a two year construction period. FIRR shows slight improvement at -5.6% and -10.0% for 20 pt and 10 pt flat fare cases respectively, compared with -9.4% and -13.8% for the elevated way case.

Fig. 16.7.1 shows the trends of the net income in the ground level upgrading case and in the elevated level upgrading case in million LE. Both cases show negative income, but losses of the ground level upgrading case are half those of the elevated level upgrading case.

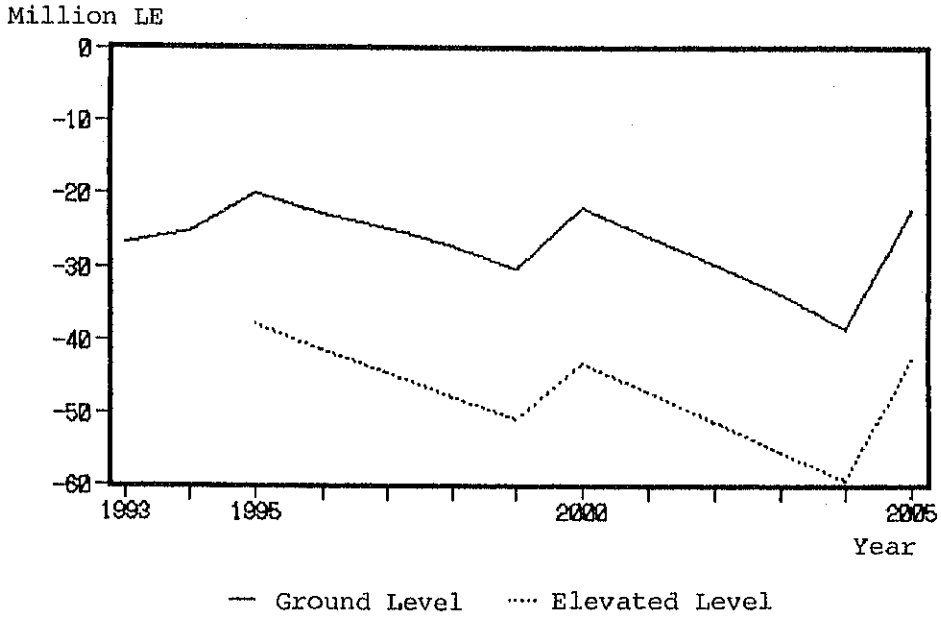


Fig. 16.7.1 Net Income by Project (million LE)

This project is considered as one of the fundamental countermeasure projects. Execution of this project is requested from the Masterplan point of view and viability of the project is assured from the economic analysis.

In order to mitigate the financial problems the phasing of the project is recommended. As the first phase of the project, the ground level upgrading shall be selected. In addition, before the execution of the project, the negative impact to road traffic, especially crossing rail traffic, shall be carefully examined.

ANNEX

Annex A - Abbreviations

ATC	Automatic Train Control
ATS	Automatic Train Stopper
B/C	Benefit Cost Ratio
Br	Bridge
BS	British Standard
CAA	Civil Aviation Authority
CAPMAS	Central Agency for People, Mobilization and Statistics
CBD	Central Business District
CG	Cairo Governorate
CIF	Cost Insurance and Freight
CORPS	Corniche-Ramses-Port Said Area
CTA	Cairo Transport Authority
CTC	Centralized Traffic Control
CTD	Central Traffic Department
CU	Cairo University
DC	Diesel Car
D/D	Detail Design
DL	Diesel Locomotive
DRTPC	Development Research and Technological Planning Center
EAGCR	Executing Agency for GCR Projects
EIRR	Economic Internal Rate of Return
ENR	Egyptian National Railway
ENTS	Egyptian National Transport Study
E/S	Engineering and Supervision
Expwy	Express Way
FIRR	Financial Internal Rate of Return
F/S	Feasibility Study
GCBC	Greater Cairo Bus Company
GCMR	Greater Cairo Metropolitan Region
GCR	Greater Cairo Region
GDP	Gross Domestic Product
GOPP	General Organization for Physical Planning
GRDP	Gross Regional Domestic Product
HCHD	Heliopolis Company for Housing and Development
IAURIF	Institut d'Amenagement et d'Urbanisme de la Region d'Ile-de-France
ISO	International Standard Organization
IZLI	Inter-Zonal Linkage Intensity
JICA	Japan International Cooperation Agency
JIS	Japan Industrial Standard
LE	Egyptian Pound
M.LE	Million Egyptian Pound
MODANC	Ministry of Development and Construction
MOI	Ministry of Interior
MOLG	Ministry of Local Government
MOT	Ministry of Transport
MP	Masterplan
MPS	Master Plan Study
NAT	National Authority for Tunnel
NMSO	National Metro Subway Organization
NTI	National Transport Institute
NPC	Nile Public Bus Company

NPV	Net Present Value
OD	Origin and Destination
OTUI	Omnium Technique de l'Urbanisme et de l'Infrastructure
pax	Passenger
PC	Prestressed Concrete
PC	Personal Computer
PCU	Passenger Car Unit
PM	Project Manager
pt	Piaster (1/100 LE)
PT	Person Trip Survey
PVC	Poli-Vynil Chloride
RBA	Road and Bridge Authority
ROC	Railway Operating Cost
rd	Road
rv	River
SER	Shadow Exchange Rate
S/C	Steering Committee
SLG	Secretariat of Local Government
sq	Square
st	Street
sta	Station
SWR	Shadow Wage Rate
TFA	Total Floor Area
TMU	Traffic Management Unit
TOC	Total Operating Cost
TPA	Transport Planning Authority
UNIDO	United Nations Industrial Development Organization
veh	Vehicle
VOC	Vehicle Operating Cost