15.5.4 Alternative Bridge Planning

(1) Sinza Bridge

Two alternatives were considered for the proposed site on the Sinza River as shown in Fig. 15.18. A box culvert and reinforced concrete hollow slab bridge were selected as alternatives as shown below:

(i) Alternative 1: Box Culvert

Height x Width x Span = 2.2 m x 3.6 m x 2
Box Length = 47.0 m
Skew Angle = 72 degree
Construction Cost = Tshs. 185,200,000

(ii) Alternative 2: Reinforced Concrete Hollow Slab Bridge

Bridge Length = 7.50 m
Width = 2 x 11.5 m
Skew Angle = 72 degree
Height of L-type Abutment = 4.5 m
Cast-in-situ Concrete Pile Foundation (D=1,000mm) = 20 m
Construction Cost = Tshs. 351,013,000

In order to minimize the initial investment, the superstructure for the median strip was excluded. However, the substructure was planned to be constructed to cover the whole section of the proposed road taking for a future widening.

As a result of the alternative study, the construction cost of the bridge became almost two times as large as the box culvert. The box culvert in Fig.15.18 is therefore recommended for the proposed site on Sinza River instead of bridge from the economic point of view. The detailed construction costs of bridge and box culvert is presented in Appendix 15.2.

(2) Gerezani Bridge

The proposed bridges will pass over the existing railway tracks. The geometric conditions to be considered for the design of the proposed bridge are presented in Table 15.3.

The height of the proposed bridge shall be determined taking into account the vertical clearance specified in the railway standard. Bridge length shall also be decided taking into consideration the required horizontal clearance to the railway track.

The proposed bridges will be the curve bridges with a skew because of that the priority is given to the alignment of road taking into account the high design standards of the proposed road, but not construction cost of bridge.

Table 15.4 Design Conditions of Gerezani Bridge

		Gerezani Bridge
Bridge Length		20. 8 m
Carriageway Width		11.5 m x 2 = 23.0 m
Alignment of Bridge	Horizontal	R = 120 m
	Longitudinal	5.0% (transition section)
	Cross	2.0% (super elevation)
Degree of Bridge Skew		76°30' 30"
Vertical Clearance		5.60 m
Horizontal Clearance		3.60 m

1) Superstructure

Considering the type of bridge structure over passing the railway tracks as well as the short span length, the following types of superstructure are considered as alternatives:

a) Reinforced Concrete Simple Hollow Slab (RC-SH)
b) Non-composite Simple Steel Plate Girder (St-Gr)

Layout of bridge plan is presented in Fig. 15.19.

Reinforced concrete simple hollow slab bridge (RC-SH) is advantageous in terms of the construction cost, availability of local materials, relatively free maintenance and credibility, while the steel girders (St-Gr) is advantageous in respect of construction period, geological conditions and interference of the railway operations.

Considering the advantages in terms of construction cost as well as the maintenance, the following type of bridge has been selected for the proposed bridge:

Gerezani Bridge:	Reinforced Concrete Simple Hollow Slab
	Bridge Length = 20. 8 m

2) Sub-Structure

Reversed T-type abutment is recommended for the abutment of the proposed bridge taking into consideration the height of bridge as w ell as the geological conditions. No alternatives were considered.

3) Foundation

The pile foundation is required for the Gerezani Bridge. Cast-in-Place concrete pile is recommended taking into account the following:

1) Availability of local materials and construction equipment.
2) Simple construction method.
3) No negative influence to adjacent railway.
4) Small construction cost.

(3) Bandari Bridge

Two alternative plans have been considered in regard to the topographic conditions and the geographical conditions as shown below: Typical cross section and layout of each alternative are presented in Fig. 15.20.

1) Alternative 1:

Non composite Simple Steel Plate Girder Bridge (St - Gr) with Concrete Block Abutment with Pile Foundations

Bridge Length	: 27.0 m
Span Arrangement	: Single span
Abutment	: A gravity type
Foundation	: Concrete pile D = 450 mm
	L= 7 - 9 m

2) Alternative 2:

Reinforced Concrete Simple Hollow Slab (RC-HS) with Retaining Wall Abutment without Pile Foundations

Bridge Length	: 10.8 m
Span Arrangement	: Single span
Abutment	: T type retaining wall
Foundation	: No pilings

Alternative 1 has been proposed based on the existing bridge aiming at the ease of construction as well as the short construction period. The proposed type of superstructure will be a single steel plate girder and substructure will have a gravity type of abutment. This type of bridge is advantageous concerning construction period, but has a disadvantage in terms of construction cost and maintenance cost.

Alternative 2 has been planned aiming at the minimization of the construction cost by shortening the bridge length. This plan, however, requires large scale of abutments at the both end of bridge due to high vertical clearance of railway, which may require a amount of the structural excavation as well as the temporary retaining measures to support the railway facility during the construction. No pile foundations will be required because of a hard strata having a N-Value of more than 50 which is spread at a depth of 5- 6 m with a thickness of 6 - 10 m.

Considering the advantages in terms of construction cost and ease of maintenance, Alternative 2 (Concrete Simple Hollow Slab Bridge) is recommended for the Bandari Bridge.

The detailed construction cost estimate is presented in Appendix 15.3.

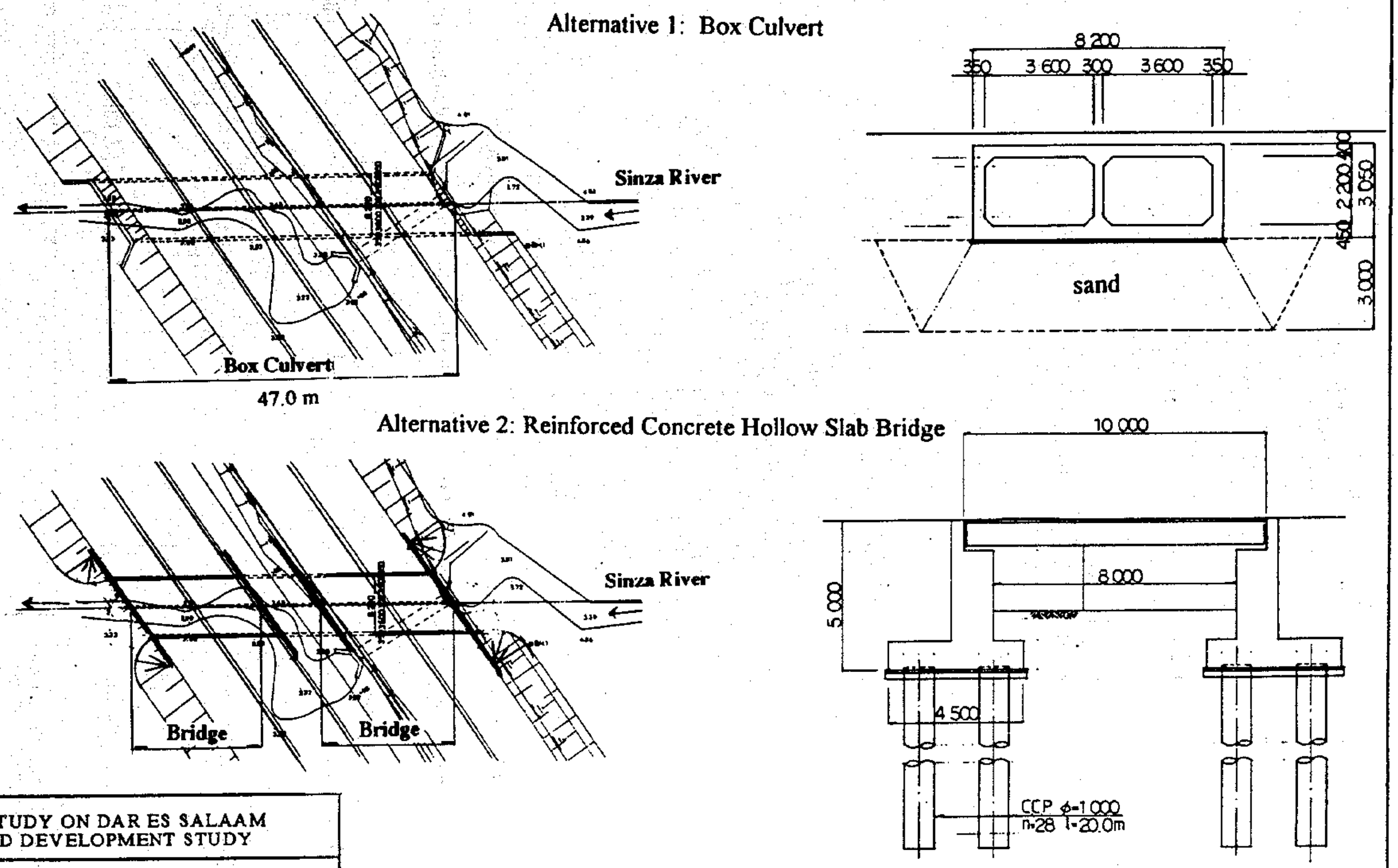

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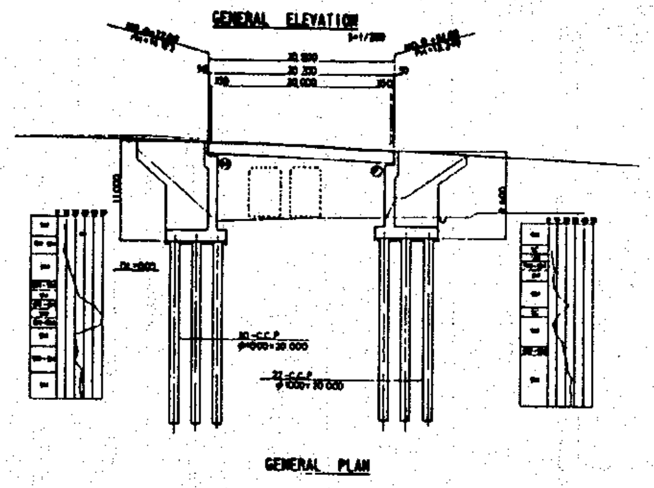
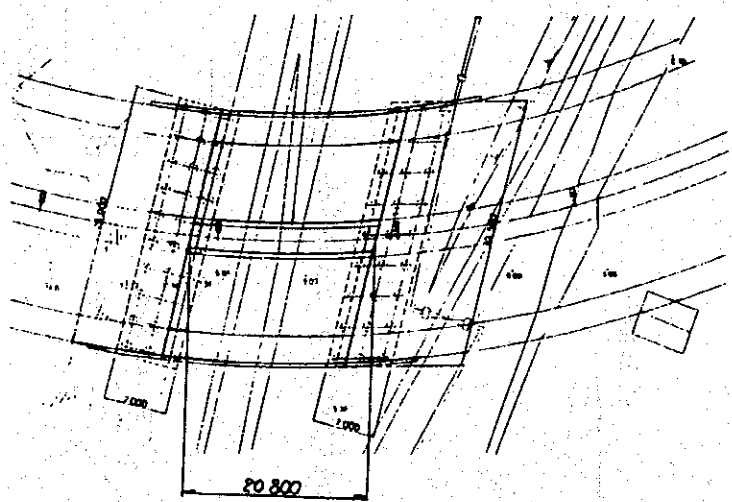
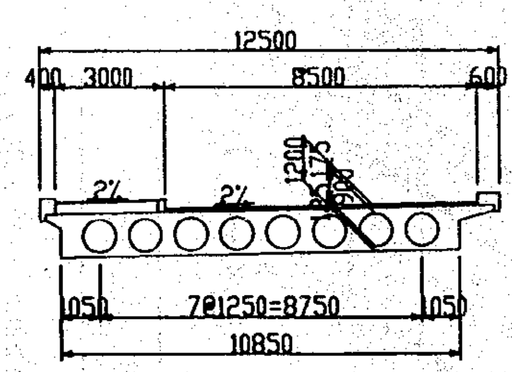
Fig. 15.18
Alternative Bridge Study for Sinza River





Alternative 1:

Reinforced Concrete Simple Hollow Slab (RC-SH)



Alternative 2:

Non-composite Simple Steel Plate Girder (St-Gr)

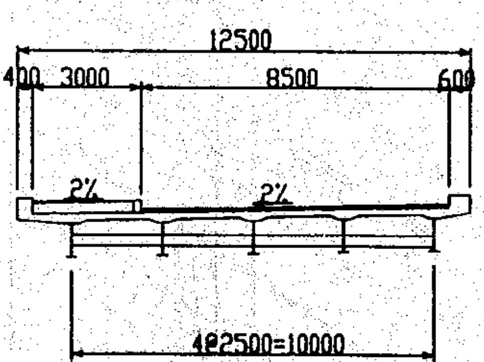


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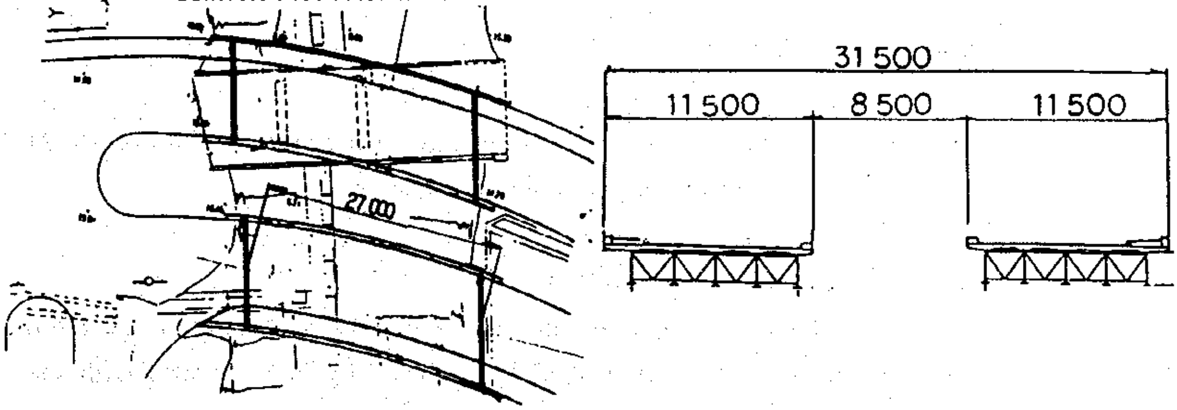
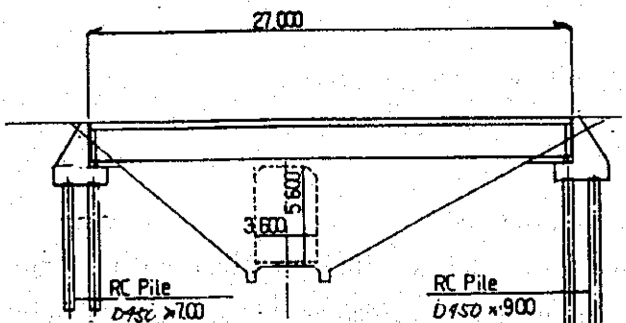
Fig. 15.19
Alternative Study
for Gerezani Bridge

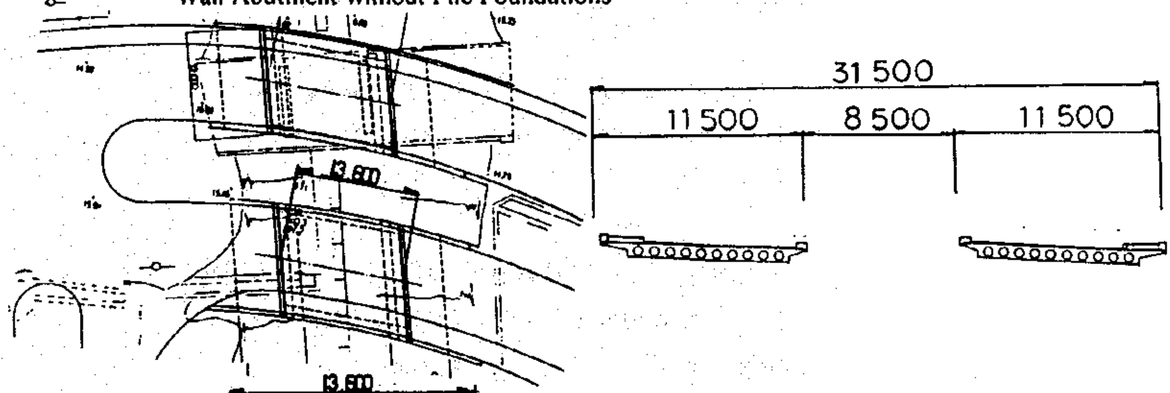
Alternative 1: Non composite Simple Steel Plate Girder Bridge (St - Gr) with Concrete Block Abutment with Pile Foundations

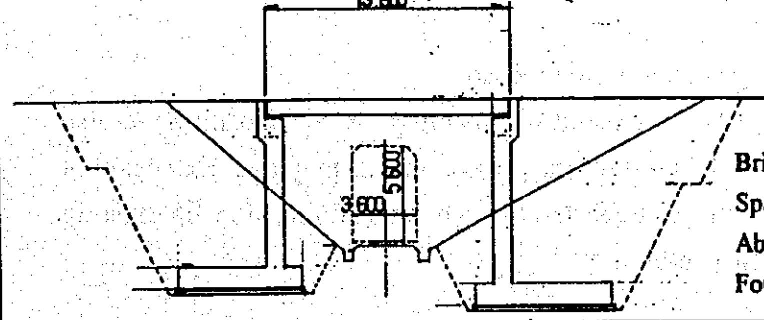




Bridge length : 27.0 m
Span Arrangement : Single span
Abutment : A gravity type
Foundation : Concrete pile D = 450 mm L= 7 - 9 m

Alternative 2: Reinforced Concrete Simple Hollow Slab (RC-HS) with Retaining Wall Abutment without Pile Foundations





Bridge Length : 10.8 m
Span Arrangement : Single span
Abument : T type retaining wall
Foundation : No pilings

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Fig. 15.20 Altemaitve Study for Bandari Bridge	

15.5.5 Box Culvert Design

(1) Proposed Box Culverts

The typical cross sections of the proposed culverts are presented in Fig. 15. 21 and the outlines of the design are summarized below:

(i) Sinza River at Morocco Road

Out of the four pipe culverts, the pipe culverts located at the main stream of Sinza River shall be replaced by box culverts with the sufficient dimensions of discharge as shown below:

Height x Width x Cells = 2.2 m x 3.6 m x 2
Box Length = 47.0 m

(ii) Ubungo River at New Kigogo Road

Two existing box culverts are laid on Ubungo River and they are recommended to be used for the project road as they are. Extension of box culverts will be made having the same dimensions of existing culverts as shown below:

- Extension of No.1 Box Culvert of Ubungo River
  Height x Width x Cells = 2.9 m x 5.0 m x 2
  Box Length = 23.5 m

- Extension of No. 2 Box Culvert of Ubungo River
  Height x Width x Cells = 2.9 m x 5.0 m x 2
  Box Length = 24.0 m

(ii) Msimbazi River at New Kigogo Road

Two box culverts are existed on Msimbazi River and they are also recommended to be used for the project road as they are. Extension of box culverts will be made having the same dimension of existing culverts as shown below:

- Extension of No.1 Box Culvert of Msimbazi River
  Height x Width x Cells = 2.8 m x 5.0 m x 4
  Box Length = 28.5 m

- Extension of No. 2 Box Culvert of Msimbazi River
  Height x Width x Cells = 2.0 m x 5.0 m x 3
  Box Length = 30.0 m

(2) Water Flow Capacities of Box Culverts

Water flow capacity of each box culvert has been calculated using Manning's Formula assuming the uniform flow of the river as shown below:

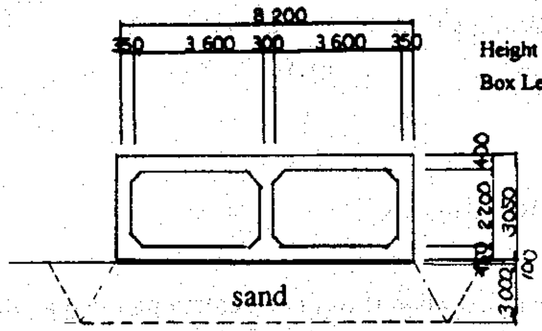
$$Q = A \cdot v$$
$$v = 1 / n \cdot R^{2/3} \cdot I^{1/2}$$

where Q : discharge (m3/sec)
A : flow area (m2)
v : flow velocity (m/sec)
R : hydraulic radius (m)
I : water surface slope
n : roughness coefficient (= 0.015 cast-in-place concrete)
N : number of cells in the box culvert

Table 15.5 Water Flow Capacity

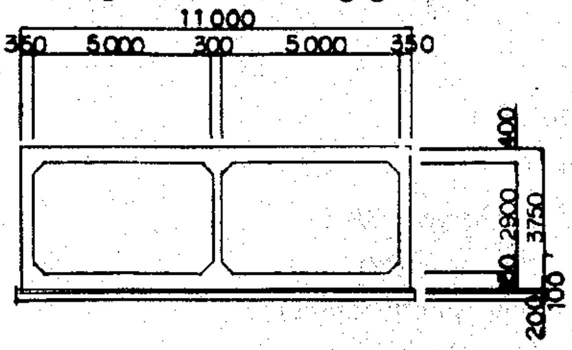
	Sinza river	Ubungo river		Msimbazi river	
	Box	No.1 Box	No.2 Box	No.1 Box	No.2 Box
Qo Design discharge	65.1	73.6		381.4	
B	3.6	5.0	5.0	5.0	2.0
D	2.2	2.9	2.9	2.8	2.0
R	0.998	1.343	1.343	1.321	0.667
I	0.00833	0.0009	0.0058	0.0105	0.0151
v	6.04	2.43	6.18	8.22	6.25
A	7.9	14.5	14.5	14.0	4.0
Qa	47.9	35.2	89.6	115.1	25.0
N	2	2	2	4	3
Qa*N	95.8	70.4	179.2	460.4	75.0
ΣQa	95.8	249.6		535.4	
Allowance	1.47	3.39		1.40	

(i) Sinza River at Morocco Road



Height x Width x Span = 2.2 m x 3.6 m x 2
Box Length = 47.0 m

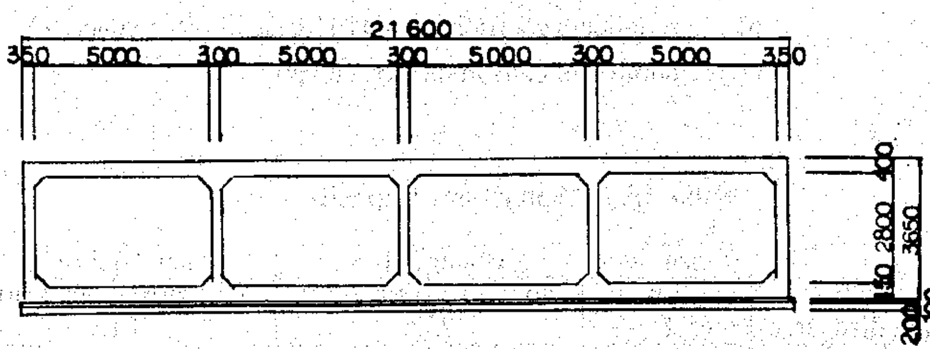
(ii) Ubungo River at New Kigogo Road



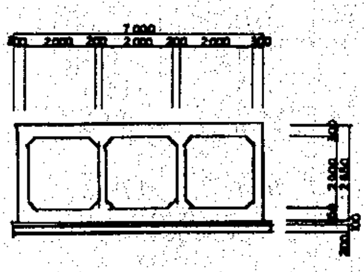
Extension of No.1 Box Culvert of Ubungo River
Height x Width x Span = 2.9 m x 5.0 m x 2
Box Length = 23.5 m

Extension of No. 2 Box Culvert of Ubungo River
Height x Width x Span = 2.9 m x 5.0 m x 2
Box Length = 24.0 m

(iii) Msimbazi River at New Kigogo Road



Extension of No.1 Box Culvert of Msimbazi River
Height x Width x Span = 2.8 m x 5.0 m x 4
Box Length = 28.5 m



Extension of No. 2 Box Culvert of Msimbazi River
Height x Width x Span = 2.0 m x 5.0 m x 3
Box Length = 30.0 m

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Fig. 15-21
Typical Cross Sections of Proposed Box Culverts

15.5.6 Other Structures

(1) Retaining Wall for Access to Road to Harbor

The widening of Sokoine Drive will affect on the access road to the harbor offices in front of City Hall. The retaining wall is required along road edge of the Sokoine Drive to minimize the land acquisition of Harbor facilities.

The height of proposed wall will be ranging from 5.5 m to 7 m. L-type retaining wall is recommended to minimize the affect on the adjacent buildings. During the construction, detour road will be necessary for the access to the port area.

(2) Slope Protection of Kivukoni Front Reclamation

The seashore from the Kivukoni Front up to the Ferry Station is planned to be used as the proposed site for new bus terminal, car park and seaside promenade which will be constructed as part of the project for widening of the Kivukoni Front and Sokoine Drive, and this reclamation is referred to as "Kivukoni Front Reclamation" in this Study. The seashore will be reclaimed toward the seaside by about 15 - 20 m from the existing road.

The slope protection is required for the reclaimed area is needed to protect scouring by sea wave and tidal movement. Three types of seashore protection could be considered; namely, sloping type, upright type and mixed type. Any slope with more than 10 percent incline is called sloping type, while the slope with less than 10 percent is called upright type. Mixed type is the one which first has an upright type, built as a caisson and bloke, is built and then sloping type slope protection is constructed on the upright type structure.

Typical type of slope protection works are as shown below:

(i) Sloping type: stone pitching, concrete pitching, concrete rapping, concrete block, etc.

(ii) Upright type: masonry, gravity, couterforted type, caisson, etc.

The selection of type will be made taking into account the following conditions:

	Sloping type	Upright Type
- Ground conditions	soft	hard
- Availability of fill materials	easy	difficult
- Land acquisition	easy	difficult
- Wave	calm	rough

Sloping type has been selected for the Kivukoni Front seashore protection taking into consideration the conditions of the site as follows;

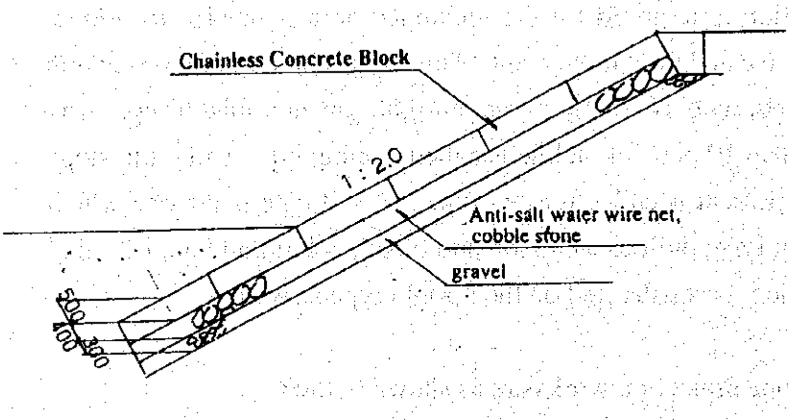
(i) Ground conditions are relatively soft.

(ii) Fill materials can be obtained easily.

(iii) Land for the seashore protection can be acquired easily.

(iv) Waves are usually calm since the proposed site is located inside the bay.

Out of several sloping type of structure, chainless concrete block slope protection has been selected because of its durability. The concrete blocks will be fastened each other using its shape without chain as shown in Fig. 15.22. Anti-salt water wire net, cobble stone and gravel are laid under the concrete block.



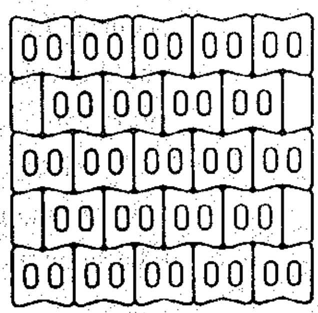


Fig. 15. 22 Chainless Concrete Block Slope

15.6 Drainage Design

Drainage structures are one of the most important facilities to keep the road in safe condition for traffic and to extend the life of the road structure, especially the pavement. The storm drainage plan proposed in the "Urban Sector Engineering Project" conducted by the Prime Minister's Office (PMO) was reviewed and incorporated in this Study.

15.6.1 Road Drainage System

The cross slope of the carriageway, shoulders and sidewalks should be sufficient to ensure the rapid drainage of surface water without causing any discomfort and danger to the road users. The minimum cross slope of the carriageway to be applied for the project road is 2.0 %.

Surface water shall be collected by U-shaped side ditch and discharged through a pipe or open lined channel installed in or out of the shoulder so that it will flow to the existing storm drainage system installed at a nearby location.

For small watersheds and roadway drainage, the Rational Method shall be used for estimating the peak rate of run-off. The velocity of flow of a stream of water is an important characteristic in the design of the size, shape, and surface requirements of a drainage structure. The Manning Formula is commonly used for calculating the velocity (V) in m/sec in a channel of uniform cross-section, roughness, and slope:

Drainage design is conducted employing the following criteria:

(i) Culvert design

- Minimum dimension of the pipe culvert shall be 600 mm taking into account ease of maintenance.
- Pipe and box culverts should be designed with concrete headwalls, wing walls, protective aprons and toes.
- Minimum allowable velocity should be 0.8 m/sec. to prevent siltation and the maximum 3.0 m/sec. to avoid excess scour.

(ii) Side ditch design

- Roadside ditches should be covered with grouted rip rap to prevent erosion of the road embankment and cut slope.

- Minimum dimension of roadside ditches should be 40 cm x 50 cm (width x height).

Outflows from road drainage need to link up properly with the present storm drainage system or natural water courses.

15.6.2 Storm Drainage System along the Proposed Road

The storm drainage system in Dar es Salaam consists of a primary and secondary storm drainage. The existing major rivers are identified as primary storm drainage and their tributaries as secondary.

A functioning of roadside drainage depends on the adequacy of the secondary and primary storm drainage systems. So, the Study Team conducted the inspection of the existing storm drainage structures along the proposed roads to confirm their working conditions as well as to investigate the necessary improvement measures. The inspection covered beyond the right-of-way limit of the proposed road to confirm the flow of water into the existing strom drainage strucutres.

The result of the inspection was presented in the Drawings, (a separated volume of this Draft Final Report), in which the direction of the outflow of the water from roadside drainage up to secondary or primary drainage system is clearly shown.

The following areas were identified by the Study Team as an inundation area where urgent improvement or rehabilitation of the existing storm drainage system are required:

(1) Inundation Area No.1

The area along the Kijitonyama River between New Bagamoyo Road and Old Bagamoyo Road was identified as Inundation Area No.1 as shown in Fig. 15.23.

Recommended improvement measure are the enlargement of capacity of the existing river by:

- Widening of the existing channel with a lining of concrete or stone masonry.
- Replacement of small capacity pipe culverts.

- Improvement of channel alignment.

The required cost for improvement is estimated to be Ths. 164 million approx. and detailed cost estimation is presented in Appendix 15.4.

(2) Inundation Area No. 2;

The area along the Sinza River near Morocco Road was identified as Inundation Area No.2 as shown in Fig. 15.24. One of the main problems with this area concerns a shoulder of Morocco Road collapsed due to heavy rain last year. The main causes of failure were (i) insufficient capacity of pipe culverts, (ii) blockage of the inlet due to lack of maintenance, and (iii) inappropriate location of culverts.

Recommended improvement measures are:

- Improvement measures to be taken for this place are the replacement of the existing pipe culverts by box culverts to enlarge the capacity of water flow.
- Protection of the embankment slope with stone masonry or concrete blocks are also required.

(3) Inundation Area No. 3;

The area along the Gerezani Creek near Bandari Road was identified as Inundation Area No.3 as shown in Fig. 15.25.

Recommended improvement measures are:

- The area along Gerezani Creek surrounded by Bandari Road are low-lands lying near the sea level, so that inundation takes place very often at high tide , especially during the rainy season. The strom water in Gerezani Creek flows into the Harbor smoothly when the tide is on the ebb, so that the capacity of the existing drainage facilities including pipe and box culverts laid below Bandari Road and the railway tracks to the Harbor should be enough for the peak flow of Gerezani Creek.

  Since the main cause of inundation in the area is the high tide of the sea (not a shortage of the capacity of the existing drainage structures), inundation will continue to occur unless permanent improvement measures are taken. One of these possible measures is an earthen reclamation for 2 to 3 m to raise up the elevation of the low-lands in the area. The reclamation work, however, will involve large amount of earthwork, including the replacement of the drainage strucutres and other related facilities which will have a large construction cost.

The required cost for improvement is estimated to be Tsh. 1,898 million approx. and detailed cost estimation is presented in Appendix 15.4.

Out of the three inundation areas stated above, No. 1 and No. 3 are excluded from this Feasibility Study because of the following reasons;

- The existing strom drainage facilities to be improved are extended away from the proposed road and improvement measures in terms of construction cost, construction period, etc. are too large to include in the road construction project. Therefore, this should be organized as a river impovement or storm drainage improvement project and be implemented in parallel with the road construction.

The preliminary design for the improvement measures recommended for the Inundation Area No.2 was included in the Study because the expansion of the existing drainage capacity is urgently needed and essential for Morocco Road.

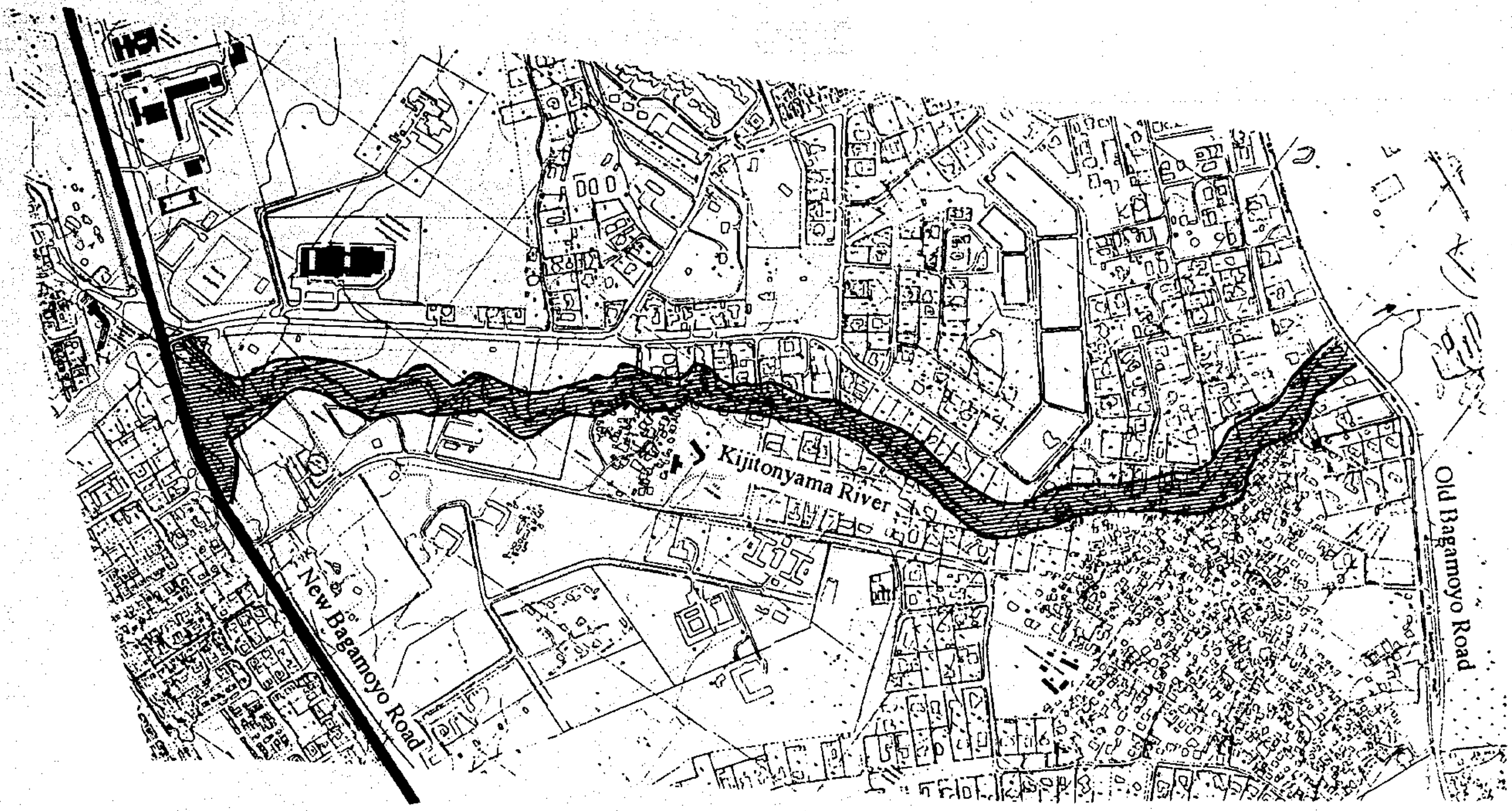


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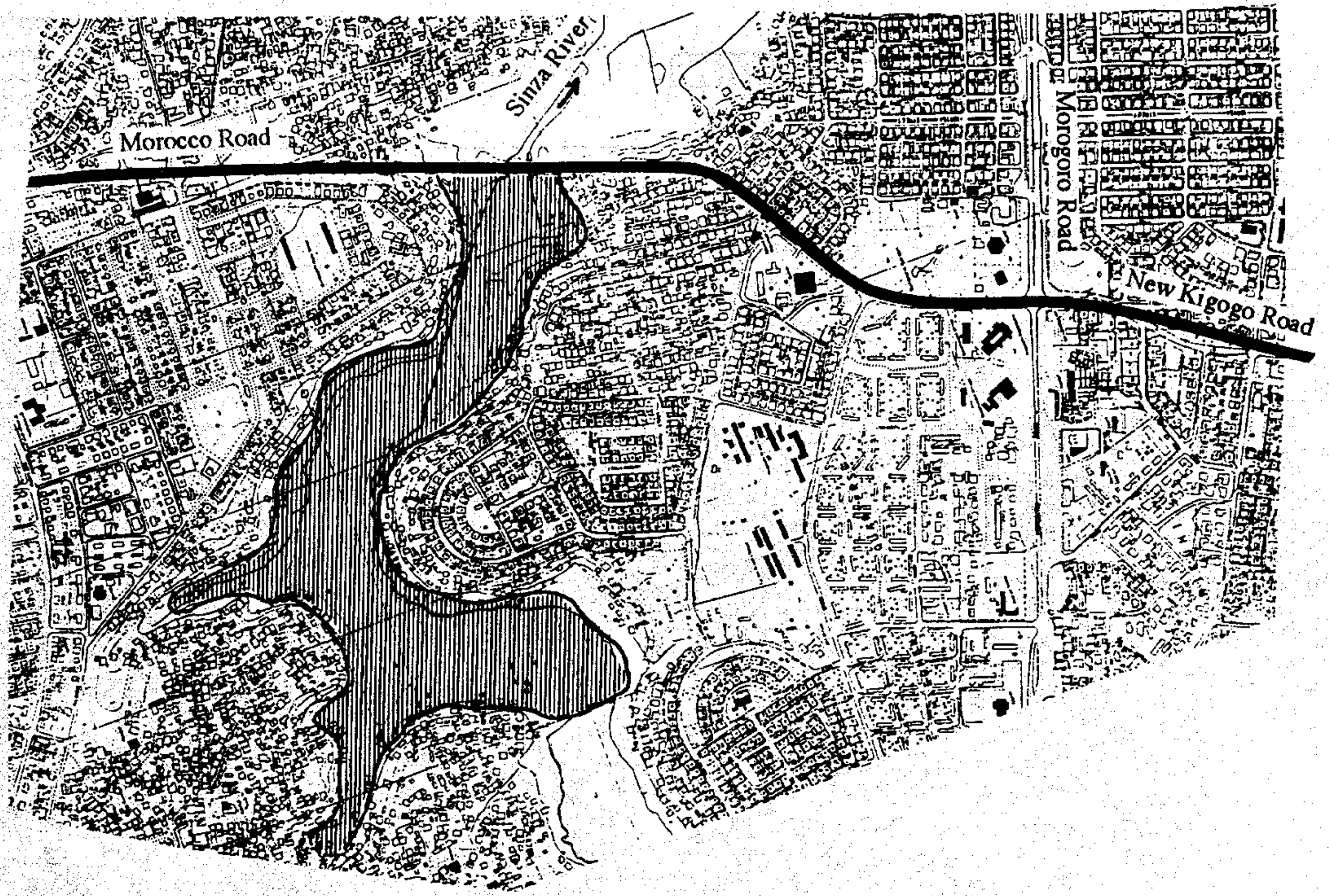
Fig. 15.23 Inundation Area No. 1:
New Bagamoyo Road

Inundation Area



THE STUDY ON DAR ES SALAAM ROAD DEVELOPMENT STUDY

Fig. 15.24 Inundation Area No. 2: Morocco Road

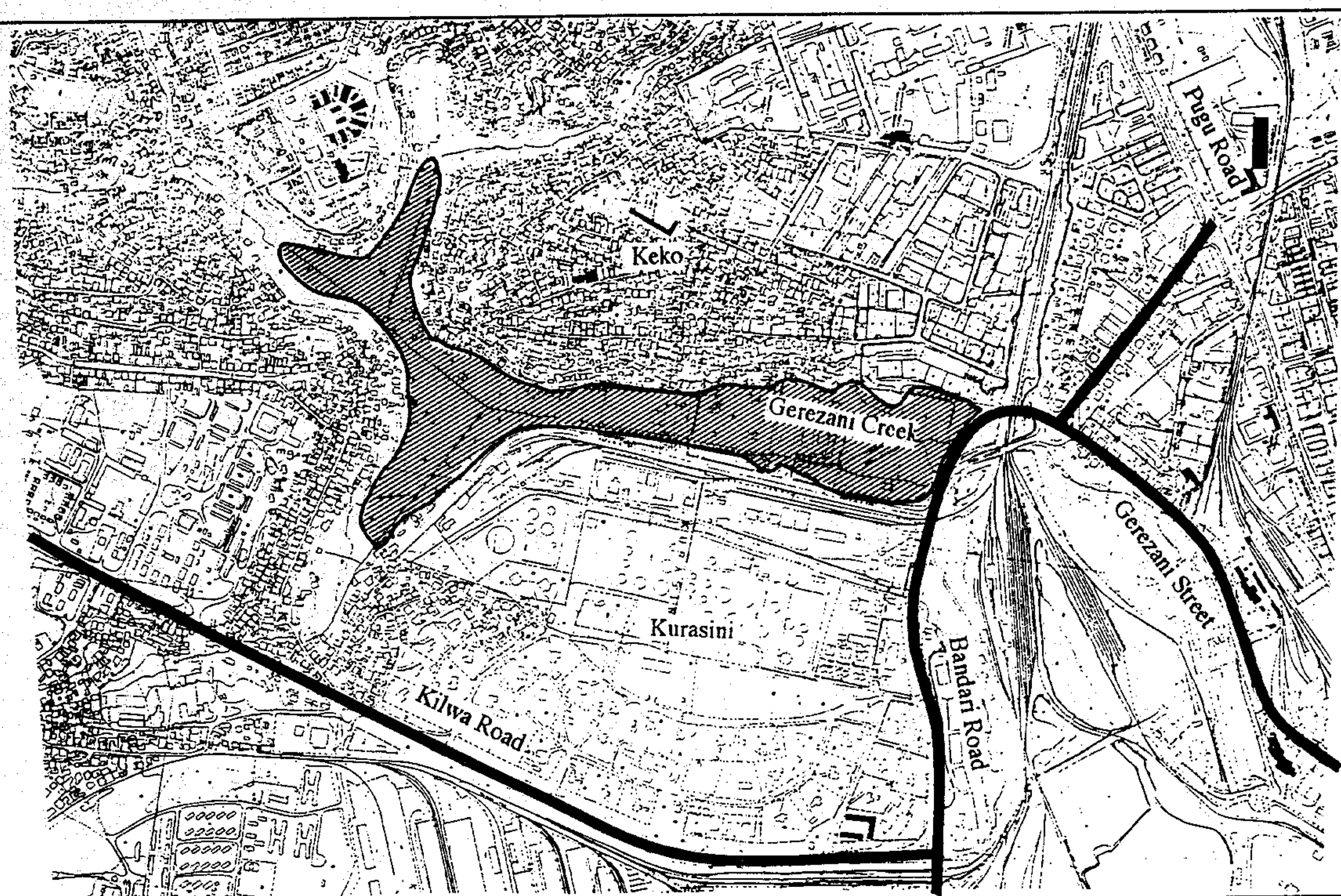


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Fig. 15.25 Inundation Area No.3
Bandari Road along Gerezani Creek

Inundation Area

15.7 Pavement Design

15.7.1 Selection of Pavement Type

Pavement structure is broadly divided into two types: namely, flexible pavement (asphalt pavement) and rigid pavement (concrete pavement). The type of pavement is determined on the basis of its characteristics of being flexible or rigid taking into account the following factors:

(i) Construction practices in terms of design life (10 years for flexible pavement and 20 - 30 years for rigid pavement).

(ii) Construction economy (the initial cost of rigid pavement is higher than that of flexible pavement).

(iii) Ground conditions (normally, rigid pavement is not adopted in soft ground area because of unequal settlement of embankment).

(iv) Local conditions (experience, availability of materials, government policy, etc.)

Considering the construction economy and local conditions, flexible pavement is recommended for the proposed roads.

15.7.2 Alternatives of Pavement

Two types of flexible pavement are considered for the alternative study: Double Bitumen Surface Treatment (DBST) and Asphalt Mixed Concrete (AMC).

(1) Double Bitumen Surface Treatment (DBST)

This method is very common in Tanzania because of its easy maintenance and low construction cost if compared with asphalt mixed concrete. However, this type of pavement is not recommendable to adopt for arterial urban roads with heavy traffic volume because of its short design life and unreliable quality.

Durability, waterproofing and stability of DBST will not be reliable unless the work is constructed by skilled laborers with experience because of the difficulty of quality control during the construction.

DBST, therefore, will not perform satisfactorily throughout its design life unless regular maintenance in the form of re-sealing or patching work would be properly and periodically conducted.

DBST is recommended to be adopted for relatively low standard roads with narrow carriageways (less than 5.5 m), but not for high standard roads such as the type of the proposed road.

(2) Asphalt Mixed Concrete (AMC)

AMC pavement is currently used for urban roads, particularly on those with heavy traffic.

The initial cost of AMC is higher than that of DBST since it requires asphalt mix plant with well trained operators and quality control at construction site.

However, AMC has a longer design life than DBST and the quality of the pavement such as durability, waterproofing and stability is superior to DBST pavement. This is because it is mixed and measured properly in a mechanical plant.

AMC is particularly suited to busy urban roads since it can be opened to traffic immediately after being laid. As such, traffic congestion can be minimized during the construction.

Although AMC pavement requires a higher initial investment, it is recommended to use it considering the function of the proposed road as well as the lower maintenance cost that would be required when compared with DBST pavement.

15.7.3 Thickness Design

The preliminary thickness design of flexible pavement was carried out in accordance with the "MANUAL FOR ASPHALT PAVEMENT, 1989" published by Japan Road Association. The Japanese method of asphalt pavement design is largely on the basis of domestically developed technology incorporated with the principles of AASHTO Road Test and the CBR Design Curve method.

Traffic load estimates were based on the results of a traffic study that was conducted for this. Design inputs including effective modules of subgrade reaction were estimated by referring to available data and information obtained by the engineering survey.

The thickness and the structure of individual layers of pavement were designed based on a comprehensive judgment of various factors including the subgrade, traffic and climate conditions as well as the economic aspects. The pavement design was conducted as follows:

(1) Classification of Roads by Traffic

The one-way daily traffic volume of heavy vehicles in the 5th year after opening the road to public is first estimated to determine the pavement standard from among the five grades shown in Table 15.7.

Table 15.6 Traffic Classification for Pavement Design

Traffic Classification	One-way Daily Traffic of Heavy Vehicles
L	Less than 100
A	100 to 250
B	250 to 1,000
C	1,000 to 3,000
D	More than 3,000

One-way daily traffic volume of heavy vehicles in the 5th year, which is the year of 2005 (assuming the completion of the project in 2000), was calculated for each road section using the basic traffic data obtained from the traffic survey. The summary of estimated traffic volume by road section as well as the traffic classification is presented in Table 15.8.

Table15.7 Estimated Heavy Traffic Volume and Traffic Classification

Proposed Roads	One-way 12 hours Traffic Volume in 1944/*					Daylight Traffic Ratio	One-way Daily Traffic of Heavy Vehicles in 1994 (Nos.)	Annual Average Increase Ratio	Increased Ratio 2005/1994	One-way Daily Traffic of Heavy Vehicles in 2005 (Nos.)	Traffic Classification
	Medium Goods Vehicles/**	Heavy Goods Vehicles	Mini Buses/**	Large Buses	Total						
1 Package 1: Arterial Roads in the City Center											
- Ohio Street	69	19	77	44	209	1.12	234	7.0%	2.25	530	B
- Kivukoni Front	83	1	138	136	358	1.12	401	7.0%	2.25	900	B
- Sokoine Drive	163	16	799	792	1770	1.12	1982	7.0%	2.25	4460	D
- Gerezani Street	327	70	357	259	1013	1.12	1135	7.0%	2.25	2550	C
- Bandari Road	207	384	540	361	1492	1.12	1671	7.0%	2.25	3760	D
2 Package 2: Middle Ring Road											
- Morocco Road	286	20	909	126	1341	1.30	1743	7.0%	2.25	3920	D
- New Kigogo Road	283	58	483	65	889	1.30	1156	7.0%	2.25	2600	C
- Chang'ombe Road	257	56	568	116	997	1.30	1296	7.0%	2.25	2920	C
- Missing Link /*	257	56	568	116	997	1.30	1296	7.0%	2.25	2920	C
3 Package 3: Radial Trunk Road											
- New Bagamoyo Road	252	71	535	95	953	1.30	1239	7.0%	2.25	2790	C
- Uhuru Road	237	145	889	376	1647	1.30	2141	7.0%	2.25	4820	D
- Kilwa Road	176	179	346	206	907	1.30	1179	7.0%	2.25	2650	C

*: Source ; 12-hour Traffic Volume in Table 3.6 x 1/2(for one way traffic)

**: One-third of medium goods vehicles and mini buses are asuumed to be heavy traffic

(2) Design CBR Value

For estimating the design CBR value which will be utilized for the calculation of pavement thickness, subgrade soils were sampled 2.0 km intervals along the proposed road. The design CBR for each proposed road was calculated at 4 % to 6 % as shown in Chapter 14.

(3) Pavement Thickness Design

The pavement thickness was based on the design CBR as well as the traffic classification given in Table 15.7, such that each individual course does not fall below the target value of T_A shown in Table 15.9.

Table 15.8 Target Values of T_A

	T_A Values by Traffic Classification				
Design CBR	Class L	Class A	Class B	Class C	Class D
2	17	21	29	39	51
3	15	19	26	35	45
4	14	18	24	32	41
6	12	16	21	28	37
8	11	14	19	26	34
12	-	13	17	23	30
20 or more	-	-	-	20	27

Note: T_A represents the pavement thickness which would be required if the entire depth of the pavement were to be constructed of hot-mixed asphalt concrete for binder and surface courses.

Based on the traffic classification as well as the design CBR of the embankment's subgrade, the thickness of the pavement structure for each proposed road was estimated as shown in Table 15.10.

Table 15.9 Pavement Design of Each Proposed Road

Proposed Roads	Classification	CBR of Subgrade (%)	TA /*	Pavement Type (See Fig.15.21)
1 Package 1: Arterial Roads in the City Center				
- Ohio Street	B	6	21.0	Type I
- Kivukoni Front	B	6	21.0	Type I
- Sokoine Drive	D	6	37.0	Type IV
- Gerezani Street	C	6	28.0	Type II
- Bandari Road	D	6	37.0	Type IV
2 Package 2: Middle Ring Road				
- Morocco Road	D	6	37.0	Type IV
- New Kigogo Road	C	4	32.0	Type III
- Chang'ombe Road	C	6	28.0	Type III
- Missink Link	C	6	28.0	Type III
3 Package 3: Radial Trunk Road				
- New Bagamoyo Road	C	6	28.0	Type II
- Uhuru Road	D	4	41.0	Type V
- Kilwa Road	C	4	32.0	Type III

*: Refer to Table 15.5

(4) Thickness design of Pavement Structure

In determining the pavement structure, the following formula was applied for the calculation of T_A:

$$T_A = a_1T_1 + a_2T_2 + \dots\dots\dots a_nT_n$$

Where $a_1, a_2, \dots\dots, a_n$: Coefficient of relative strength given in Table 15.10

$T_1, T_2, \dots\dots, T_n$: Thickness of individual layers of pavement, (cm)

The coefficients of relative strength in Table 15.11 indicate in cm the thickness of hot-mixed asphalt used for the binder and surface courses, having a strength equivalent to a 1.0 cm layer of pavement of other materials. For example, the coefficient of 0.35 for mechanically stabilized materials indicates that the strength of a 1 cm layer of such material is equivalent to that of a 0.35 cm layer of hot-mixed asphalt used for the binder and surface courses.

As the result of the calculation, two alternative pavement structures have been considered for each type of pavement as shown in Fig. 15.26. Cement stabilized base course is considered as an alternative pavement structure for the Project roads because of the limited quantities of hard rock in Dar es Salaam.

(5) Optimum Pavement Structure

Presently, base course materials are available only from the quarries near Kunduchi Beach, 20 km north from the city center of Dar es Salaam. The hard rock reserves, however, are running short due to the large demand for roads and house/building construction projects in Dar es Salaam Region. As stated in Chapter 14, the hard rock materials to be used for base course are expected to soon be in short supply and thus the price of rock will be increased by considerable amount in the future.

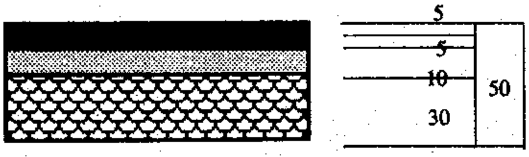
Although stabilized gravel and slag are advantageous in terms of construction cost estimated at the present value, cement stabilized base course is recommended due to the shortage of the hard rock materials.

Table 15.12 shows the optimum pavement structures recommended for the proposed roads.

Table 15.10 **Coefficient of Relative Strength for Calculating TA**

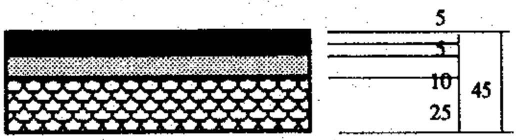
Pavement Course	Method and Materials of Construction Used	Conditions	Coefficients
Binder and Surface Courses	Hot-mix Asphalt for Binder and Surface Courses		1.00
Base Course	Bituminous stabilization	Hot-mixed, Marshall Stability: 350 kg or more	0.80
		Cold-mixed, Marshall Stability: 250 kg or more	0.55
	Cement stabilization	Unconfined compressive strength(7 days): 30kg/m2	0.55
	Lime stabilization	Unconfined compressive strength(10 days): 10kg/m2	0.45
	Mechanically stabilized gravel and slag	Modified CBR: 80 or more	0.35
	Hydraulic mechanically stabilized slag	Modified CBR: 80 or more	0.55
	Penetration macadam	Unconfined compressive strength(14 days): 12kg/m2	0.55
Subbase Course	Crusher-run, slag	Modified CBR: 30 or more	0.25
	Sand	Modified CBR: 30 or more	0.20
	Cement stabilization	Unconfined compressive strength(7 days): 10kg/m2	0.25
	Lime stabilization	Unconfined compressive strength(10 days): 7kg/m2	0.25

Type I-1



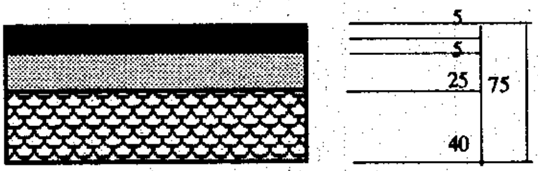
Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Mechanical stabilied crushed stone, CBR 80)
Subbase course (Crusher run, CBR 30%)
T_A =21.0

Type I-2



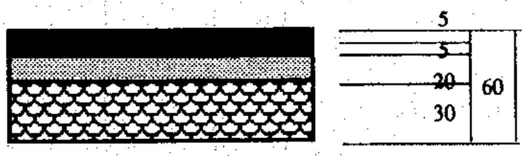
Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Cement stabiliztion, Unconfined C.S.30kg/m2)
Subbase course (Crusher run, CBR 30%)
T_A =21.75

Type II-1



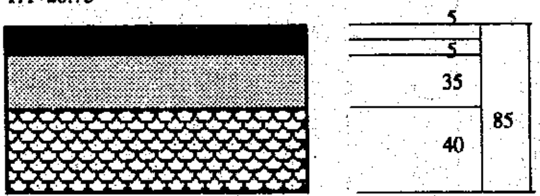
Surface course (/asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Mechanical stabilied crushed stone, CBR 80)
Subase course (Crusher run, CBR 30
TA=28.75

Type II-2



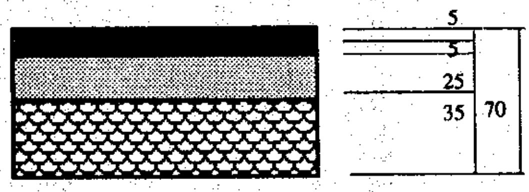
Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Cement stabiliztion, Unconfined C.S.30kg/m2)
Subbase course (Crusher run, CBR 30%)
TA=28.5

Type III-1



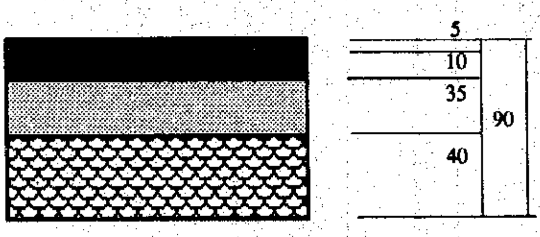
Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Mechanical stabilied crushed stone, CBR 80)
Subbase course (Crusher run, CBR 30%)
TA=32.25

Type III-2



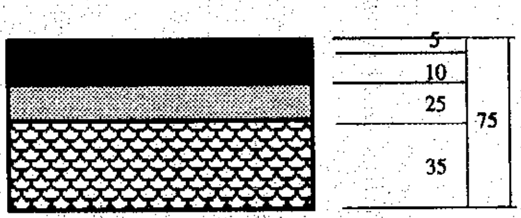
Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Cement stabiliztion, Unconfined C.S.30kg/m2)
Subbase course (Crusher run, CBR 30%)
TA=32.5

Type IV-1



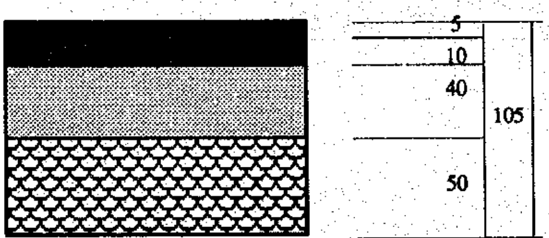
Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Mechanical stabilied crushed stone, CBR 80)
Subbase course (Crusher run, CBR 30%)
TA=37.25

Type IV-2



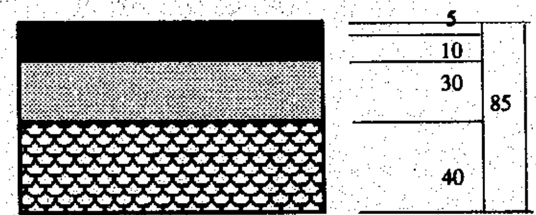
Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Cement stabiliztion, Unconfined C.S.30kg/m2)
Subbase course (Crusher run, CBR 30%)
TA=37.5

Type V-1



Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Mechanical stabilied crushed stone, CBR 80)
Subbase course (Crusher run, CBR 30%)
TA=41.5

Type V-2



Surface course (Asphalt pre-mixed)
Binder course (Asphalt pre-mixed)
Base course (Cement stabiliztion, Unconfined C.S.30kg/m2)
Subbase course (Crusher run, CBR 30%)
TA=41.5

Fig. 15.26 Alternative Pavement Structures

Table 15.11 **Pavement Thickness of Each Proposed Road**

Unit : cm

Proposed Roads	New Construction or Reconstruction of Pavement						Overlay Section
	Type of Pavement	Total Pavement Thickness (cm)	Components of Pavement Structure (cm)				
			Surface Course	Binder Course	Base Course	Subbase Course	Surface Course
			Premixed Hot Asphalt	Premixed Hot Asphlat	Cement Stabilized UCS: 30kg/m2	Crusher-run CBR:30 or more	Premixed Hot Asphalt
1 Package 1: Arterial Roads in the City Center							
- Ohio Street	Type I-2	45	5	5	10	25	Max. 10
- Kivukoni Front	Type I-2	45	5	5	10	25	Max. 10
- Sokoine Drive	Type IV-2	75	5	10	25	35	Max. 10
- Gerezani Street	Type II-2	60	5	5	20	30	Max. 10
- Bandari Road	Type IV-2	75	5	10	25	35	Max. 10
2 Package 2: Middle Ring Road							
- Morocco Road	Type IV-2	75	5	10	25	35	Max. 10
- New Kigogo Road	Type III-2	70	5	5	25	35	Max. 10
- Chang'ombe Road	Type III-2	70	5	5	25	35	Max. 10
- Missink Link	Type III-2	70	5	5	25	35	Max. 10
3 Package 3: Radial Trunk Road							
- New Bagamoyo Road	Type II-2	60	5	5	20	30	Max. 10
- Uhuru Road	Type V-2	85	5	10	30	40	Max. 10
- Kilwa Road	Type III-2	65	5	5	25	30	Max. 10

15.7.4 Overlay Pavement

In order to reduce the Project cost, existing road should be utilized as much as possible, providing the road conditions have been reasonably maintained and are in good condition.

Pavement overlays are proposed for some sections of the proposed roads where reconstruction of pavement or overlay work was conducted under the Japanese Grant Aid Program for the "Dar es Salaam Road Improvement and Maintenance Project", referred to "DRIMP".

The following roads have been and will be improved under the DRIMP program during 1992 through 1996.

(i) Phase 1 of DRIMP (The work was completed in 1992):
- Overlay for 21.0 km of Arterial Roads in Central Area including;

  Ohio Street, Kivukoni Front, Sokoine Drive, Gerezani Street, Bandari Road, and other major city roads inside the Central Area.

(ii) Phase 2 of DRIMP (The work was completed in 1993):
- Widening of Upanga Road and New Bagamoyo Road up to Morocco Road having a total length of 9.8 km.
- Overlay of New Bagamoyo Road from Morocco Junction to Mpakani Junction.

(iii) Phase 3 of DRIMP (The work is being undertaken in 1994):
- Widening 5.7 km of Morogoro Road from Morocco Junction up to Port Access.

(iv) Phase 4 of DRIMP (The work will be undertaken in 1995):
- Overlay and reconstruction of pavement for 21 km of main roads in the Kariakoo Area, including:
  Uhuru Road in Kariakoo Area, Msimbazi Road, etc.

The overlay design for the above project was made assuming a pavement design life of 10 years. The pavement design for the Project roads, therefore, shall be done taking the above rehabilitation and improvement Project into account so that the Project cost can be minimized.

The sections of the existing road to be utilized for part of the Project should be investigated in detail to clarify the thickness and strength of existing pavement. The required thickness of overlay should be determined on the basis of a detailed subsoil investigation for the existing pavement to be conducted during the next detailed design stage.

The overlay may require either strengthening of the pavement structures to meet the requirement for the anticipated future traffic demand or to adjust the elevation of the existing pavement to the height of the proposed road. In this Study, the thickness of the overlay is assumed to be 10 cm for cost estimation purposes.

15.7.5 Pavement Structure of Sidewalks

The pavement structure for the sidewalks was determined as shown in Fig.15.27.

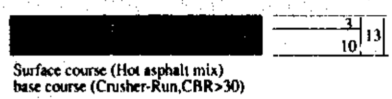


Fig. 15.27 Pavement Structure of Sidewalks

15.8 Road Facilities Design

15.8.1 Pedestrian Crossing and Promenade

(1) Pedestrian Crossing

At-grade zebra crossings, either signal controlled or uncontrolled, will be provided at major intersections and busy streets at appropriate intervals. To encourage the safe and proper use of these crossings, they should be provided with pedestrian guard rails on the approaches. Refuge areas should be provided at appropriate points to assist pedestrians in crossing the road. The exact type and location of the at-grade crossings shall be determined during the detailed design stage.

No underpasses by means of box culverts are planned because of the problems of security, maintenance for drainage and required lighting.

Pedestrian over-bridges are effective for the safety of pedestrians as well as for streamlining traffic at the busy intersections and streets where pedestrians need to cross the road in large numbers as such near to bus terminals and markets.

However, the location and layout of such pedestrian bridges should be studied carefully taking into account the site conditions as well as the characteristics of vehicular and pedestrian flow. In this Study, the provision of pedestrian bridges is recommended to be minimized and rather to be implemented in the long-term plan because of the following reasons:

(i) Pedestrian bridges require pedestrians to climb stairs, which will be disadvantage for the physically handicapped, people who are carrying heavy luggage, cyclists and push carts.

(ii) The safety of pedestrians could be reasonably assured by provision of pedestrian crossing lane using traffic signals and refuge islands at appropriate locations.

(iii) Pedestrian bridges may not be so sightly and could sometimes act as obstructions to the future development of road facilities.

(iv) Pedestrian bridges across 4-lane roads with wide median strips would require a fairy large amount of construction cost.

(2) Promenade

A spacious promenade will be provided along the seaside of Kivukoni Front to improve the environment of seashore as shown in Fig.15.28. Presently, many kiosks are located alongside the seashore which may sometimes interfere with the pedestrian movement and detract from the seaside scenery along the harbor.

The promenade shall be extended along the Kivukoni Front up to the fish market located at the northern tip of Harbor taking into account the convenience of pedestrian and non-motorized people.

15.8.2 Bus Stops, Bus Bays and Bus Stations

Bus service is the main means of public transport in Dar es Salaam and as such special attention should be paid to the design of the bus service facilities.

(1) Bus Stops and Bus Bays

For all trunk roads carrying large volumes of traffic at a high speed, the provision of bus bays at regular intervals is essential for maintaining a steady traffic flow as well as for operating the bus services smoothly and efficiently. To maintain reasonable operating speeds and minimize interference to other traffic, bus stops on the major roads should be spaced at intervals of not less than about 500 m, however, a shorter spacing may be warranted where the demand is heavy.

The proposed roads are now being utilized as the major bus service routes so that bus bays should be provided. Two types of bus bays have been considered depending on the number of bus users. The proposed locations of the bus bays are marked with circles in Fig. 15.29, however, the actual locations shall be determined in accordance with the following criteria, after discussion with the agencies concerned:

(i) The location of bus bays should avoid as much as possible places where the stopping and starting movement of buses is likely to be interfered with by vehicles from other roads.

(ii) They shall be close to the pedestrian crossing facilities.

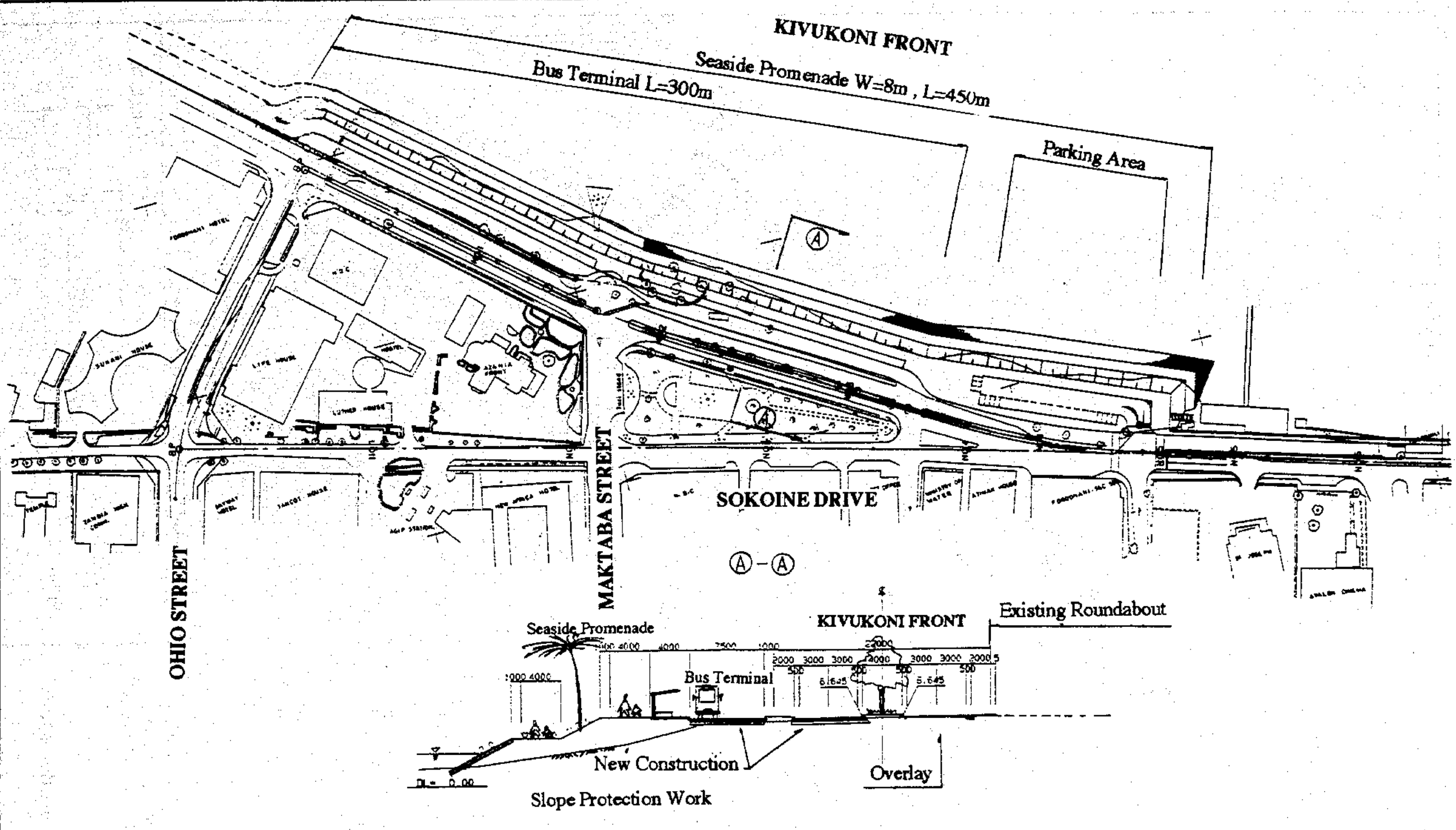
(iii) They shall be placed where sufficient spaces are remaining within the given ROW.

To enable vehicles to leave or rejoin the carriageway smoothly, bus bays should be tapered at each end. The standard type of stopping bay is designed to be 3.0 m wide, which will be sufficient for stopping one large bus, plus a 20 m length of taper to minimize the disturbance to other vehicles on the through lanes. A passenger's shelter should also be provided for each bus bay in principle.

(2) Bus Station

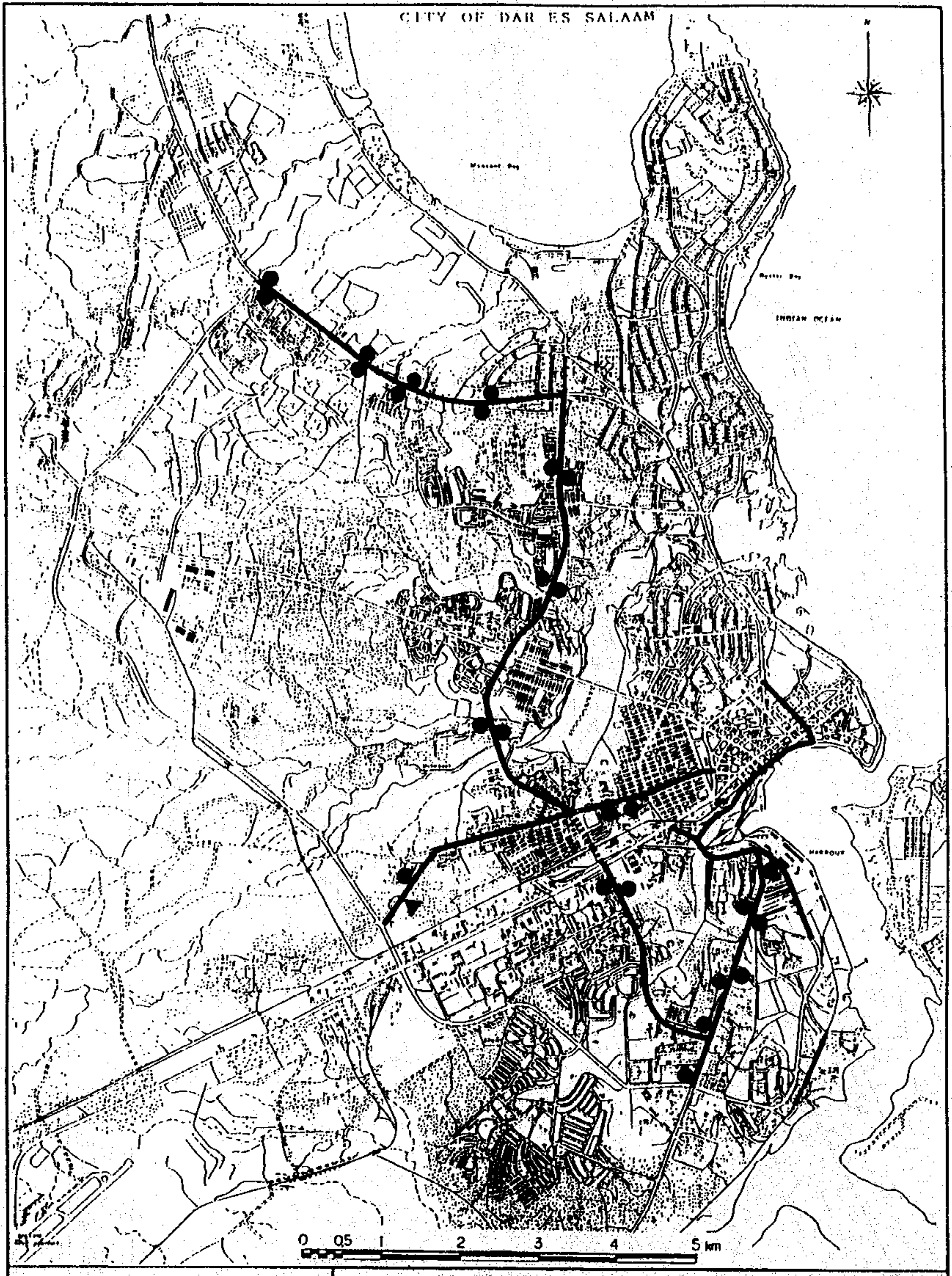
Bus stations were planned at the major road junctions where many services radiate from the city center, so as to ensure smooth transit from long-distance to local bus services. Two types of bus stations (depending on the future demand) are recommended, the layouts of which are presented in Fig. 15. 30. The location of bus stations on the proposed road are shown in Fig. 15.31.

The bus stations should be equipped with bus berths, office space for loading and unloading, waiting rooms, car parking and other related facilities.



THE STUDY ON DAR ES SALAAM
ROAD DEVELOPMENT STUDY

Fig.15.28
The Seaside Promenade of Kivukoni Front



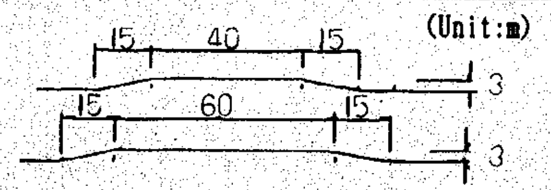
THE STUDY ON DAR ES SALAAM ROAD DEVELOPMENT PLAN

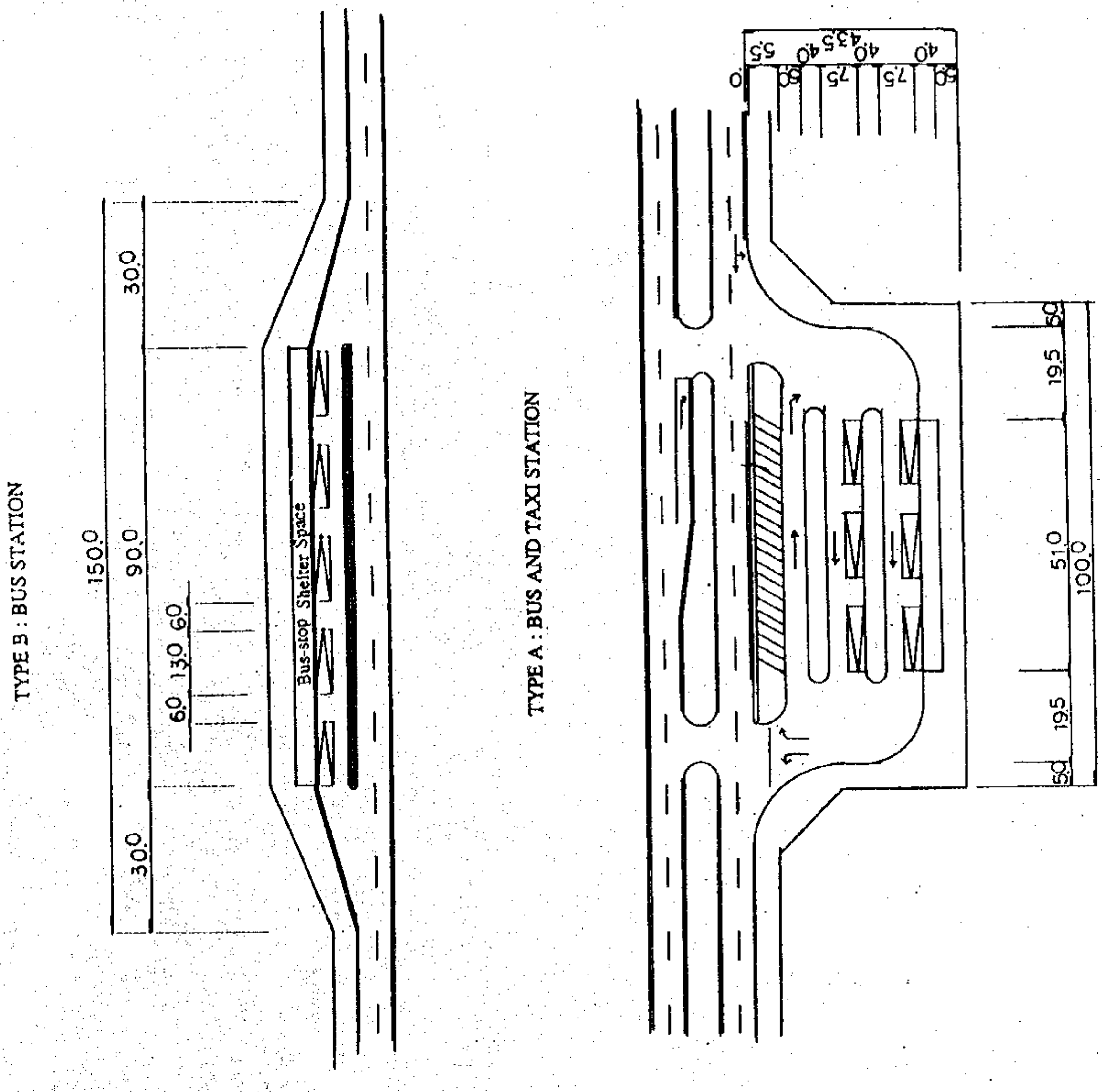
Fig. 15.29

Bus Bay Location Map

Type 1 ●

Type 2 ▲

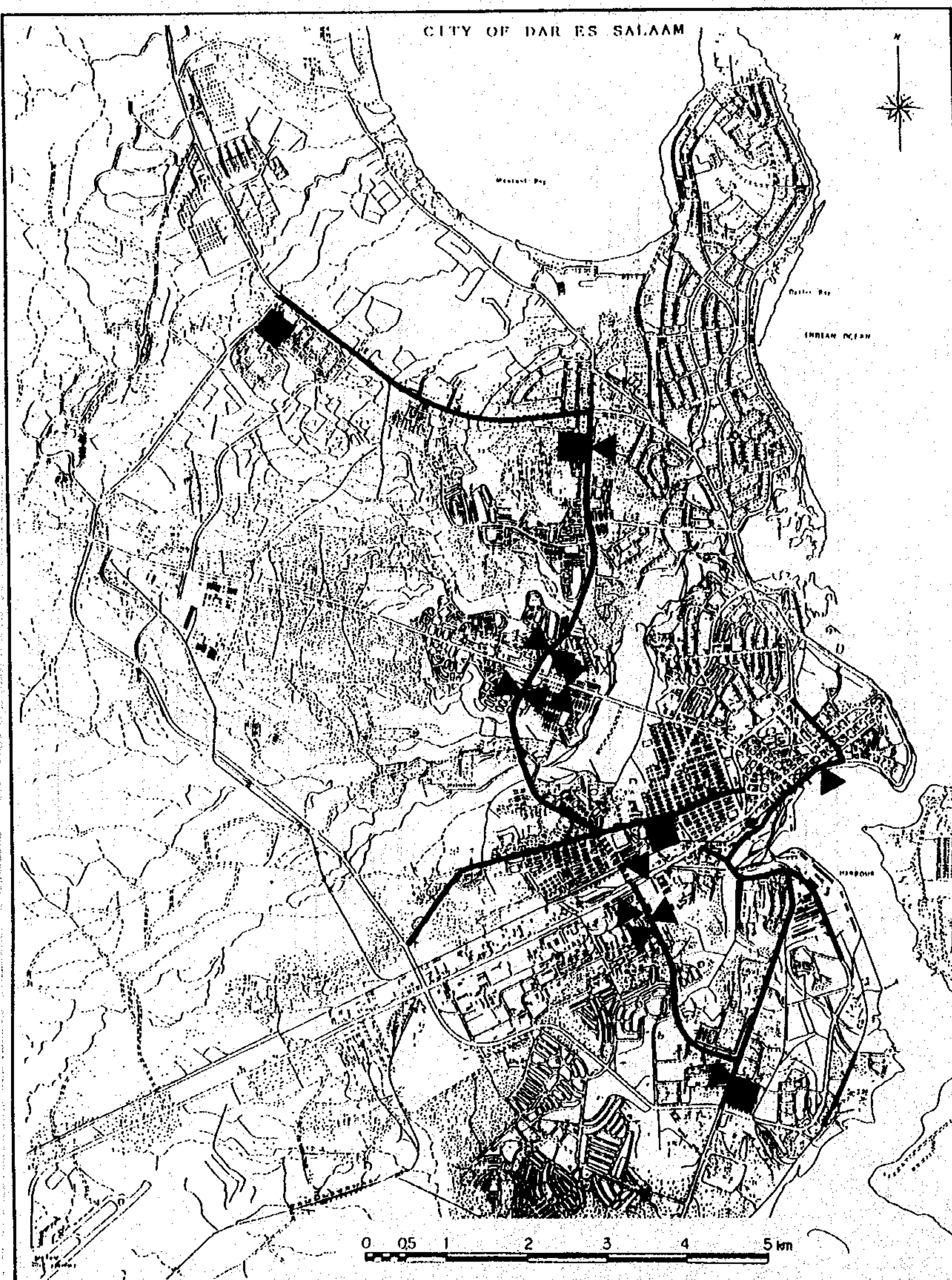




THE STUDY ON DAR ES SALAAM
ROAD DEVELOPMENT PLAN

Fig. 15. 30

The Layouts of Bus Stations



THE STUDY ON DAR ES SALAAM ROAD DEVELOPMENT PLAN

Fig. 15.31

Bus Station Location Map

Type A ■

Type B ▲

15.8.3 Lighting and Other Road Facilities

(1) Lighting Facilities

The objective of the lighting facilities is to maintain safe driving conditions for drivers, to reduce the number of traffic accidents at night time and to make the roads and bridges more attractive for potential users.

Lighting facilities should be provided alongside the proposed roads including intersections. The number of lighting columns, mounting positions, heights of luminaries and the degree of road surface luminance should be determined during the detailed design.

(2) Traffic Signs

On heavily trafficked urban roads, traffic signs are essential to prevent congestion and danger. Warning signs, restriction signs and information signs should be installed at proper locations so as to allow ample time for any necessary action of the vehicular drivers.

The types and dimensions of the signs will be finalized during the detailed design and should conform to the statutory regulations of the authority concerned.

(3) Guard Rails

Guard rails are most helpful for the safety of pedestrians and vehicles at busy intersections and are also useful for preventing heedless walking or running into the carriageway from the passageways, school exits, etc.

However, when erected on the streets, they might become unduly confining and could create difficulties at narrow sidewalks, shops, bus stops and vehicular access points.

The provision of guard rails, therefore, should be determined taking into consideration the roadside conditions after discussing with shop owners and other people concerned.

(4) Right-turn Lanes

Storage lanes for right-turning traffic should be provided at major intersections of the project roads in principle. The storage lanes will be constructed within the width of median strip if sufficient and be normally designed as full-width deceleration lanes with an end taper of 30 m. Suggested minimum lengths for right-turn lanes including the end taper are 80 m.

(5) Carriageway Markings

Carriageway markings should be used not only to define traffic lanes but also to guide vehicles at junction and indicate the position of bus stops, waiting lanes and parking bays.

Yellow markings will be used on the busy roads to reduce the number of traffic signs. Reflecting studs will also be useful for the road where the ROW situation is tight.

15.8.4 Traffic Signals

Traffic signals shall be installed at at-grade intersections for traffic control, safety of drivers and smooth handling of the traffic flow. They must be designed to meet peak conditions with appropriate reserve capacity, taking into consideration the traffic volume, turning movement for each peak period and estimated growth rate of traffic.

Traffic signals having standard lenses with red, amber and green colors are recommended. They should be installed on overhanging tapered poles with arms at a height of 6 m. Signals for pedestrians, (a signal head covered with a symbol of a person and using standard red and green colors), are also recommended to be installed at the top of a 3.5 m high pole in each direction at the intersection.

The linking signal system is quite effective when signal-controlled intersections are located close to each other, or less than 500 m intervals.

15.9 Relocation and Protection of Public Utilities

Relocation of existing utilities is one of the most difficult aspects of road construction in urban areas due to the involvement of many authorities or agencies who have different policies, development time schedules and technical standards.

The existing utilities were investigated by the Study Team referring to the available data obtained from the authorities and agencies concerned.

Public service utilities, either underground or overhead, are planned to be installed at sidewalks or shoulders so that repair and maintenance operations for the services will not hinder traffic and accelerate the deterioration of the road structures after they are opened to traffic. The shoulders and sidewalks will provide space to contain the following public utilities:

(i) Water main and distribution pipes
(ii) Electric wires and poles
(iii) Telecommunication lines

The inventory of the existing public utilities to be relocated and protected by the Project is shown in a separated volume entitled "Drawings".

All utilities to be affected by the construction of the proposed roads must be relocated and replaced or protected. Normally, the authorities or agencies concerned are responsible for the relocation and replacement of electric facilities, telephone cables, water mains at their own cost.

15.10 Preliminary Right-of-way (ROW) Design

The ROW limit lines for the proposed roads were indicated in the plans showing the road facilities which are compiled in the separate volume of Drawing.

The ROW plan was made in accordance with the basic concepts established by the Study Team as stated in Chapter 3.

CHAPTER 16 CONSTRUCTION PLAN AND COST ESTIMATE

Chapter 16 CONSTRUCTION PLAN AND COST ESTIMATE

16.1 General

The Project is composed of three packages as shown below:

Package 1: Widening to 4 lanes of the Arterial Roads in the City Center consisting of:
- Ohio, Sokoine, Gerezani and Bandari Roads including reconstruction of Gerezani Bridge (total length: 5.4 km).

Package 2: Widening to 4 lane of the Middle Ring Road with construction of the Missing Link, consisting of:
- Morocco, New Kigogo and Chang'ombe Roads with construction of Missing Link (total length: 9.9 km).

Package 3: Widening to 4 lanes of the Radial Trunk Roads consisting of:
- New Bagamoyo, Uhuru and Kilwa Roads (total length: 11.6 km).

The project cost, which consists of construction cost, land acquisition and compensation costs, physical contingency, costs for engineering services and supervisory services, etc. have been estimated with the details being included herein.

16.2 Conditions Affecting the Construction Sites

(1) Weather Conditions

The estimated workable days for construction planning are estimated based on the assumption that the number of days suspended due to rain (depending on the work items) and other conditions including national holidays (14 days) and Sundays (52 days) as follows:

- Earthwork : 228 days (62 %)
- Pavement work : 216 days (59 %)
- Drainage work : 252 days (69 %)
- Structural work : 252 days (69 %)

(2) Natural Material Sources

For the purpose of the cost estimate, road construction materials to be used for the embankment, concrete and pavement structures are assumed to be obtained from the following materials sources:

- Coarse aggregates for concrete and asphalt surface course:
  Lugoba quarry located 34 km north from the Chalinze - Segera Road or 134 km west of Dar es Salaam.
- Fine aggregates for concrete and asphalt surface course:
  The bed of the Mpiji River located 45 km north of Dar es Salaam.
- Rock materials for subbase and base courses;
  Private quarries around the Kunduch areas, 20 km north of Dar es Salaam.
- Soil materials for embankment;
  Borrow pits at Chamazi along Kilwa Road that are located 19 km from Tazara Junction or Ukonga at Kitunda along Pugu Road

(3) Local Plant and Equipment

Some types of construction equipment are available from local companies in Dar es Salaam such as United Construction Co. Ltd., BECCO Contractors Ltd., MECCO (Mechanical Engineering & Contracting Corporation) and PECHOL (Plant & Equipment Hiring Company Ltd..

Major types of equipment available in Dar es Salaam are as shown below:

- Bulldozers, D5 -D8
- Wheel loaders, 1.0 m3 - 2.5 m3
- Truck cranes, 20 ton - 30 ton
- Portable concrete mixers, 0.4 m3 - 1.0 m3
- Dump trucks, 7 ton - 12 ton
- Vibration compactors, 10 ton - 15 ton
- Motor graders, 2-3 m blade

These items of equipment, however, are generally not maintained in good condition and the capacity and numbers of equipment are relatively limited. As such, equipment to be used for the Project's critical work should be brought to Dar es Salaam by the foreign contractor who is awarded the contract.

(4) Abandoned Ships in Dar es Salaam Harbor

About 10 abandoned ships are now located along the seashore in front of Kivukoni Front and Sokoine Drive where the seaside promenade and new bus station are proposed in the Study by reclamation of the seashore. These ships should be disposed by either being moved to another place or dismantling them.

(5) Relocation of TRC (Tanzanian Railway Corporation) Railway Line

The Missing Link of the proposed Middle Ring Road has to cross three railway lines in the section between New Kigogo and Chang'ombe Roads. Out of three lines, the main railway from Dar es Salaam Station and the sidetrack line is running in parallel with a maximum gap of 2.5 m height (The sidetracks are located higher than the main railway).

The road is planned to intersect these existing lines at the same level, so that the main railway should be raised to the same level of the sidetracks, which would require a change in vertical alignment of the main railway for a length of 1.5 km. The alignment change of the railway tracks should be included as a part of the Project, and the work should be done keeping close coordination with TRC so as to minimize interference with the railway operations.

(6) Relocation of Public Utilities

All utilities to be affected by the construction of the proposed roads must be relocated and replaced or protected. Normally the authorities or agencies concerned are responsible for the relocation and replacement of electric facilities, telephone cables, water mains at their own cost.

Existing water mains along the proposed roads are mostly laid beneath the existing sidewalks at about 2.0 meters in depth. These water mains should be relocated before commencing the Project's widening work. Relocation should be done maintaining close coordination with the agencies concerned.

(7) Traffic Management During the Construction

The widening of the existing road may sometimes seriously interfere with the traffic flow during construction. Since the proposed roads carry large number of vehicles, special care should be taken for traffic management, especially safety. Diversion roads should be properly provided with appropriate traffic signs and guides. Also, night work should be considered to minimize the traffic congestion during the construction of proposed roads in the City Center.

Widening of the existing roads sometimes requires relocation of existing bus bays and bus stops which may hinder not only the operation of the bus services but also the passengers getting on and off. Temporary facilities should be provided near the existing bus bays for the convenience of passengers during the construction.

16.3 Conditions for Cost Estimation

The Project cost has been estimated on the basis of the preliminary design, construction plan and schedule. The unit prices are computed in accordance with the following basic assumptions and conditions:

(i) The Project cost is estimated assuming that all construction work will be carried out by an international contractor.

(ii) The unit prices of labor, materials and equipment have been computed based on the economic conditions and the market prices prevailing in July 1994.

(iii) The exchange rates for the US$, Japanese Yen and Tanzanian Shilling are as follows as of the end of July 1994:

US$ 1.0 = ¥ 100.0 = Tsh. 530 (Tsh. 1.0 = ¥ 0.189)

(iv) The unit prices have been divided into a foreign currency portion (indicated in Yen) and a local currency portion (indicated in Tsh.). The foreign and local components consist of the following items:

(a) Foreign Currency Components:
- Imported equipment, materials and supplies.
- Imported materials in the local market.
- Wages of expatriate personnel.
- Overhead and profit of the foreign contractor and consultant.

(b) Local Currency Components:
- Domestic materials and supplies.
- Wages of local personnel.
- Indirect local costs including temporary facilities.
- Duties and tax.

(v) Constitution of the Project Cost

The Project cost consists of the following items:
- Construction cost.

- Engineering costs including detailed design and construction supervision.
- Physical contingency and price contingency.
- Land/house compensation cost including the relocation of existing public utilities.
- Tanzanian government administration cost.

(vi) Constitution of the Construction Cost

The construction cost consists of the following items:

- Direct construction cost.
- Direct cost for temporary works (temporary road, etc).
- General cost for temporary works (project offices, etc).
- Transportation cost and packing cost.
- Site operation and administration cost.
- General expenses of general contractor.

(vii) Imported equipment and materials, with the exception of fuel, are assumed to be exempted from tax and duties by the Tanzanian Government. Fuel, including tax and duties, is estimated in terms of the local currency.

(viii) Land/house compensation costs are estimated on the basis of current standard unit rates applied by the Dar es Salaam City Council, the agency responsible for compensation to the house owners.

(ix) 25% for overhead, including profit, has been included as a part of the unit costs.

(x) Physical and price contingencies are estimated to be 10 % of the total construction cost.

(xi) The cost for the engineering services is estimated at 10 % of the total construction cost.