CHAPTER 7

DESIGN, CONSTRUCTION

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7-1 Facility Design

7-1-1 General

The aim in this section is to design the facilities, which will protect the sand-nourished tourist beaches from erosion.

Since groins are the main facility in this protect, the procedure and discussion of the groin design is mostly emphasized.

The design work flow is shown below in Fig. 7-1-1.

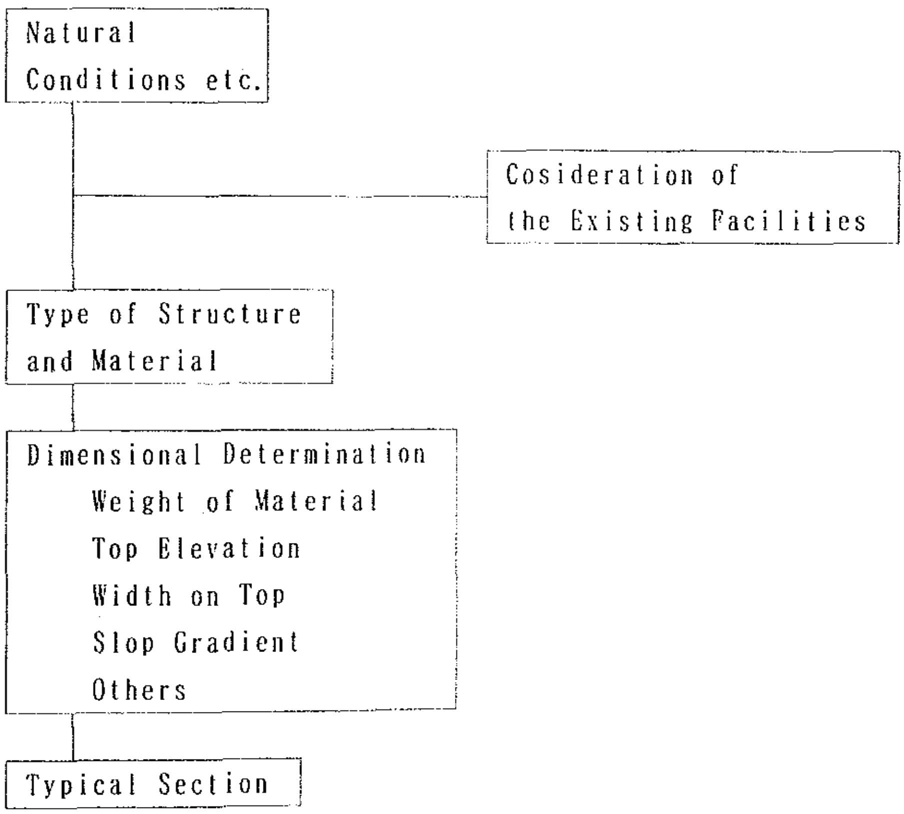


Fig. 7-1-1 Dewign Work Flow

7-1-2 Design Conditions

(1) Tide

From the tide observation record and the information in the tide table, the tide for the design is determined as below:

M H W L = + 1.30 m
M S L = ± 0.00 m (DL)
M L W L = − 1.30 m
Tidal Range = 2.60 m

(2) Sea-bed Level

The sea-bed level in the reef area is in general shallower than -2.0 m, but mostly -1.0 m with an almost flat bed according to the site survey.

(3) Waves

All the facilities are planned to be constructed at shallow water depth in the reef area, where, after the primary wave breaking at the reef edge, only the smaller waves exist. Thus, regardless of the off-shore wave, the design wave without breaking against the facilities can be given as follows:

Hb = 0.78 x hb where Hb = Design wave height
hb = Water depth at the envisaged point
= (+1.30m) - (-1.00m) = 2.3m
Hb = 0.78 x 2.3 = 1.8m

(4) Sub-soil Condition

Although sub-soil exploration was not conducted in this study, it is generaly understood through experience at the site that the sub-soil, principally coral, seems strong enough for the overburden from the facilities.

It is reported that reclamation works on the existing sub-soil were carried out during the air-strip extension into the sea at Bali airport, and thus the above assumption seems reasonable.

(5) Seismic Condition

There is a general map showing seismic condition or coefficients in Indonesia which may be applicable in this study.

(6) Others

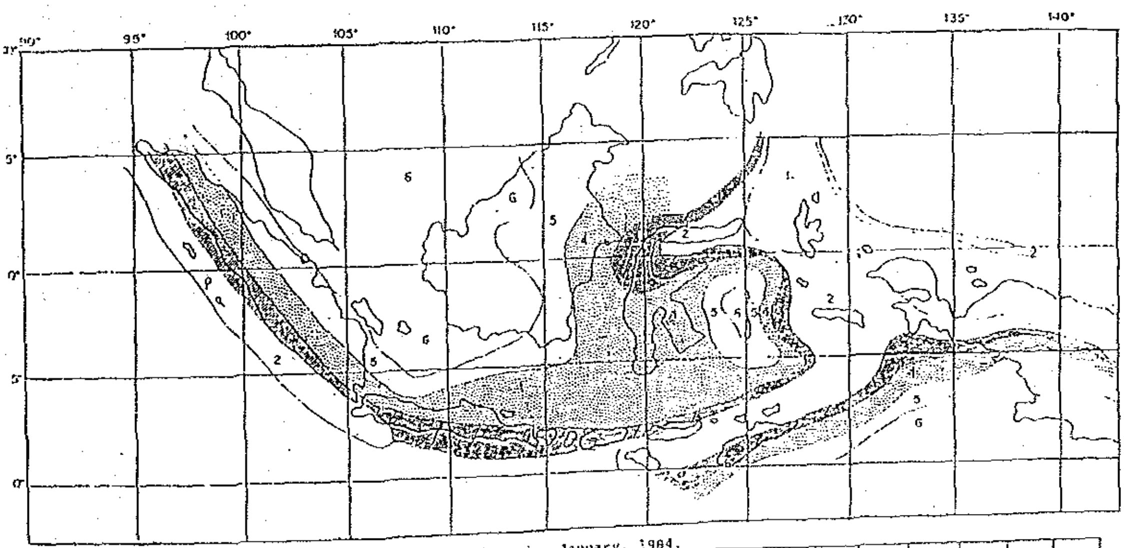
1) Regulations

In line with the establishment of design criteria for coastal engineering, such regulations will hopefully come into force soon under the direction of the Public Works Department. Thus all shoreline facilities will likely be put under the control of the Public Works Department, and no planning and construction of private facilities will be executed without prior approval.

2) Service Life

Various service lives are adopted for various facilities in Indonesia, mostly depending upon the importance of the concerned structures/facilities from the social, economic and engineering view points.

Through discussions, it is deemed prudent to apply some 30-50 years as the service life of the facilities in this study.



Source: Standard Design Criteria for Ports in Indonesia, January, 1984.

Soil Type \ Zone	1	2	3	4	5	6
Stiff Soil	0.09	0.07	0.05	0.03	0.01	0
Soft Soil	0.13	0.09	0.07	0.05	0.03	0

Fig. 7-1-2 Classification of Seismicity by Regiopnal Areas in Indonesia

7-1-3 Existing Facilities

The typical sections of the existing groins are shown in the previous chapter.

Although coastal engineering falls within a rather new field of engineering in Indonesia and facility design has so far been experimentally and practically worked out through experience at various sites, it is clear that the following consideration have been taken into account in the design of the existing facilities.

1) In order to use to the utmost the locally available materials and to facilitate works within the tidal range by manual labour, 1 m dia. concrete unit pipes with in-fill have been adopted. Inserted connection bars are used to overcome shortcomings in structural unity and rigidity.

2) In order to moderate the disturbance of the natural view by artificial engineering facilities, unit concrete pipes for groins are not exposed, but covered by natural coral.

From the engineering and economic viewpoints, the above considerations are appraised reasonable and practical, and so they also applicable to the facility design of this project. In other words, the following 3 items are taken into consideration in this study:

① Workability in a shallow reef area under a wide tidal range
② Material availability
③ Maintaining the natural view

7-1-4 Types of Structures and Materials

Various types of structures and materials for groins have been introduced and adopted throughout the world. Typical types are as shown in Fig. 7-1-4.

Permeable groins, which literally allow sand to move through to some extent, are widely used and especially at beaches with constant natural sand-supply from outside, or a balance of inflow and outflow. On the other hand, impermeable groins are used at the beaches where sand is allowed to move only in between groins. This project aims to maintain the beaches by sand-nourishment without a constant natural supply from the outside, and thus impermeable groins are adopted.

As for the materials, the traditional concrete unit pipes with in-fill are adopted. This is because the quantity of big stones (approx. 1 ton) is limited at some river areas and there would be some difficulty to transport them from the bottom of river valleys, and revetment type groins require mechanical construction, which is deemed unacceptable at tourist beach.

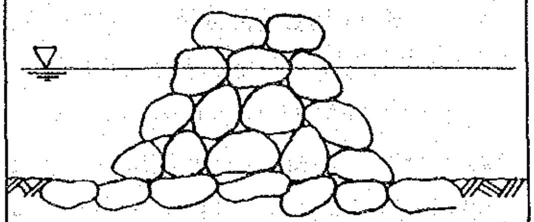
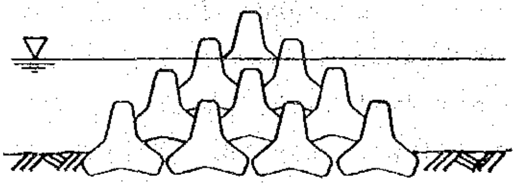
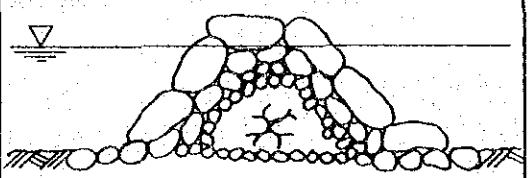
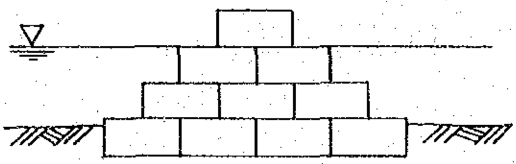
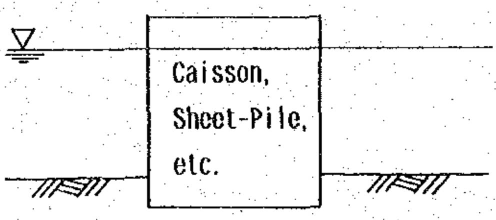
	Type	Sketch
Permeable Groin	Rubble Mound	
	Concrete Block	
Impermeable Groin	Stone-pitched Mound	
	Concrete Block	
	Revetment	

Fig. 7-1-4 Type of Structure

7-1-5 Dimensions

(1) Typical Section of Groin

With the above discussion in mind, the various dimensions and particulars are determined below.

1) Weight of Material

The required unit weight of material (concrete unit pipe in this case) is given by the following formula by Hudson.

$$W = \frac{\gamma_r \cdot M^3}{Kd\ (Sr - 1)^3 \cdot \mathrm{Cot}\,\alpha}$$

Where W = Minimum weight of material (ton)

γ_r = Unit weight of material (ton/m^3)

Sr = Specific gravity of material to sea - water

= Angle of slope to the horizontal plane (degree)

H = Wave height (m)

Kd = Constant for material and damage race

γ_r = Conctete pipe and infill sand/stone = 2.0 t/m^3

Sr = 2.0

α = 1:1

H = 1.8 m

Kd = 12.8 (damage rate 15 - 40%), reasonable for smaller scale structures under rather conservative wave height.

$$W = \frac{2.0 \times 1.8^3}{12.8 \times (2.0 - 1)^3 \times 1} \doteq 0.9 \text{ ton (required)}$$

The weight of the concrete unit pipe with in fill (0.8 ton) is slightly less than the required weight, which can however be offset by introducing the inserted connection bars.

2) Top Elevation

It is general practice that the top elevation is approximately determined by;

L = HWL + 0.5 H + Allowance (m)
= (+ 1.30) + (0.5 x 1.8) + (0.8)
= + 3.0 m constantly flat

There may be an argument that the top elevation should slant lower towards the offshore area. This may be applicable to the groins, which only need to function as engineering facilities at deeper areas. However, in order to avoid a slippery pedestrian walk because of topping waves, the top elevation of + 3.0 m is kept constantly flat.

3) Top Width

It is observed that some people enjoy having a stroll on the existing groins, and it is prudent to presume that such a practice may continue. Therefore, a minimum width of 2m as pedestrian walk is provided.

4) Slope Gradient

It is again recommendable that the slope gradient of the natural stone covering allow people to comfortably walk into the sea. Thus, a 1 : 2 slope gradient is adopted, instead of the 1 : 1 gradient of many of the existing facilities.

5) Others

As discussed in the beginning of this section, the structural core with concrete pipe is to be covered with natural coral stones.

The typical section of groin is shown in Fig. 7-1-5.

TYPICAL SECTION

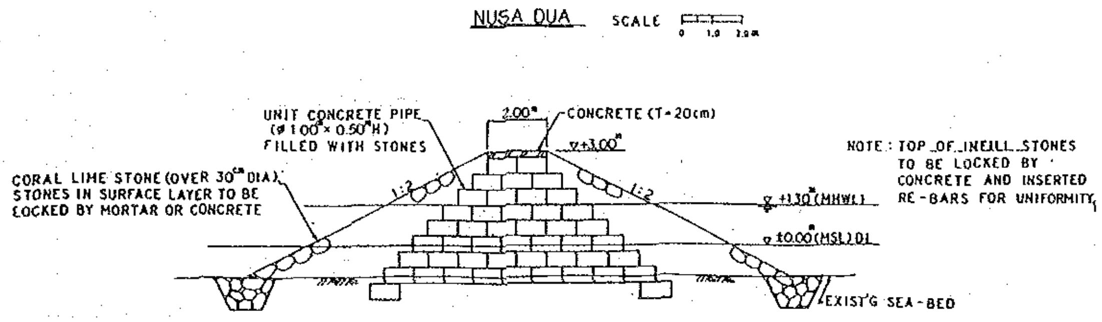


Fig. 7-1-5 Typical Section of Groin

(2) Submerged Off-shore Breakwater at Sanur

The required unit weight of material (concrete block and/or hard rock) is given by the following formula;

$$W = \frac{K_L \cdot \gamma_w{}^3 \cdot R^3}{\gamma_d{}^2 \cdot \cos^3\alpha}$$

Where W = Minimum weight of material (ton)

γ_w , γ_d = Unit weight of sea-water and material (ton/m³)

R = Water depth above breakwater (m)

α = Angle of the slope to the horizontal plane (degree)

K_L = Constant

γ_w = 1.0 t/m³

γ_d = 2.3 ~2.7 t/m³

R = 1.3m max with top level ±0.0m

α = 1 : 2 ~1 : 3

K_L = 0.5 in general

$$W = \frac{0.5 \times 1.0^3 \times 1.3^3}{2.3^2 \times 0.95^3} \doteq 0.30 \text{ ton}$$

→ 500 kg/pc

(3) Appraisal of Concrete Blocks at Tanah Lot

The appraisal of the concrete blocks (actual weight 1.8 ton)* is conducted below.

1) Wave

Water depth = sea-bed level 2.7   1.7m below MSL

= 3.5 m average

Hb = 0.78 x hb = 2.73 m

2) Required block weight

By Hudson formula;

$$W = \frac{2.3 \times 2.73^3}{10.2 \times (2.3 - 1)^3 \times 1} = 2.1 \text{ ton}$$

3) Conclusion

The weight of the existing concrete blocks is deemed slightly less than that required, but is presumably within the acceptable deviation from the viewpoint of functioning as an urgent counter-measure. Thus, it is not necessary to provide any new facilities in addition to the existing blocks.

* The designed weight of concrete blocks (2.4 ton) was eventually reduced to 1.8 ton due to the capacity of the available construction equipment.

7-1-6 Designs

Based upon the foregoing, the typical sections of structures and sand nourishment at each beach are shown in Fig. 7-1-6-1 through 7-1-6-6.

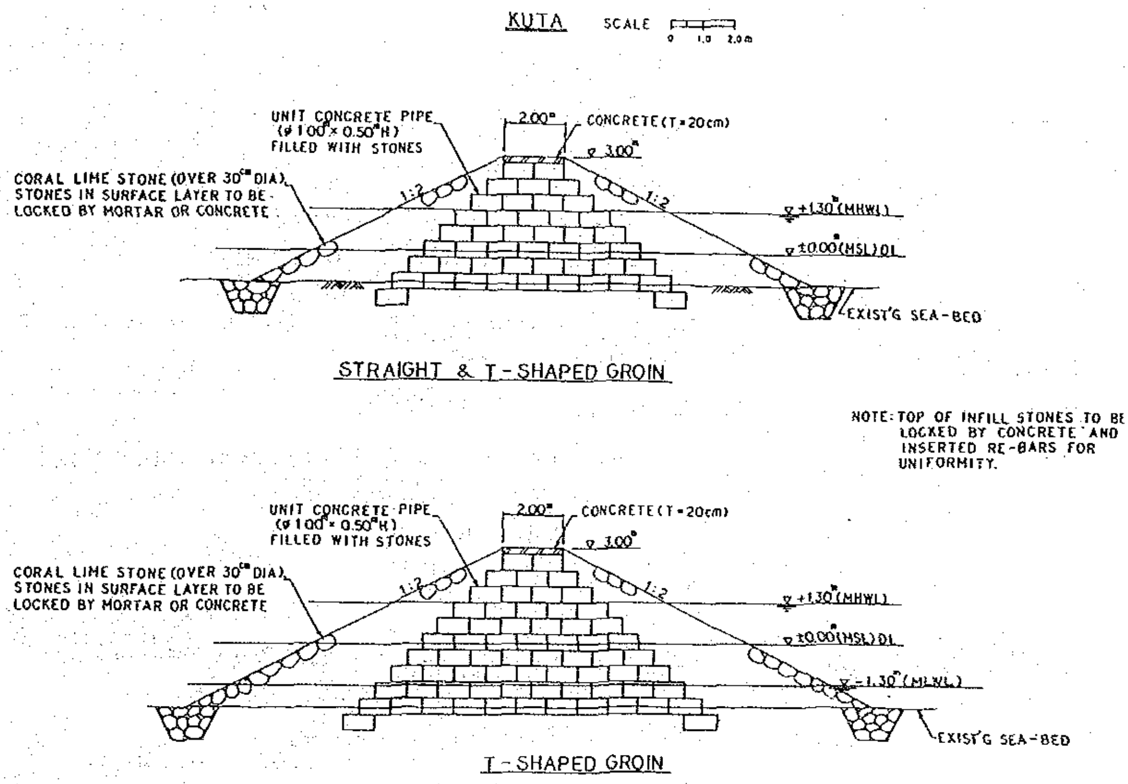


Fig. 7-1-6-1 Preliminary Design (Structures, Kuta)

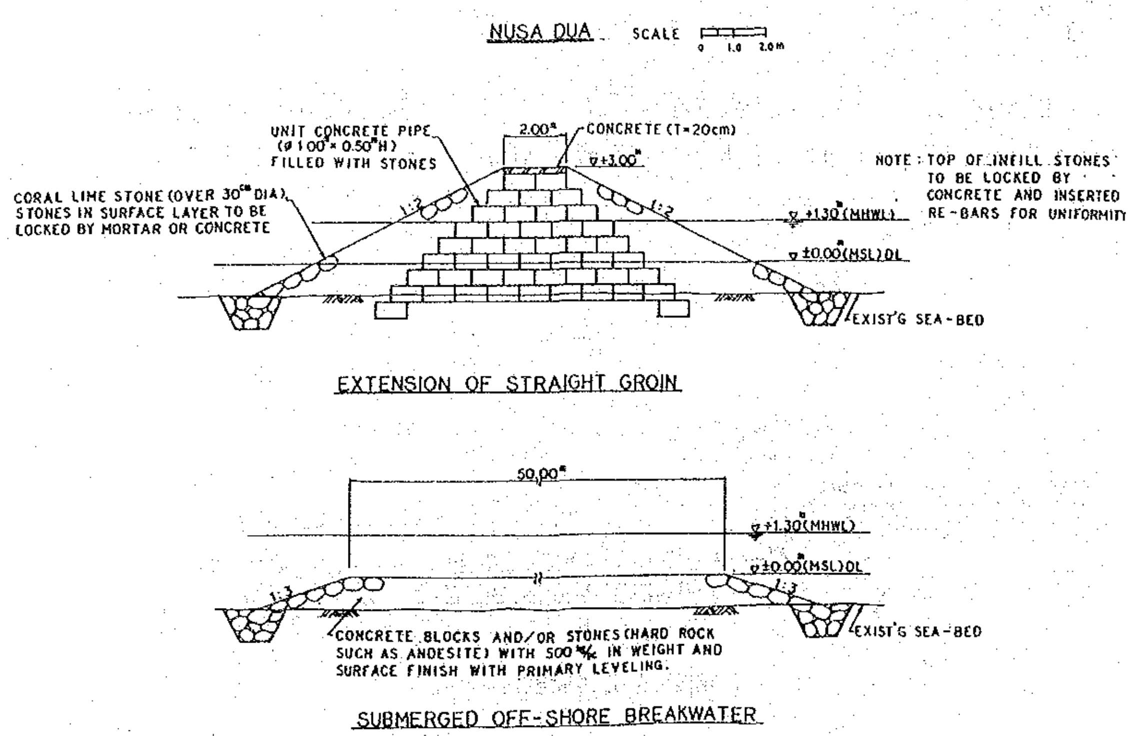


Fig. 7-1-6-2 Preliminary Design (Structures, Nusa Dua)

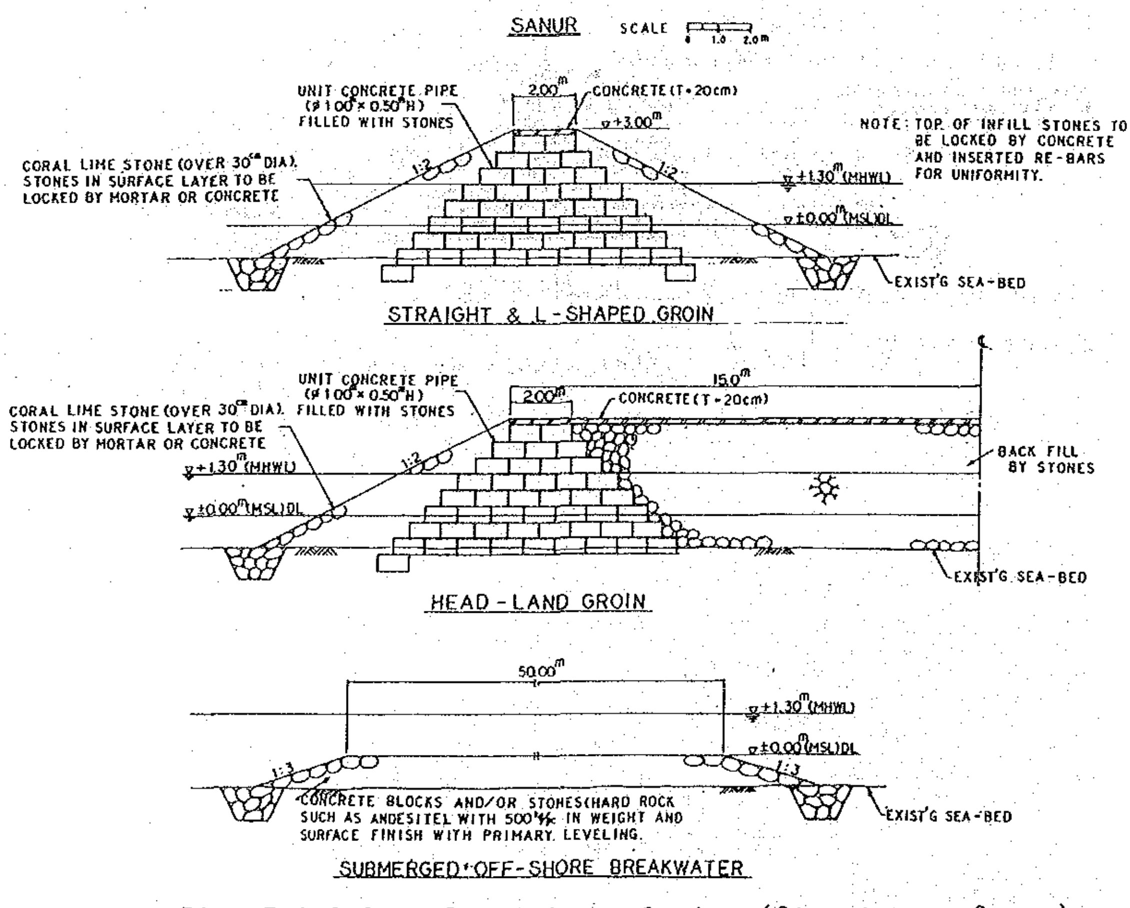


Fig. 7-1-6-3 Preliminary Design (Structures, Sanur)

KUTA

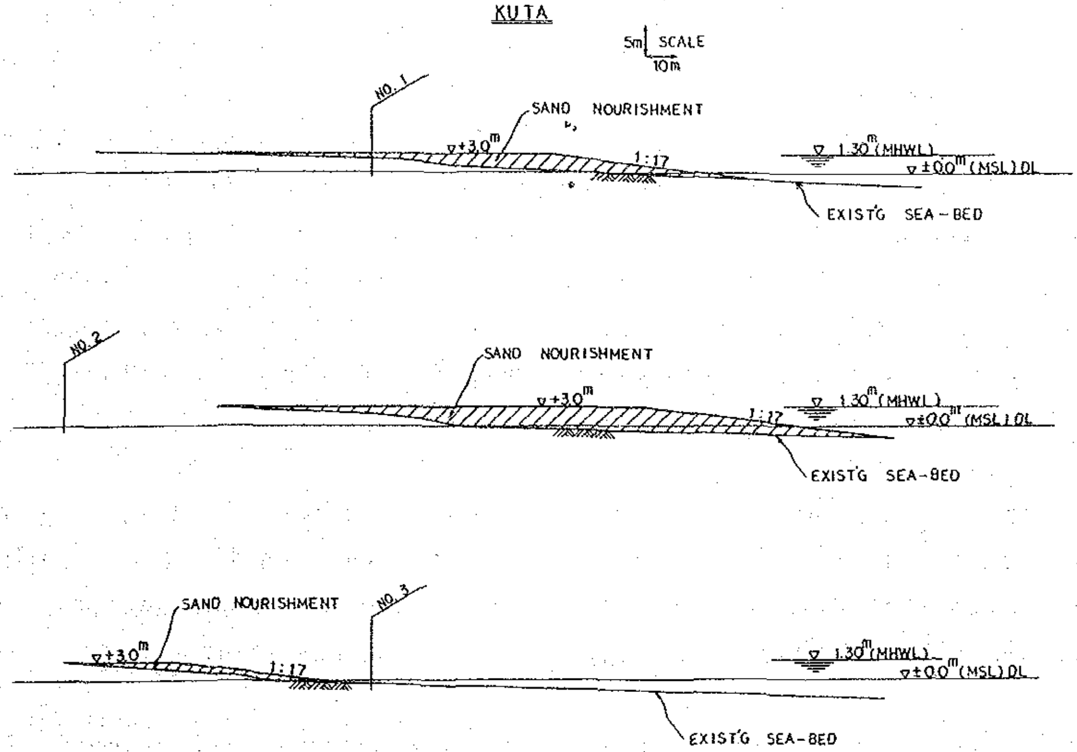


Fig. 7-1-6-4 Preliminary Design (Nourishment, Kuta)

NUSA DUA

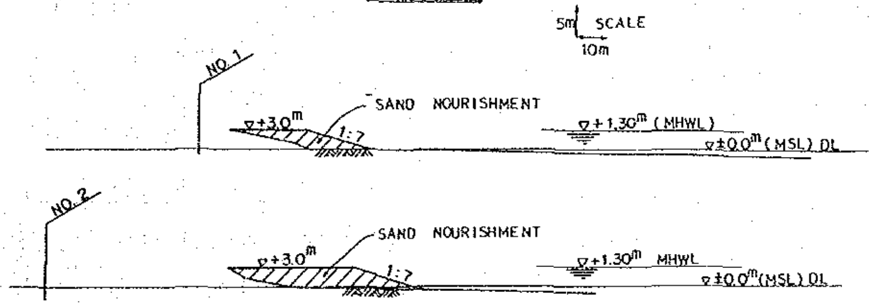


Fig. 7-1-6-5 Preliminary Design (Nourishment, Nusa Dua)

SANUR

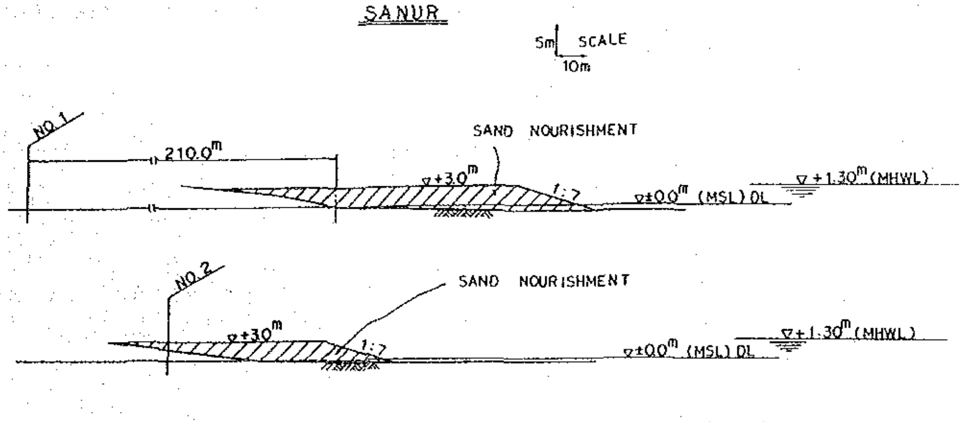


Fig. 7-1-6-6 Preliminary Design (Nourishment, Sanur)

7-2 Construction Plan

7-2-1 General

All the work sites of the Urgent Bali Beach Conservation Project are situated in front of a beach behind hotels where many tourists are lodged, enjoying their holidays at the seaside all year round.

In these circumstances, the construction plan has been prepared so as to minimize the nuisance to tourists based on the following assumptions:

(1) In the construction of the groin works, construction equipment and materials will be transported by land at night and the execution of the works will also be carried out from the land side. However, the equipment is selected to minimize the construction period.

(2) In the construction of the offshore breakwater, the construction equipment will be set on a barge and all construction materials will be transported from the jetty to the sites. Therefore, the construction works will not occupy the beach area for a long period of times.

(3) In the construction of the submerged offshore breakwater, all construction equipment and materials will be transported from the jetty to the sites. Therefore, the construction works will not disturb the toourists even during the construction period.

(4) In the beach sand nourishment works, the following conditions are the essential prerequisities:

1) The sand source area offshores has no adverse influence on the beachline.

2) The transportation of sand will be carried out by means of seaborne traffic.

3) The sand will be spread using a pump dredger from outside of the

coral reefs to the beaches. Therefore, the construction works will occupy the beach area for a relatively short period of time.

7-2-2 Formalities

The formalities of this project from the preparation of the general agreement between the Indonesian Government and the Japanese Government until the completion of the urgent construction works are as follows:

I T E M	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.
IP	—						
General Agreement	↓						
Loan Agreement		↓					
Consultant Tender & Evaluation		↓					
Consultant Contract Negotiations		↓					
Award of Consultant Contract		↓					
Detailed Design			—				
P.Q. of Contractor			—	—			
Tender of Contractor				—			
Tender of Evaluation & Negotiations				—			
Award of Contract				-			
Construction					—	—	—

Fig. 7-2-2-1 Work Schedule for Project Implementation

The above Work Schedule for Project Implementation is based on the premise that the detailed design and supervisory services should be awarded under a single, unified contract.

7-2-3 Basic Policy of Construction Plan

(1) Construction Framework

For the Bali Beach Conservation Project a full contracting system is applied so as to complete the works using a large number of machines in a relatively short time.

In principle, the construction works at the three beaches of Kuta, Nusa Dua and Sanur are required to start at the same time.

The proposed construction is required to be completed within a period of three years.

At first, the groin, offshore breakwater and submerged offshore breakwater works are required to be completed within a 2-1/2 year period after the commencement of the works.

The beach sand nourishment works at each beach will begin after the groin, offshore breakwater and submerged offshore breakwater works. All these works are required to begin by the middle of the second year, at the latest.

The transportation of materials to the temporary stock yards at each beach from outside of the project area will take place at night.

(2) Workable Days

It is assumed that the construction works will be completed within three years without suspension even on strong wind days.

The construction of coast protection works is affected by strong winds from the offshore, and the workable days within a year for executing the construction of coast protection works are estimated by month using the wind velocity record of the fourteen-year period from 1974 through 1987 at the Bali Airport Station.

In this case, the days with a wind velocity of more than six knots per hour, which is converted into a wave height of 0.6 m, are regarded as waiting days for the construction of protection works. The number of working days each month is shown in the followings table.

Table 7-2-3-1 Workable Days in the Year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Workable days	17	17	24	24	17	14	12	12	16	20	24	23	220

The total number of workable days per year is 220 days. However, 20 extra days are subtracted for Hari Raya, etc., and the net workable days per year are assumed as 200 days per year.

(3) Working Hours

Working hours are assumed as follows:

Two 8-hour shifts per day are assumed for civil works, and the net operation hours of equipment for civil works is estimated as 10 hours per day except for dredging works for the beach sand nourishment works.

Two 8-hour shifts per day are assumed for dredging works in the supply area for collection of sand, and the net operation hours of equipment for the works were estimatetd as 14 hours per day.

7-2-4 Execution Plan

This project must be completed urgently and all the works are planned to be completed in the three-year period by using construction machinery.

(1) Urgent Bali Beach Conservation Project

The main erosion prevention works are summarized below.

Groin	:	2,940 meters
Offshore Breakwater	:	330 meters
Submerged Offshore Breakwater	:	12,500 cubic meters
Beach Sand Nourishment	:	1,460,000 cubic meters
Demolition	:	363 meters

This project is composed of three sites at Kuta, Nusa Dua and Sanur, and the outline of the main works is presented below:

1) Preparatory Works

An existing asphalt-paved road of about 6 meters in width runs from Benoa Port to Kuta, Nusa Dua and Sanur, instead of passing through Denpasar City. A certain existing non-paved road will also be available for this project as an access road to the work area branching from the main road by improving small bridges.

It is required, however, that a new access road shall be constructed with a small bridge to secure the transportation of equipment and regular traffic. Also, a small bridge on the existing road must be imporved.

The preparatory works shall be completed within three months from January to March, the first year.

2) Groin

The groin works shall be carried out by four (4) teams at Kuta, Nusa Dua, and Sanur beaches with a total length of 2,940 meters within 28 months from April, the 2nd year, to July, the 4th year.

Two of the four teams will work at Kuta beach with a total groin length of 1,600 meters over 28 months from April, the 2nd year, to July, the 4th year.

Another team shall work at Sanur beach with a total length of 890 meters over 28 months from April, the 2nd year, to July of the 4th year.

The last team shall carry out works at Nusa Dua beach with a total length of 100 meters within 3 months from April to June, the 2nd years, and the team shall then transfer to Sanur beach and carry out works within 20 months up to February, the 3rd year with a total length of 350 meters.

3) Beach Sand Nourishment

The beach sand nourishment works will be carried out at three beaches by two fleets of suction pump dredgers with three grab dredgers for sand excavation offshore, with a total volume of 1,460,000 m^3 during the 15-month period from October, the 3rd year, to

December, the 4th year.

One fleet of pump dredgers shall work at Kuta beach for 13 months from October, the 3rd year, to October, the 14th year, totaling 783,000 m³.

The other fleet of pump dredgers shall work at Nusa Dua Beach over 4 months from October to January, the 3rd year, with a total volume of 229,000 m³ and then move to Sanur Beach.

A total volume of 448,000 m³ will be moved at Sanur Beach within 11 months from February, the 3rd year, to December, the 4th year.

The process of the beach sand nourishment for the Bali Beach Conservation Project is illustrated in Fig. 7-2-4-1.

4) Submerged Offshore Breakwater

The submerged offshore brerakwater works at Sanur beach will utilize 0.6 m³ concrete and around 500 kg pieces of andesite stone offshore with a total volume of 12,500 m³ within a period of 7 months from April to October, the 3rd year.

5) Offshore Breakwater

The offshore breakwater works at Nusa Dua Beach shall be carried out within a period of 9 months from July to March, the 2nd year, with a total length of 330 meters, and the team will then transfer to Sanur beach for the submerged offshore breakwater works.

The detailed execution plans of the three beaches are presented below:

(2) Kuta Beach

The main erosion prevention works at Kuta beach are as follows:

Groin	:	1,600 meters
Beach Sand Nourishment	:	783,000 cubic meters
Demolition	:	70 meters

Groin works will use materials hauled from the nearby temporary stock yards, transported from the concrete batching plant and the quarry sited. The forming of groins will be executed using crawler

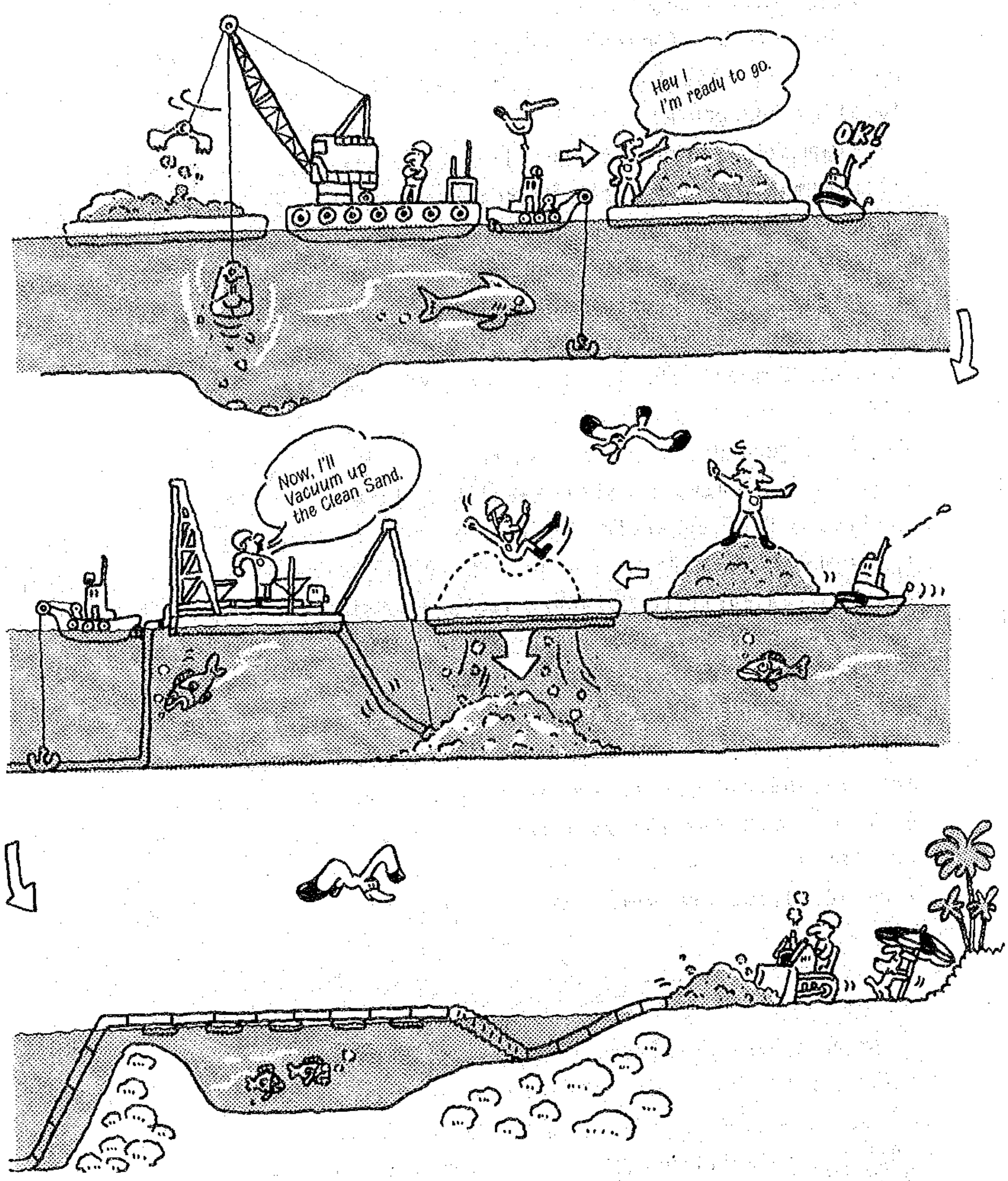


Fig. 7-2-4-1 Illustration of the Beach Sand Nourishment cranes, amphibious soft-terrain excavators, concrete mixers, wheel carriers and manual labor.

Beach Sand Nourishment works will be executed using a grab dredger and a pump dredger. The source area will be an offshore site which has no adverse influence on the beachline, and hence the sand will be carried by barges.

The sand will be carried using a pump dredger from outside of the coral reefs to the beach, and the sand will be spread over the beach using bulldozers.

The demolition of the existing groin will be executed by using a crawler crane from the land side and the broken materials will be removed by wheel carriers and manpower. These materials will be used for building new groins.

(3) Nusa Dua Beach

The main erosion prevention works at Nusa Dua beach are as follows:

Groin	:	100 meters
Offshore Breakwater	:	330 meters
Beach Sand Nourishment	:	229,000 cubic meters
Demolition	:	213 meters

Groins will be constructed using the same method as at Kuta Beach.

The offshore breakwater will also be constructed using the same method. However, there is some difference. The construction materials of the offshore breakwater can be transported by barge. So, a jetty shall be planned as part of the preparatory works. The forming of the offshore breakwater can be executed using a crawler crane which is set on a barge.

Beach sand nourishment works will use the same system as at Kuta.

The demolition of the existing offshore breakwater will be executed using a crawler crane set on a barge, and the broken materials will be transported by seaborne traffic and these materials will be used for building the submerged offshore breakwater.

(4) Sanur Beach

The main erosion prevention works at Sanur beach are as follows:

Groin	:	1,240 meters
Submerged Offshore Breakwater	:	12,500 cubic meters
Beach Sand Nourishment	:	448,000 cubic meters
Demolition	:	80 meters

Groin works will be executed using the same method as at the other beaches.

Submerged offshore breakwater works will use materials hauled by barges from the nearby temporary stock yard through the jetty, transported from the batching plant yard and the river banks. The submerged offshore breakwater will be formed using a crawler crane and an amphibious soft-terrain excavator.

Beach sand nourishment works will be executed by the same method as at the other beaches.

Demolition of the existing groin will also use the same method as at the other beaches.

7-2-5 Construction Schedule

The construction time schedule is given in Fig. 7-2-5-1 and the works were planned based on the assumptions mentioned in the Work Schedule for the Project Implementation in Fig. 7-2-2-1.

Name of Place and Description	Quantity
1. Preparatory Works	
Temporary Access Road	L.S
Temporary Facilities & Buildings	L.S
2. Kuta Beach	
Groin	1,600 m
No. 5	100 m
No. 4	350 m
No. 3	250 m
No. 2	400 m
No. 1	500 m
Beach Sand Nourishment	783,000 m²
No. 5 L = 600 m	149,000 m²
No. 4 L = 400 m	99,000 m²
No. 3 L = 300 m	74,000 m²
No. 2 L = 800 m	409,000 m²
No. 1 L = 750 m	52,000 m²
Demolish	70 m
Groin	70 m
3. Nusa Dua Beach	
Groin	100 m
No. 1	100 m
Offshore Breakwater	330 m
No. 1	330 m
Beach Sand Nourishmeut	229,000 m²
No. 1 L = 350 m	28,000 m²
No. 2 L = 800 m	56,000 m²
No. 3 L = 700 m	107,000 m²
No. 4 L = 250 m	38,000 m²
Demolition	
Offshore Groin 4 NOS	213 m

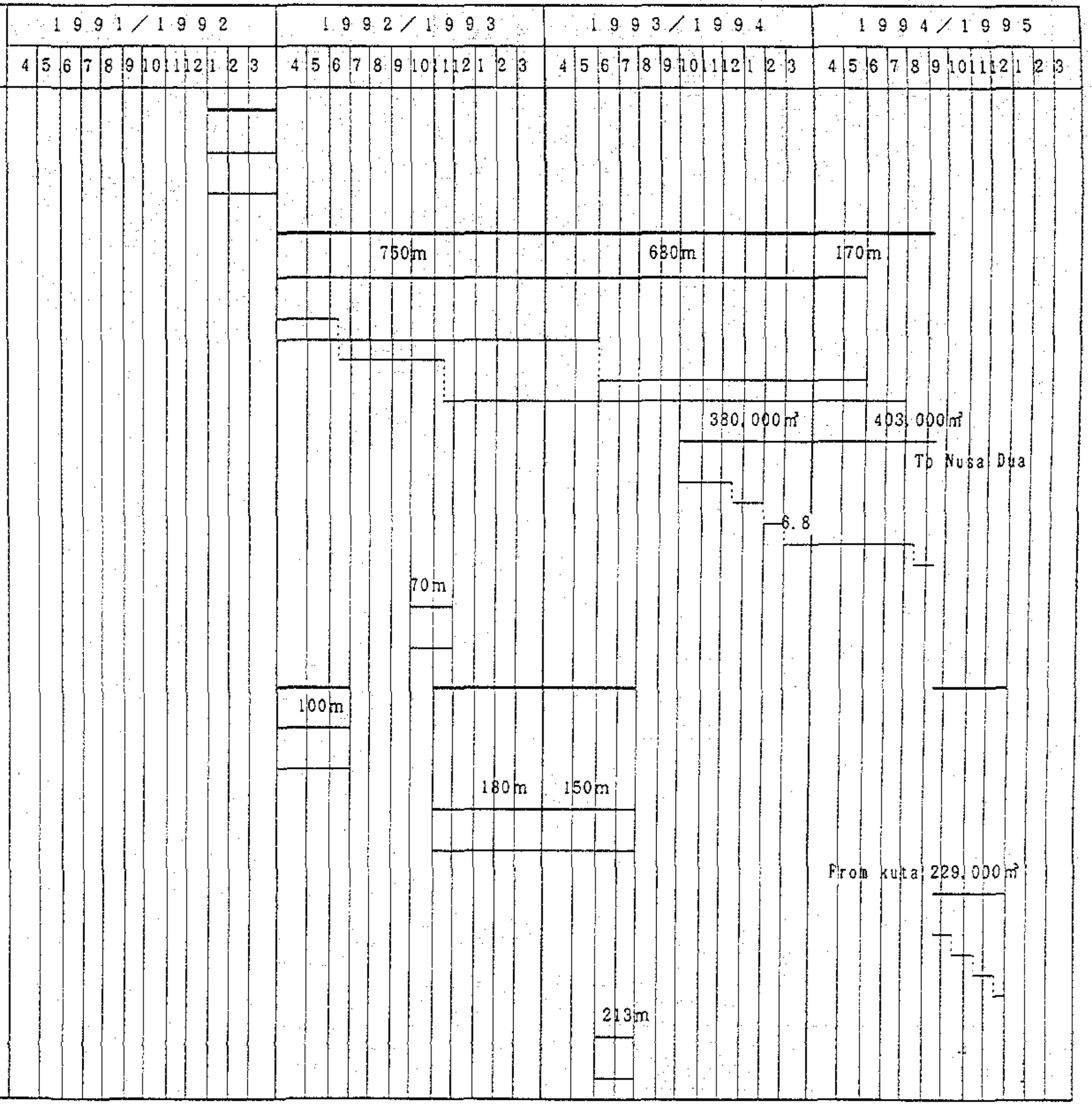


Fig. 7-2-5-1 Construction Schedule (One-Contract Method)

(2)

Name of Place and Description	Quantity
4. Sanur Beach	
Groin	1,240 m
No. 9	200 m
No. 8	200 m
No. 7	200 m
No. 6	100 m
No. 5	100 m
No. 4	100 m
No. 3	50 m
No. 2	190 m
No. 1	100 m
Submerged Offshore Breakwater	12,500 m³
No. 1	12,500 m³
Beach Sand Nourishmeut	448,000 m³
No. 10 L = 400 m	139,000 m³
No. 9 L = 350 m	122,000 m³
No. 8 L = 350 m	122,000 m³
No. 7 L = 300 m	104,000 m³
No. 6 L = 600 m	116,000 m³
No. 5 L = 550 m	106,000 m³
No. 4 L = 500 m	96,000 m³
No. 3 L = 250 m	48,000 m³
No. 2 L = 200 m	39,000 m³
No. 1 L = 500 m	96,000 m³
Demolition	80 m
No. 1	80 m

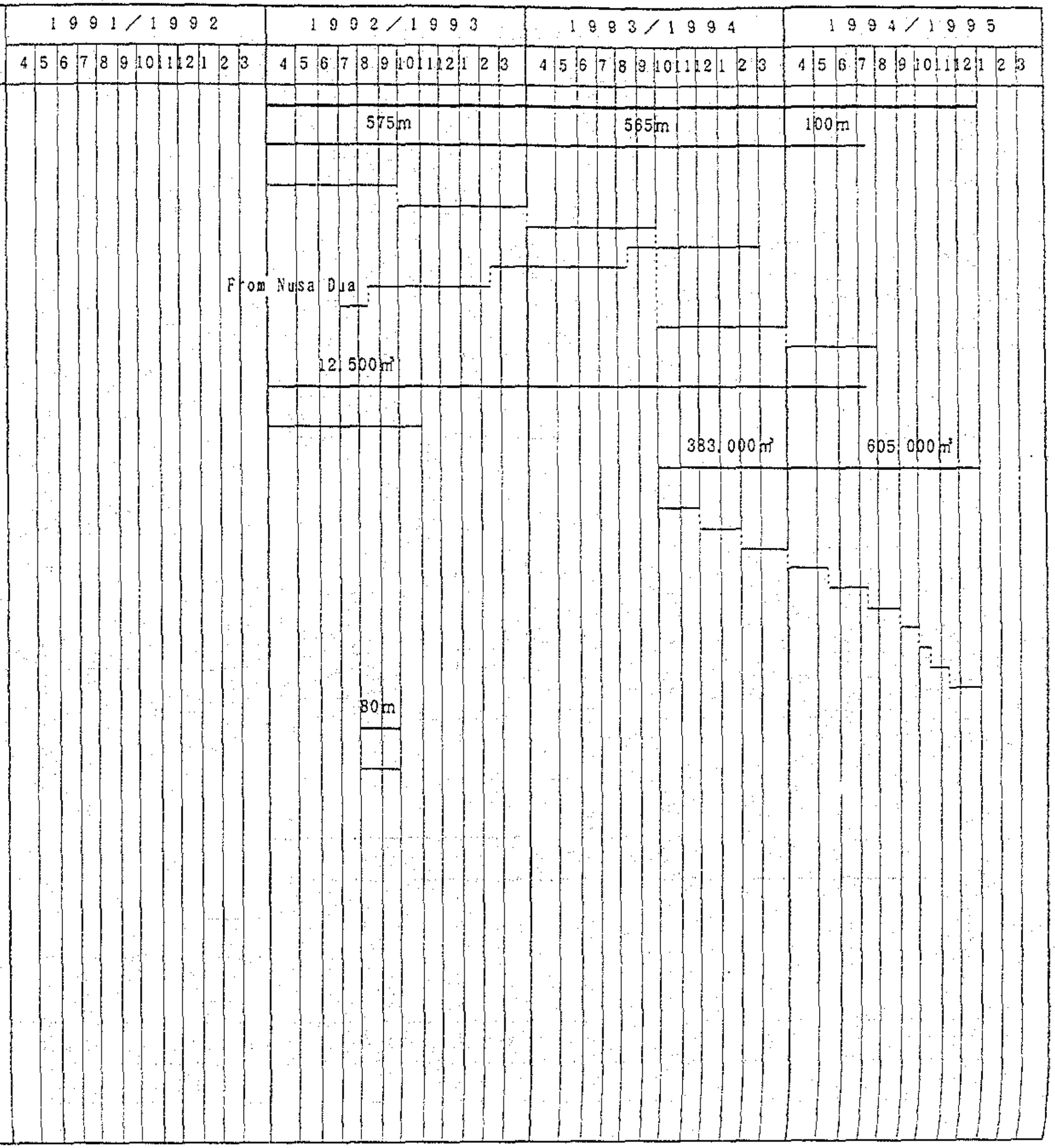


Fig. 7-2-5-1 Construction Schedule (One-Contract Method)

7-2-6 Construction Materials

The main construction materials of this project are cement aggreate, sand and boulders. The sources of these materials are as follows:

(1) Cement

Cement is produced on Java and Timer Islands in Indonesia, and it is unloaded at Benoa port of Bali Island.

(2) Concrete materials

Gravel and sand for the concrete materials could be produced using machinery at East Quarry and West Quarry. The locations of the quarry are shown in Fig. 3-4-2-1.

(3) Boulder stone

Andesite boulder stones for the submerged offshore breakwater could be obtained at East Quarry and West Quarry using machinery.

(4) Limestone

The limestone for the groin and offshore breakwater works could be produced at Bukit Padung Quarry by using explosives with a crawler drill hammer and a hydraulic breaker. The location of the quarry is shown in Fig. 3-4-2-1.

(5) Sand

A total volume of 1,460,000 m^3 of sand is required at Kuta, Nusa Dua and Sanur beaches for the beach sand nourishment works, and the volume at each beach is 783,000 m^3, 229,000 m^3 and 448,000 m^3 respectively.

At present, the characteristics of the sand at each beach are as follows:

1) Kuta Beach

This beach is composed of fine sand with an average of 5-10% of over 0.42 mm in diameter, and the sand color is dark brown.

2) Nusa Dua Beach

This beach is composed of the coarsest sand of three beaches. The average remaining percentage of sand over 0.42 mm in diameter is 80 - 85%, and the sand color is white.

3) Sanur Beach

This beach is composed of fairly coarse sand. The average remaining percentage of sand over 0.42 mm in diameter is 50 - 60% and the sand color is white.

As mentioned above, the characteristics of these three beaches are different and it is necessary to carry out the beach sand nourishment works in consideration of the existing sand quality at each beach.

The proposed sand source areas for the beach sand nourishment works are shown in Table 7-2-6-1 and Fig. 7-2-6-1.

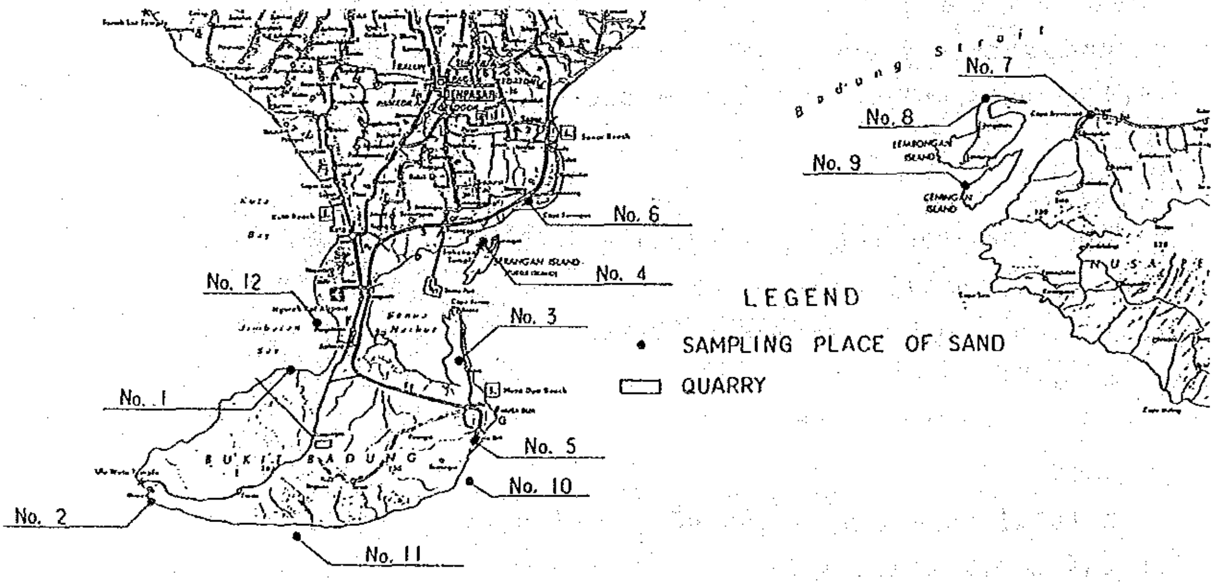


Fig. 7-2-6-1 Location Map of Proposed Sand Source Areas

Table 7-2-6-1 Proposed Sand Source Areas

Location	Grading of sand (%)	Color	Presumed Volume	Remarks
1 River mouth of Ayung River	20	Black	Approx 100,000 m³	Seashore
2 South area of Sanur Beach	14	White	Approx 90,000 m³	Seashore and Inland
3 In front of Serangan Island	8	Dark brown	Great volume	Offshore
4 Back of Serangan Island	8	Dark brown	Great volume	Offshore
5 South area of Nusa Dua	85	White	Over 700,000 m³	In land
6 South area of Tg. Lebang	Approx 85	White	Over 200,000 m³	Seashore
7 In front of Bukit Badung	40	White	Great volume	Offshore
8 River mouth of Jimbaran Bay	4	White	Not much	Seashore
9 Jimbaran Bay	5	Dark brown	Over 500,000 m³	Offshore
10 Kuta Bay	very fine	Gray	Over 500,000 m³	Offshore
11 In front of Nusa Penida	7	White	Fairly great volume	Seashore
12 In front of Lembongan Island	66	White	Fairly great volume	Seashore
13 In front of Ceningan Island	63	White	Fairly great volume	Seashore

Note : 1. The number in the grading of sand column Shows the remaining percentage of Sand over 0.42mm in diameter by the sieving test.

2. At Locations No.2 and No.5, it might be necessary to fill up dredged holes with some materials to make the ground level.

7-3 Cost Estimate

7-3-1 General

The cost of the project is comprised of the costs required for construction, operation and maintenance.

The construction costs are comprised of land, civil works, engineering and administration, contingency and VAT costs. The costs for civil works are comprised of the depreciation and operation costs of construction equipment, labour cost, materials cost, cost for technicians and other costs for contractors.

The cost for engineering and administration includes the cost for foreign consultants.

The construction costs are calculated on the following assumptions and are based on the 1988 prices.

(1) The execution of works is carried out based on the one-contract system.

(2) The construction schedule is presented in Fig. 7-2-5-1.

(3) The necessary construction equipment and spare parts are prepared by the contractors, and all the customs charges etc. at the port are borne by the contractors except for the payment of import tax.

The estimated costs are classified into local and foreign currency portions. The foreign currency costs are counted in Japanese Yen. The following conversion rates are applied.

US$1 = Rp 1600 = ¥130

The local currency portion is comprised of the costs for land compensation, domestic labour, materials, engineering and administration of the executing agency including the cost for foreign consultants such as per-diem and general expenses on the site, and other costs such as those for contractors, contingencies and VAT.

Construction materials except for the meteorological station elquipment and computer water recorder are to be procured on the local market.

The foreign currency portion is comprised of the cost for construction equipment on the basis of the depreciation estimated at CIF prices at Benoa Port and the life of the equipment, the cost for spare parts for the construction equipment, special materials such as observation equipment (rain gauge, anemometer and water-level gauge with computer), and the costs for technicians for executing works, foreign consultants including the cost of procuring equipment for survey and laboratory use and cars required on the occasion of the detailed design and during the supervision period and contingency. The cost for foreign consultants' services consists of remuneration and out-of pocket expenses for the leader of the consultants surveying engineers, civil engineers, geologists, design engineers, construction engineers, tender documents and specifications experts, staff for general affairs and other specialists.

(4) The construction materials will be obtained as follows:

1) Concrete materials are collected from the East Quarry and West Quarry which are located near Klungkung town 60 km east from Denpasar city and at Gadungan town 30 km west from Denpasar city.

2) Stone for groin works is collected from Bukit Padung Quarry which is located about 20 km south from Denpasar City.

3) Sand for sand beach nourishment works is collected from places which have no adverse influence on the beachline such as offshore Bukit Padung beach, offshore Serangan Island and offshore Kuta beach.

7-3-2 Construction Cost

The cost of land compensation for renting land for the construction of temporary roads and working yards is estimated based on the unit prices for similar works in this area.

The costs for civil works are estimated based on the quantity of works and unit costs, which are estimated on the basis of costs rerquired for labour materials, equipment, spare parts, technicians for execution, operation of equipment and contractor's cost. The cost for operation of equipment includes operators, fuel and consumables.

The adopted unit prices of labour and materials are shown in Tables 7-3-2-1 and 7-3-2-2. The major construction equipment and plans to be used for the Project are listed in Table 7-3-2-3, together with those showing the hourly depreciation cost in Table 7-3-2-4. The unit operation costs used in this estimation are shown in Table 7-3-2-5 classifying them into local and foreign currency portions.

The preparatory works are comprised of such works as transportation roads, access roads, offices and quarters, and the detailed costs of the preparatory works are shown below.

1988 prices

Description	Estimated cost		
	L.C. (1,000Rp)	F.C. (1,000Yen)	Total (1,000Rp)
1. Access roads	381,300	22,600	659,280
2. Offices and quarters	65,000		65,000
3. Total	446,300	22,600	724,280

The miscellaneous work in the civil works includes the costs required for construction of the meteorological station and the water-level-gauge station.

The government administration cost was assumed at about 2% of the sum of the costs for land compensation and civil works.

The engineering services fee includes the cost for detailed design and supervision services.

The contingency was assumed as 15% of the sum of the costs for land compensation, civil works, government administration and engineering services.

The Value Added Tax (VAT) was assumed as 10% of the sum of the costs for land compensation and civil works.

The retribution tax is not included in this cost estimate.

Table 7-3-2-1 Unit Price of Labor (8 hour work day)

1988 prices

Description	Unit Price
1. Pekerja biasa	Rp. 1,500
2. Pekerja pembantu tukang	Rp. 2,500
3. Mandor	Rp. 4,000
4. Tukang batu-batu	Rp. 3,000
5. Tukang batu kepala	Rp. 3,500
6. Tukang besi	Rp. 3,000
7. Tukang besi kepala	Rp. 3,500
8. Tukang kayu	Rp. 3,500
9. Tukang kayu kepala	Rp. 4,000
10. Tukang listrik	Rp. 2,500
11. Tukang aspal	Rp. 3,000
12. Sopir sim A	Rp. 2,500
13. Sopir sim B1	Rp. 3,000
14. Sopir sim B2	Rp. 3,000
15. Mesines mesin gilas	Rp. 3,000
16. Montir	Rp. 3,500

Table 7-3-2-2 Unit Price of Materials

1988 prices

Description	Unit	Price
1. Cement	ton	Rp. 90,000
2. Steel bar	ton	Rp. 651,000
3. Steel form	ton	Rp. 2,500,000
4. H-steel H=300x300 ℓ=6～9m	ton	¥ 60,000
5. Wood	m^3	Rp. 424,000
6. Diesel oil	ℓ	Rp. 220
7. Gasoline	ℓ	Rp. 400
8. Asphalt concrete	kg	Rp. 400

Table 7-3-2-3 Major Equipment and Plants

Equipment	Description	Number
Grab dredger	Bucket Capacity 8 m³, 1,000 ps	3
Anchor boat	with 10 t crane, 180 ps	5
Carrier boat	700 m³	8
Tugboat	1,200 ps	6
- do -	300 ps	1
Traffic boat	40 ps	6
Flat barge	500 WT	1
Pump dredger	1,000 ps 250 m³/h	2
Bulldozer	D-7 LGP	7
Backhoe	1.2 m³	1
- do -	0.7 m³	2
Dump truck	15 t	3
- do -	10 t	25
Ordinary truck	10 t	2
Wheel loader	CAT, 1.0 m³	2
- do -	CAT, 1.5 m³	4
- do -	CAT, 3.1 m³	2
Crushing plant	40 ton/hour	1
Crawler crane	40 t	1
- do -	16 t ～ 20 t	6
Amphibious soft-terrain excavator	2.8 t	9
Concrete plant	0.5 m³, 18 m³/h	2
Vibrator	8,000 - 10,000 vpm	17
Tractor shovel	1.7 m³	2
Concrete mixer	0.3 m³	4
Wheel carrier	3 t	12
Crawler drill	CM 351	2
Compressor	17 m³/min	2
Hydraulic breaker	UB-11, 980 kg	2

Table 7-3-2-4 Depreciation Cost of Major Equipment and Plants

Equipment	Description	Unit	Depreciation Cost (Yen)
Grab dredger	Bucket Capacity 8 m³, 1,000 ps	Hourly	58,550
Anchor boat	with 10t crane, 180 ps	〃	10,000
Carrier boat	700 m³	〃	15,260
Tugboat	1,200 ps	〃	16,900
- do -	300 ps	〃	6,000
Traffic boat	40 ps	〃	720
Flat barge	500 WT	Daily	34,500
Pump dredger	1,000 ps	Hourly	58,000
Bulldozer	D-7 LGP	〃	5,640
Backhoe	1.2 m³	〃	8,370
- do -	0.7 m³	〃	4,660
Dump truck	15 t	〃	4,100
- do -	10 t	〃	2,300
Ordinary truck	10 t	〃	2,300
Wheel loader	CAT, 1.0m³	〃	2,290
- do -	CAT, 1.5m³	〃	5,350
- do -	CAT, 3.1m³	〃	6,800
Crushing plant	40 ton/hour	〃	50,500
Crawler crane	40 t	〃	12,900
- do -	16 t～ 20 t	〃	6,480
Amphibious soft-terrain excavator	2.8 t	〃	10,600
Concrete plant	0.5 m³, 18m³/h	Daily	33,480
Vibrator	8,000 - 10,000 vpm	Hourly	370
Tractor shovel	1.7 m³	〃	4,570
Concrete mixer	0.3 m³	〃	5,800
Wheel carrier	3 t	〃	1,740
Crawler drill	CM 351	〃	3,850
Compressor	17m³/min	Daily	14,300
Hydraulic breaker	UB-11, 980 kg	〃	14,200

Table 7-3-2-5 Unit Operation Cost

1988 prices

Items	Unit	Unit Cost	
		L.C (Rp)	F.C (Yen)
Groin Works			
Excavation	m³	2,738	631
Concrete tube d = 1 m, H = 0.5m	NO	18,930	834
Concrete (C = 300 kg)	m³	38,115	1,517
Aggregate	m³	3,212	689
Batu Karan	m³	2,704	1,131
Breach Sand Nourishment Works			
Excavation	m³	404	444
Transportation	m³	687	292
Dumping	m³	613	509
Spreading	m³	185	78
Submerged Offshore Breakwater Works			
Andesite stone 500kg	m³	1,913	389
Concrete block 0.6m cube	NO	9,936	412
Loading charge (Andesite stone)	m³	1,793	308
Loading charge (Concrete block)	NO	327	147
Offshore transportation & pitching	m³	6,025	3,454

7-3-3 Summary of the Cost Estimate

In conclusion, the project cost is estimated at Rp. 71,445,456,000 except for price escalation, consisting of Rp. 16,937,809,000 of local currency portion and Yen 4,431,516,000 of foreign currency portion at 1988 prices. A summary of the project cost is shown in Table 7-3-3-1.

The annual project cost is estimatetd at 1988 prices based on the construction schedule mentioned in paragraphs 7-2-5, Fig. 7-2-5-1 and the annual project cost is shown in Table 7-3-3-2. The costs includes no price escalation during the construction period.

The project costs at three sites at Kuta, Nuse Dua and Sanur are estimated at 1988 prices based on the execution plan mentioned in paragraph 7-2-4, and are presented in Table 7-3-3-3. The costs includes no price escalation during the construction period.

Table 7-3-3-1 Project Cost (One-Contract Method)

1988 - Price

Description	Cost			Remarks
	L.C (10^3Rp)	F.C (10^3¥)	Total (10^3Rp)	
1. Land Compensation	600,000	———	600,000	
2. Civil works	11,814,765	3,379,185	53,378,741	
a Preparatory works	446,300	22,600	724,280	
b Groin	7,529,798	876,515	18,310,933	
c Submerged offshore breakwater	516,700	126,350	2,070,805	
d Beach sand nourishment	3,030,960	2,299,500	31,314,810	
e Demolition	11,945	6,167	87,799	
f Miscellaneous	6,000	3,800	52,740	
g Offshore breakwater	273,062	44,253	817,374	
3. Government administration	248,295	67,584	1,079,578	
4. Engineering services	900,348	406,723	5,903,041	
Subtotal	13,563,408	3,853,492	60,961,360	
5. Physical contingency	1,944,511	578,024	9,054,206	
Subtotal	15,507,919	4,431,516	70,015,566	
6. VAT	1,429,890	———	1,429,890	
GRAND TOTAL	16,937,809	4,431,516	71,445,456	

Table 7-3-3-2 Project Cost by Year (One-Contract Method)

Unit L.C. = Rp 10^3
F.C. = ¥ 10^3

1988 prices

Description	Summary		1st year		2nd year		3rd year		4th year		5th year		6th year	
	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)
1. Land Compensation	600.000	—	—	—	—	—	600.000	—	—	—	—	—	—	—
2. Civil works	11.814.765	3.379.185	—	—	—	—	452.300	26.400	3.866.147	465.090	5.241.062	1.597.163	2.555.256	1.290.532
a Preparatory works	446.300	22.600	—	—	—	—	446.300	22.600	—	—	—	—	—	—
b Groins	7.529.798	876.515	—	—	—	—	—	—	3.586.635	417.507	3.288.503	382.801	654.660	76.207
c Submerged offshore breakwater	516.700	126.350	—	—	—	—	—	—	—	—	516.700	126.350	—	—
d Beach sand nourishment	3.030.960	2.299.500	—	—	—	—	—	—	—	—	1.430.364	1.085.175	1.600.596	1.214.325
e Demolition	11.945	6.167	—	—	—	—	—	—	6.450	3.330	5.495	2.837	—	—
f Miscellaneous	6.000	3.800	—	—	—	—	6.000	3.800	—	—	—	—	—	—
g Offshore breakwater	273.062	44.253	—	—	—	—	—	—	273.062	44.253	—	—	—	—
3. Government administration	248.295	67.584	—	—	—	—	21.046	528	77.323	9.302	104.821	31.943	45.105	25.811
4. Engineering services	900.348	406.723	223.822	48.413	178.713	75.416	60.110	55.339	153.265	85.890	153.071	72.017	131.367	69.648
Subtotal (1.～4.)	13.563.408	3.853.492	223.822	48.413	178.713	75.416	1.133.456	82.267	4.096.735	560.282	5.498.954	1.701.123	2.431.728	1.385.991
5. Physical contingency	1.944.511	578.024	33.573	7.262	26.807	11.312	80.019	12.340	614.510	84.042	824.843	255.169	364.759	207.899
Subtotal (1.～5.)	15.507.919	4.431.516	257.395	55.675	205.520	86.728	1.213.475	94.607	4.711.245	644.324	6.323.797	1.956.292	2.796.487	1.593.890
6. PPM (1+2+5) ×10%	1.429.890		—	—	—	—	113.232	—	448.066		606.591		262.001	
GRAND TOTAL	16.937.809	4.431.516	257.395	55.675	205.520	86.728	1.326.707	94.607	5.159.311	644.324	6.930.388	1.956.292	3.058.488	1.593.890

Table 7-3-3-3 Project Cost by Each Beach (One-Contract Method)

Unit ×10³Rp
×10³Yen

1988−prices

Description	Kuta			Nusa Dua			Sanur			Total		
	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)
1. Land Compensation	200,000	——	200,000	200,000	——	200,000	200,000	——	200,000	600,000	——	600,000
2. Civil works	5,830,200	1,715,129	26,926,287	1,116,263	441,189	6,542,888	4,868,302	1,222,867	19,909,566	11,814,765	3,379,185	53,378,741
a Preparatory works	148,767	7,534	241,435	148,766	7,533	241,422	148,767	7,533	241,423	446,300	22,600	724,280
b Groin	4,050,915	471,550	9,850,980	211,536	24,624	514,411	3,267,347	380,341	7,945,542	7,529,798	876,515	18,310,933
c Submerged offshore breakwater	——	——	——	——	——	——	516,700	126,350	2,070,805	516,700	126,350	2,070,805
d Beach sand nourishment	1,625,508	1,233,225	16,794,176	475,404	360,675	4,911,706	930,048	705,600	9,608,928	3,030,960	2,299,500	31,314,810
e Demolition	3,010	1,554	22,124	5,495	2,837	40,390	3,440	1,776	25,285	11,945	6,167	87,799
f Miscellaneous	2,000	1,266	17,572	2,000	1,267	17,584	2,000	1,267	17,584	6,000	3,800	52,740
g Offshore breakwater	——	——	——	273,062	44,253	817,374	——	——	——	273,062	44,253	817,374
3. Government administration	120,604	34,303	542,531	26,324	8,824	134,859	101,367	24,457	402,188	248,295	67,584	1,079,578
4. Engineering services	375,373	168,597	2,449,116	198,529	87,207	1,271,175	326,446	150,919	2,182,750	900,348	406,723	5,903,041
Subtotal	6,526,177	1,918,029	30,117,934	1,541,117	537,220	8,148,923	5,496,114	1,398,243	22,694,503	13,563,408	3,853,492	60,961,360
5. Physical contingency	948,927	287,706	4,487,711	201,167	80,581	1,192,313	794,417	209,737	3,374,182	1,944,511	578,024	9,054,206
Subtotal	7,475,104	2,205,735	34,605,645	1,742,284	617,801	9,341,236	6,290,531	1,607,980	26,068,685	15,507,919	4,431,516	70,015,566
6. PPN	695,900		695,900	149,731		149,731	584,259		584,259	1,429,890		1,429,890
GRAND TOTAL	8,171,004	2,205,735	35,301,545	1,892,015	617,801	9,490,966	6,874,790	1,607,980	26,652,945	16,937,809	4,431,516	71,445,456

7-3-4 Maintenance Cost

The maintenance cost for the Urgent Bali Beach Conservation Project is estimated as Rp.700,000,000 per year after completion.

The maintenance cost includes the followings:

1) Salary, allowances, transportation fees, etc. for the maintenance works for the coastal facilities.
2) The cost of topography surveys and sounding surveys for studyingthe change of the seashore.
3) The cost of supplementary sand for maintaining the seashore lineproperly.
4) The cost of taking aerial photographs.

7-4 Three-Contract Method

7-4-1 General

The three-contract method is an alternative plan which has been devised considering that this Project consists of three beaches, particularly assuming that the works at each beach are carried out separately and independently.

The major premises for analysing the proposed three-contract method are as follows.

1) The contract of each package is independent.
2) The date of the commencement of the construction works for each of the three contracts is the same, including a three-months period of preparatory works.
3) The capacity of the construction equipment and plants for the three-contract method is the same as the capacity for the one-contract method.
4) Each construction period of each work item is the same under both the one-contract and the three-contract method.

In accordance with the assumptions mentioned above, the construction schedules of each contract are shown in Fig. 7-4-1-1.

Name of Place and Description	Quantity
1. Preparatory Works	
Temporary Access Road	L.S
Temporary Facilities & Buildings	L.S
2. Kuta Beach	
Groin	1,600 m
No. 5	100 m
No. 4	350 m
No. 3	250 m
No. 2	400 m
No. 1	500 m
Beach Sand Nourishment	783,000 m³
No. 5 L = 600 m	149,000 m³
No. 4 L = 400 m	99,000 m³
No. 3 L = 300 m	74,000 m³
No. 2 L = 800 m	409,000 m³
No. 1 L = 750 m	52,000 m³
Demolition	70 m
Groin	70 m
3. Nusa Dua Beach	
Groin	100 m
No. 1	100 m
Offshore Breakwaters	330 m
No. 1	180 m
No. 2	150 m
Beach Sand Nourishment	229,000 m³
No. 1 L = 350 m	28,000 m³
No. 2 L = 800 m	56,000 m³
No. 3 L = 700 m	107,000 m³
No. 4 L = 250 m	38,000 m³
Demolition	
Offshore Groin 4 NOS	213 m

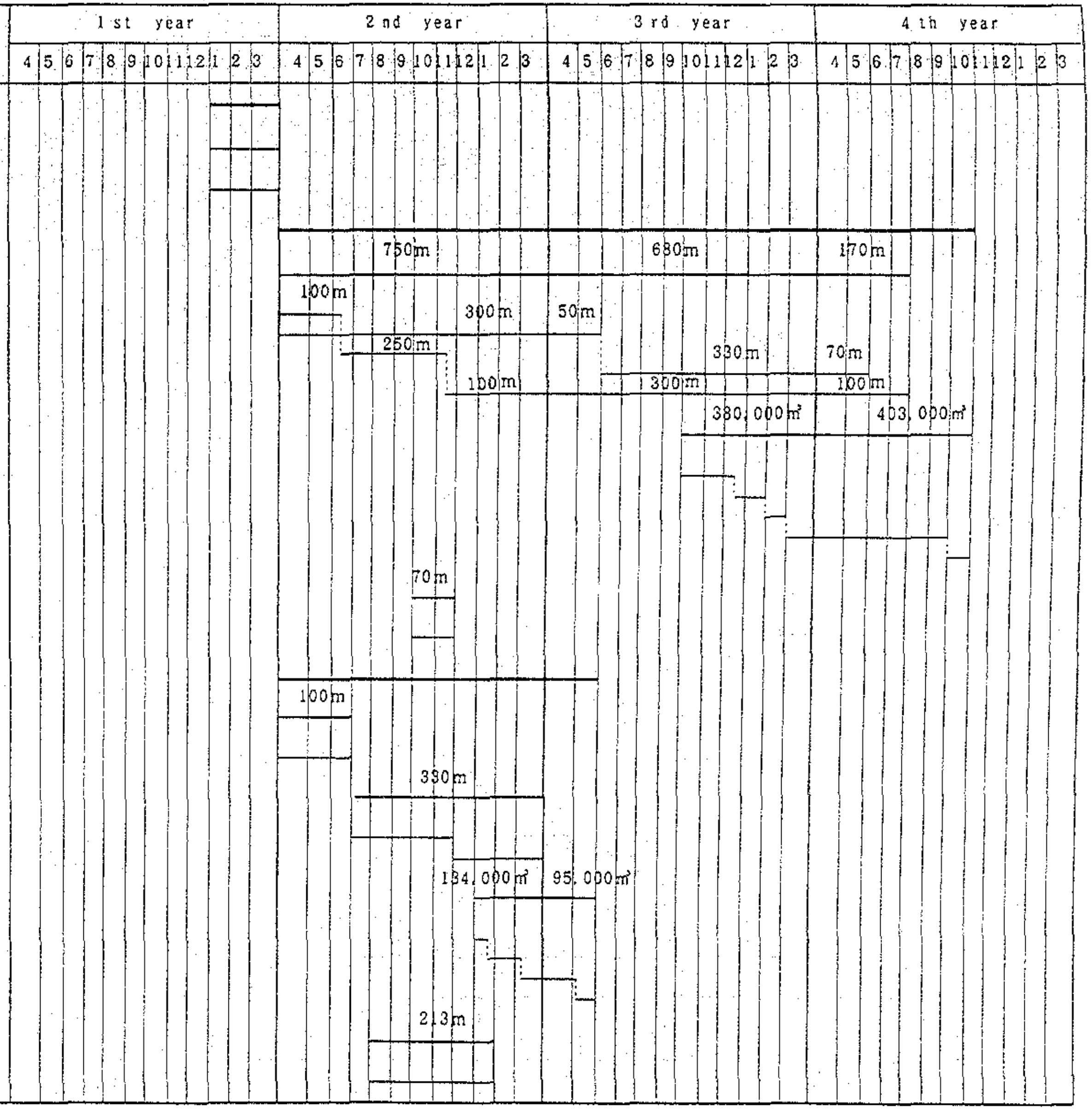


Fig. 7-4-1-1 Construction Schedule (Three-Contract Method)

(2)

Name of Place and Description	Quantity
4. Sanur Beach	
Groins	1,240 m
No. 9	200 m
No. 8	200 m
No. 7	200 m
No. 6	100 m
No. 5	100 m
No. 4	100 m
No. 3	50 m
No. 2	190 m
No. 1	100 m
Submerged Offshore Breakwater	12,500 m²
No. 1	12,500 m²
Beach Sand Nourishment	448,000 m²
No. 10 L = 400 m	55,000 m²
No. 9 L = 350 m	48,000 m²
No. 8 L = 350 m	48,000 m²
No. 7 L = 300 m	41,000 m²
No. 6 L = 600 m	46,000 m²
No. 5 L = 550 m	42,000 m²
No. 4 L = 500 m	38,000 m²
No. 3 L = 250 m	19,000 m²
No. 2 L = 200 m	15,000 m²
No. 1 L = 500 m	96,000 m²
Demolition	80 m
No. 1	80 m

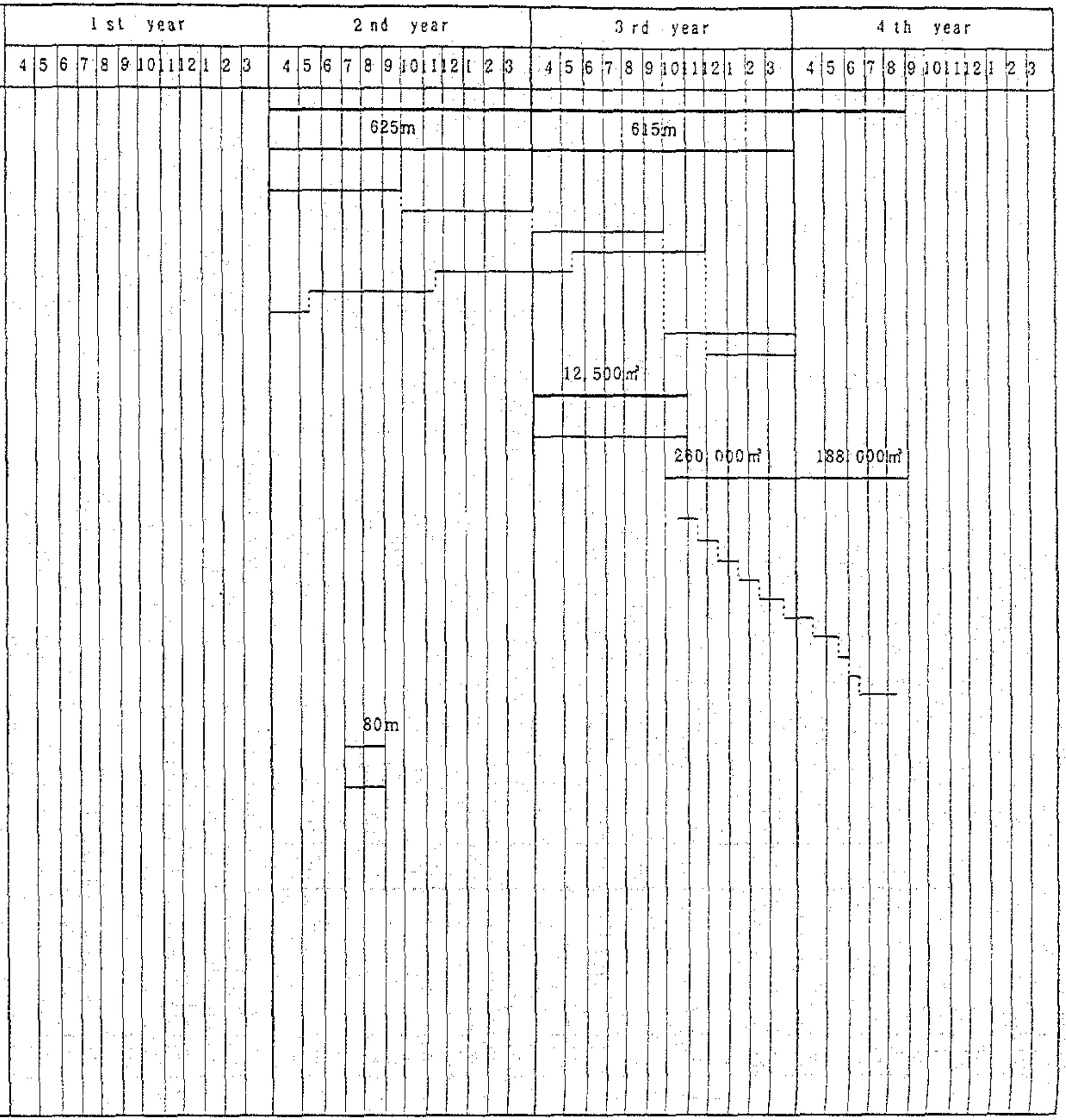


Fig. 7-4-1-1 Construction Schedule (Three-Contract Method)

7-4-2 Kuta Beach

(1) Execution Plan

The main erosion prevention works at Kuta beach are given below.

Groin	:	1,600 meters
Beach Sand Nourishment	:	783,000 cubic meters
Demolition	:	70 meters

The proposed construction period at Kuta Beach is a total of 34 months after the works commence, and the groin works shall be completed within 31 months. The beach sand nourishment works shall begin within 21 months.

The groin works shall utilize the materials hauled from the nearby temporary stock yeard, transported from the concrete batching plant and the quarry site. Groins shall be formed using crawler cranes, an amphibious excavator, concrete mixers, wheel carriers and manual labor.

Beach sand nourishment works will be executed by using a grab dredger and a pump dredger. Sand will be collected using a grab dredger at an offshore place which has no adverse influence on the beachline, and hence the sand will be carried by means of seaborne traffic. The sand will be transported from outside the coral reefs to the beach using a pump dredger and spread over the beach using a bulldozer.

Demolition of the existing groin will be executed by using a crawler crane from the land side. The broken materials will be removed by wheel carrier and manpower and these materials will be used for building new groins.

(2) Construction schedule

The construction time schedule is given in Fig. 7-4-1-1.

(3) Cost Estimate

1) Construction cost

The construction cost was estimated Rp. 34,870,178,000 except for price escalation, consisting of Rp. 8,187,863,000 of local currency and Yen 2,169,294,000 of foreign currency at 1988 prices. The summary of the construction cost is shown in Table 7-4-2-1.

2) Annual Construction Cost

The annual construction cost was estimated at 1988 prices based on the construction schedule presented in Paragraph 7-4-1 and Fig. 7-4-1-1. The annual construction costs are preserved in Table 7-4-2-2. The costs include no price escalation during the construction period.

3) Major Equipment and Plants

The major construction equipment and plants to be used for the project are listed in Table 7-4-2-3.

Table 7-4-2-1 Construction Cost (Three-Contract Method, Kuta)

1988 Prices

Description	Cost			Remarks
	L.C. (10^3 Rp.)	F.C. (10^3 ¥)	Total (10^3 Rp.)	
1. Land Compensation	210,000	———	210,000	
2. Civil Works	6,147,036	1,849,356	28,894,114	
a) Preparatory Works	195,000	7,684	289,513	
b) Groins	4,097,492	350,041	8,402,996	1,600 m
c) Offshore Breakwater	———	———	———	-
d) Submerged Offshore Breakwater	———	———	———	-
e) Beach Sand Nourishment	1,851,795	1,490,308	20,182,583	783,000 m³
f) Demolition	2,749	1,323	19,022	70 m
Subtotal	6,357,036	1,849,356	29,104,114	
3. Government Administration	127,141	36,987	582,081	
Subtotal	6,484,177	1,886,343	29,686,195	
4. Physical Contingency	972,627	282,951	4,452,924	
Subtotal	7,456,804	2,169,294	34,139,119	
5. VAT	731,059	———	731,059	
Grand Total	8,187,863	2,169,294	34,870,178	

Table 7-4-2-2　Construction Cost by Year (Three-Contract Method, Kuta)

Unit ×10³ Rp
×10³ Yen 1988 prices

Description	Summary		1st year		2nd year		3rd year		4th year	
	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)
1. Land compensation	210,000	—	210,000	—	—	—	—	—	—	—
2. Civil works	6,147,036	1,849,356	195,000	7,684	1,916,363	164,799	2,635,251	871,617	1,400,422	805,256
a. Preparatory works	195,000	7,684	195,000	7,684	—	—	—	—	—	—
b. Groins	4,097,492	350,041	—	—	1,913,614	163,476	1,736,551	148,351	447,327	38,214
c. Offshore breakwater	—	—	—	—	—	—	—	—	—	—
d. Submerged offshore breakwater	—	—	—	—	—	—	—	—	—	—
e. Beach sand nourishment	1,851,795	1,490,308	—	—	—	—	898,700	723,266	953,095	767,042
f. Demolition	2,749	1,323	—	—	2,749	1,323	—	—	—	—
Subtotal (1 + 2)	6,357,036	1,849,356	405,000	7,684	1,916,363	164,799	2,635,251	871,617	1,400,422	805,256
3. Government administration	127,141	36,987	8,100	154	38,327	3,296	52,705	17,432	28,009	16,105
Subtotal	6,484,177	1,886,343	413,100	7,838	1,954,690	168,095	2,687,956	889,049	1,428,431	821,361
4. Physical contingency	972,627	282,951	61,965	1,176	293,204	25,214	403,193	133,357	214,265	123,204
Subtotal	7,456,804	2,169,294	475,065	9,014	2,247,894	193,309	3,091,149	1,022,406	1,642,696	944,565
5. VAT	731,059	—	46,575	—	220,382	—	303,054	—	161,048	—
GRAND TOTAL	8,187,863	2,169,294	521,640	9,014	2,468,276	193,309	3,394,203	1,022,406	1,803,744	944,565

Table 7-4-2-3 Major Equipment and Plants (Kuta)

Equipment	Description	Number
Grab dredger	Bucket Capacity 8 m^3, 1,000 ps	2
Anchor boat	with 10 t crane, 180 ps	3
Carrier boat	700 m^3	4
Tugboat	1,200 pcs	4
- do -	300 ps	1
Traffic boat	40 ps	2
Flat barge	500 WT	1
Pump dredger	1,000 ps 250 m^3/h	1
Bulldozer	D-7 LGP	4
Backhoe	1.2 m^3	1
- do -	0.7 m^3	1
Dump truck	15 t	1
- do -	10 t	12
Ordinary truck	10 t	1
Wheel loader	CAT, 1.0 m^3	3
Crushing plant	20 ton/hour	1
Crawler crane	40 t	3
Amphibious soft-terrain excavator	SH-30	4
Concrete plant	0.5 m^3, 18 m^3/h	1
Vibrator	8,000 - 10,000 vpm D = 46 mm	7
Tractor shovel	1.7 m^3	3
Concrete mixer	0.3 m^3	2
Wheel carrier	3 t HD-30	5
Crawler drill	CD-6	1
Compressor	17 m^3/min	1
Hydraulic breaker	UB-11, 980 kg	1

7-4-3 Nusa Dua Beach

(1) Execution Plan

The main erosion prevention works at Nusa Dua beach are as follows:

Groin	:	100 meters
Offshore Breakwater	:	330 meters
Beach Sand Nourishment	:	229,000 cubic meters
Demolition	:	213 meters

The proposed construction period at Nusa Dua beach is a total of 17 months after the commencement of works. The groin and the offshore breakwater works shall be completed within 15 months. The beach sand nourishment works shall start within 12 months.

Groin works will be executed using the same method as at the other beaches.

Offshore Breakwater Works will be use the same method as the groin works. However, there are some differences. The construction materials of the offshore breakwater can be transported by barge. So, a jetty shall be prepared as part of the preparatory works. Also, the forming works shall be executed using a crawler crane which is set on a barge.

Beach sand nourishment works will be executed using the same system as at the other beaches.

Demolition of the existing offshore breakwater will be executed using a crawler crane set on a barge, and the broken materials will be transported by seaborne traffic. These materials will be used for building the submerged offshore breakwater.

(2) Construction Schedule

The construction schedule is given in Fig. 7-4-1-1.

(3) Cost Estimate

1) Construction Cost

The construction cost is estimated at Rp. 12,217,931,000, except for price escalation, consisting of Rp. 3,485,603,000 of local currency and Yen 709,945,000 of foreign currency at 1988 prices. A summary of the construction cost is shown in Table 7-4-3-1.

2) Annual Construction Cost

The annual construction cost is estimated at 1988 prices based on the construction schedule presented in Paragraph 7-4-1 and Fig. 7-4-1-1. The annual construction cost is presented in Table 7-4-3-2. The costs include no price escalation during the construction period.

3) Major Equipment & Plants

The major construction equipment and plants to be used for the project are listed in Table 7-4-3-3.

Table 7-4-3-1 Construction Cost (Three-Contract Method, Nusa Dua)

1988 Prices

Description	Cost			Remarks
	L.C. (10^3 Rp.)	F.C. (10^3 Y)	Total (10^3 Rp.)	
1. Land Compensation	65,000	———	65,000	
2. Civil Works	2,641,213	605,239	10,085,653	
a) Preparatory Works	79,000	2,260	106,798	
b) Groins	524,215	9,959	646,711	100 m
c) Offshore Breakwater	1,126,364	32,865	1,530,604	330 m
d) Submerged Offshore Breakwater	———	———	———	- m³
e) Beach Sand Nourishment	896,764	557,404	7,752,833	229,000 m³
f) Demolition	14,870	2,751	48,707	213 m
Subtotal	2,706,213	605,239	10,150,653	
3. Government Administration	54,124	12,105	203,013	
Subtotal	2,760,337	617,344	10,353,666	
4. Physical Contingency	414,051	92,601	1,553,050	
Subtotal	3,174,388	709,945	11,906,716	
5. VAT	311,215	———	311,215	
Grand Total	3,485,603	709,945	12,217,931	

Table 7-4-3-2 Construction Cost by Year (Three-Contract Method, Nusa Dua)

Unit $\times 10^3$ Rp
$\times 10^3$ Yen 1988 prices

Description	Summary		1st year		2nd year		3rd year	
	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)
1. Land compensation	65,000	—	65,000	—	—	—	—	—
2. Civil works	2,641,213	605,239	79,000	2,260	2,190,193	371,742	372,020	231,237
a. Preparatory works	79,000	2,260	79,000	2,260	—	—	—	—
b. Groins	524,215	9,959	—	—	524,215	9,959	—	—
c. Offshore breakwater	1,126,364	32,865	—	—	1,126,364	32,865	—	—
d. Submerged offshore breakwater	—	—	—	—	—	—	—	—
e. Beach sand nourishment	896,764	557,404	—	—	524,744	326,167	372,020	231,237
f. Demolition	14,870	2,751	—	—	14,870	2,751	—	—
Subtotal	2,706,213	605,239	144,000	2,260	2,190,193	371,742	372,020	231,237
3. Government administration	54,124	12,105	2,880	45	43,804	7,435	7,440	4,625
Subtotal	2,760,337	617,344	146,880	2,305	2,233,997	379,177	379,460	235,862
4. Physical contingency	414,051	92,601	22,032	346	335,100	56,876	56,919	35,379
Subtotal	3,174,388	709,945	168,912	2,651	2,569,097	436,053	436,379	271,241
5. VAT	311,215	—	16,560	—	251,872	—	42,783	—
GRAND TOTAL	3,485,603	709,945	185,472	2,651	2,820,969	436,053	479,162	271,241

Table 7-4-3-3 Major Equipment and Plants (Nusa Dua)

Equipment	Description	Number
Grab dredger	Bucket Capacity 8 m^3, 1,000 ps	2
Anchor boat	with 10 t crane, 180 ps	3
Carrier boat	700 m^3	3
Tugboat	1,200 ps	2
- do -	300 ps	1
Traffic boat	40 ps	2
Flat barge	500 WT	1
Pump dredger	1,000 ps 250 m^3/h	1
Bulldozer	D-7 LGP	4
Backhoe	1.2 m^3	1
- do -	0.7 m^3	1
Dump truck	15 t	1
- do -	10 t	7
Ordinary truck	10 t	1
Wheel loader	CAT, 1.0 m^3	3
Crushing plant	20 ton/hour	1
Crawler crane	40 t	3
Amphibious soft-terrain excavator	SH-30	2
Concrete plant	0.5 m^3, 18 m^3/h	1
Vibrator	8,000 - 10,000 vpm D = 46 mm	7
Tractor shovel	1.7 m^3	1
Concrete mixer	0.3 m^3	2
Wheel carrier	3 t HD-30	2
Crawler drill	CD-6	1
Compressor	17 m^3/min	1
Hydraulic breaker	UB-11, 980 kg	1

7-4-4 Sanur Beach

(1) Execution Plan

The main erosion prevention works at Sanur Beach are as follows:

Groins	:	1,200 meters
Submerged Offshore Breakwater	:	12,500 cubic meters
Beach Sand Nourishment	:	448,000 cubic meters
Demolition	:	80 meters

The proposed construction period at Sanur beach is a total of 32 months after commencement of the works, and the groin work shall be completed within 27 months. The submerged offshore breakwater work should be completed within 22 months after the commencement. The beach sannourishment works shall begin within 21 months.

Groin works shall be executed using the same method as at the other beaches.

Submerged offshore breakwater works shall utilize materials hauled by barges from the nearby temporary stock yard through the jetty, transported from the batching plant yard and the riverside. The offshore breakwater will be formed using a crawler crane and an amphibious soft-terrain excavator.

Beach sand nourishment works will be executed using the same method as at the other beaches.

Demolition of the existing groins will also use the same method as at the other beaches.

(2) Construction Schedule

The construction lschedule is given in Fig. 7-4-1-2.

(3) Cost Estimage

1) The construction cost is estimated at Rp. 29,367,681,000 except for price escalation, consisting of Rp. 7,921,315,000 of local currency and Yen 1,743,607,000 of foreign currency at 1988 prices. A summary of the construction cost is presented in Table 7-4-4-1.

2) Annual Consturction Cost

The annual construction cost is estimated at 1988 prices based on the construction schedule presented in Paragraph 7-4-1 and Fig. 7-4-1-1. The annual construction cost is presented in Table 7-4-4-2. The costs include no price escalation during the construction period.

3) Major Equipment & Plants

The major construction equipment and plants to be used for the project are listed in Table 7-4-4-3.

Table 7-4-4-1 Construction Cost (Three-Contract Method,Sanur)

1988 Prices

Description	Cost			Remarks
	L.C. (10^3 Rp.)	F.C. (10^3 ¥)	Total (10^3 Rp.)	
1. Land Compensation	325,000	———	325,000	
2. Civil Works	5,825,089	1,486,451	24,108,436	
a) Preparatory Works	279,000	12,656	434,669	
b) Groins	3,667,605	342,987	7,886,345	1,240 m
c) Offshore Breakwater	———	———	———	-
d) Submerged Offshore Breakwater	702,350	106,497	2,012,263	12,500 m³
e) Beach Sand Nourishment	1,172,864	1,022,707	13,752,160	448,000 m³
f) Demolition	3,270	1,604	22,999	80 m
Subtotal	6,150,089	1,486,451	24,433,436	
3. Government Administration	123,002	29,729	488,669	
Subtotal	6,273,091	1,516,180	24,922,105	
4. Physical Contingency	940,964	227,427	3,738,316	
Subtotal	7,214,055	1,743,607	28,660,421	
5. VAT	707,260	———	707,260	
Grand Total	7,921,315	1,743,607	29,367,681	

Table 7-4-4-2 Construction Cost by Year (Three-ContractMethod, Sanur)

Unit $\times 10^3$ Rp
$\times 10^3$ Yen 1988 prices

Description	Summary		1st year		2nd year		3rd year		4th year	
	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)
1. Land compensation	325,000	—	325,000	—	—	—	—	—	—	—
2. Civil works	5,825,089	1,486,451	279,000	12,656	1,913,502	180,245	3,140,403	864,378	492,184	429,172
a. Preparatory works	279,000	12,656	279,000	12,656	—	—	—	—	—	—
b. Groins	3,667,605	342,987	—	—	1,910,232	178,641	1,757,373	164,346	—	—
c. Offshore breakwater	—	—	—	—	—	—	—	—	—	—
d. Submerged offshore breakwater	702,350	106,497	—	—	—	—	702,350	106,497	—	—
e. Beach sand nourishment	1,172,864	1,022,707	—	—	—	—	680,680	593,535	492,184	429,172
f. Demolition	3,270	1,604	—	—	3,270	1,604	—	—	—	—
Subtotal	6,150,089	1,486,451	604,000	12,656	1,913,502	180,245	3,140,403	864,378	492,184	429,172
3. Government administration	123,002	29,729	12,080	253	38,270	3,605	62,808	17,288	9,844	8,583
Subtotal	6,273,019	1,516,180	616,080	12,909	1,951,772	183,850	3,203,211	881,666	502,028	437,755
4. Physical contingency	940,964	227,427	92,412	1,936	292,766	27,578	480,482	132,250	75,304	65,663
Subtotal	7,214,055	1,743,607	708,492	14,845	2,244,538	211,428	3,683,693	1,013,916	577,332	503,418
5. VAT	707,260	—	69,460	—	220,053	—	361,146	—	56,601	—
GRAND TOTAL	7,921,315	1,743,607	777,952	14,845	2,464,591	211,428	4,044,839	1,013,916	633,933	503,418

Table 7-4-4-3 Major Equipment and Plants (Sanur)

Equipment	Description	Number
Grab dredger	Bucket Capacity 8 m^3, 1,000 ps	1
Anchor boat	with 10 t crane, 180 ps	2
Carrier boat	700 m^3	3
Tugboat	1,200 ps	2
- do -	300 ps	1
Traffic boat	40 ps	2
Flat barge	500 WT	1
Pump dredger	1,000 ps 250 m^3/h	1
Bulldozer	D-7 LGP	3
Backhoe	1.2 m^3	1
- do -	0.7 m^3	1
Dump truck	15 t	1
- do -	10 t	16
Ordinary truck	10 t	1
Wheel loader	CAT, 1.0 m^3	3
- do -	CAT, 1.5 m^3	1
Crushing plant	20 ton/hour	1
Crawler crane	40 t	4
Amphibious soft-terrain excavator	SH-30	4
Concrete plant	0.5 m^3, 18 m^3/h	1
Vibrator	8,000 - 10,000 vpm D = 46 mm	12
Tractor shovel	1.7 m^3	1
Concrete mixer	0.3 m^3	2
Wheel carrier	3 t HD-30	4
Crawler drill	CD-6	1
Compressor	17 m^3/min	1
Hydraulic breaker	UB-11, 980 kg	1

7-4-5 Summary of the Cost Estimate

(1) Construction Cost

The total construction cost of the works at the three beaches to be executed separately and independently is estimated at Rp. 76,455,790,000, except for price escalation, consisting of Rp. 19,594,781,000 of local lcurrency and Yen 4,622,846,000 of foreign currency at 1988 prices.

A summary of the construction cost is presented in Table 7-4-5-1.

(2) Annual Construction Cost

The total annual construction cost of the works at the three beaches is estimated at 1988 prices based on the construction schedule presented in Fig. 7-4-1-1. The summary of the annual construction cost is presented in Table 7-4-5-2. The costs include no price escalation lduring the construction period.

(3) Project Cost

A summary of the total project cost under the three contracts is shown in Table 7-4-5-3.

(4) Annual Project Cost

The total annual project costs at the three beaches at 1988 prices based on the construction schedule in Fig. 7-4-1-1 and 7-4-1-2 are shown in Table 7-4-5-4. The costs include no price escalation lduring the construction period.

(5) Major Equipment and Plants

A summary of the number of major equipment and plants of the three contracts is presented in Table 7-4-5-5.

Table 7-4-5-1 Summary of Construction Cost (Three-Contract Method)

Unit×10³ Rp
×10³ Yen 1988 prices

Description	Summary			Kuta			Nusa Dua			Sanur		
	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)
1. Land compensation	600,000	—	600,000	210,000	—	210,000	65,000	—	65,000	325,000	—	325,000
2. Civil works	14,613,338	3,941,046	63,088,203	6,147,036	1,849,356	28,894,114	2,641,213	605,239	10,085,653	5,825,089	1,486,451	24,108,436
a. Preparatory works	553,000	22,600	830,980	195,000	7,684	289,513	79,000	2,260	106,798	279,000	12,656	434,669
b. Groins	8,289,312	702,987	16,936,052	4,097,492	350,041	8,402,996	524,215	9,959	646,711	3,667,605	342,987	7,886,345
c. Offshore breakwater	1,126,364	32,865	1,530,604	—	—	—	1,126,364	32,865	1,530,604	—	—	—
d. Submerged offshore breakwater	702,350	106,497	2,012,263	—	—	—	—	—	—	702,350	106,497	2,012,263
e. Beach sand nourishment	3,921,423	3,070,419	41,687,576	1,851,795	1,490,308	20,182,583	896,764	557,404	7,752,833	1,172,864	1,022,707	13,752,160
f. Demolition	20,889	5,678	90,728	2,749	1,323	19,022	14,870	2,751	48,707	3,270	1,604	22,999
Subtotal	15,213,338	3,941,046	63,688,203	6,357,036	1,849,356	29,104,114	2,706,213	605,239	10,150,653	6,150,089	1,486,451	24,433,436
3. Government administration	304,267	78,821	1,273,763	127,141	36,987	582,081	54,124	12,105	203,013	123,002	29,729	488,669
Subtotal	15,517,605	4,019,867	64,961,966	6,484,177	1,886,343	29,686,195	2,760,337	617,344	10,353,666	6,273,091	1,516,180	24,922,105
4. Physical contingency	2,327,642	602,979	9,744,290	972,627	282,951	4,452,924	414,051	92,601	1,553,050	940,964	227,427	3,738,316
Subtotal	17,845,247	4,622,846	74,706,256	7,456,804	2,169,294	34,139,119	3,174,388	709,945	11,906,716	7,214,055	1,743,607	28,660,421
5. VAT	1,749,534	—	1,749,534	731,059	—	731,059	311,215	—	311,215	707,260	—	707,260
GRAND TOTAL	19,594,781	4,622,846	76,455,790	8,187,863	2,169,294	34,870,178	3,485,603	709,945	12,217,931	7,921,315	1,743,607	29,367,681

Table 7-4-5-2 Summary of Construction Cost by Year (Three-Contract Method)

Unit $\times 10^3$ Rp
$\times 10^3$ Yen 1988 prices

Description	Summary		1rd year		2th year		3th year		4th year	
	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)
1. Land compensation	600,000	—	600,000	—	—	—	—	—	—	—
2. Civil works	14,613,338	3,941,046	553,000	22,600	6,020,058	716,786	6,147,674	1,967,232	1,892,606	1,234,428
a. Preparatory works	553,000	22,600	553,000	22,600	—	—	—	—	—	—
b. Groins	8,289,312	702,987	—	—	4,348,061	352,076	3,493,924	312,697	447,327	38,214
c. Offshore breakwater	1,126,364	32,865	—	—	1,126,364	32,865	—	—	—	—
d. Submerged offshore breakwater	702,350	106,497	—	—	—	—	702,350	106,497	—	—
e. Beach sand nourishment	3,921,423	3,070,419	—	—	524,744	326,167	1,951,400	1,548,038	1,445,279	1,196,214
f. Demolition	20,889	5,678	—	—	20,889	5,678	—	—	—	—
Subtotal (1+2)	15,213,338	3,941,046	1,153,000	22,600	6,020,058	716,786	6,147,674	1,967,232	1,892,606	1,234,428
3. Government administration	304,267	78,821	23,060	452	120,401	14,336	122,953	39,345	37,853	24,688
Subtotal	15,517,605	4,019,867	1,176,060	23,052	6,140,459	731,122	6,270,627	2,006,577	1,930,459	1,259,116
4. Phisical contingency	2,327,642	602,979	176,409	3,458	921,070	109,668	940,594	300,986	289,569	188,867
Subtotal	17,845,247	4,622,846	1,352,469	26,510	7,061,529	840,790	7,211,221	2,307,563	2,220,028	1,447,983
5. VAT	1,749,534	—	132,595	—	692,307	—	706,983	—	217,649	—
GRAND TOTAL	19,594,781	4,622,846	1,485,064	26,510	7,753,836	840,790	7,918,204	2,307,563	2,437,677	1,447,983

Table 7-4-5-3 Project Cost (Three-Contract Method)

Unit×10³ Rp
×10³ Yen 1988 prices

Description	Kuta			Nusa Dua			Sanur			Sub Total			Common Expenses			Grand Total		
	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)	L.C (Rp)	F.C (Yen)	Total (Rp)
1. Land compensation	210,000	—	210,000	65,000	—	65,000	325,000	—	325,000	600,000	—	600,000	—	—	—	600,000	—	600,000
2. Civil works	6,147,036	1,849,356	28,834,114	2,641,213	605,239	10,085,653	5,825,089	1,475,051	24,108,436	14,613,338	3,941,046	63,088,203	6,000	3,800	52,740	14,619,338	3,944,846	63,140,943
a. Preparatory works	195,000	7,684	289,513	79,000	2,260	106,798	279,000	12,656	434,669	553,000	22,600	830,980	—	—	—	553,000	22,600	830,980
b. Groins	4,097,492	350,041	8,402,996	524,215	9,959	646,711	3,667,609	342,987	7,886,345	8,289,312	702,987	16,936,052	—	—	—	8,289,312	702,987	16,936,052
c. Offshore breakwater	—	—	—	1,126,364	32,865	1,530,604	—	—	—	1,126,364	32,865	1,530,604	—	—	—	1,126,364	32,865	1,530,604
d. Submerged offshore breakwater	—	—	—	—	—	—	702,350	106,497	2,012,263	702,350	106,497	2,012,263	—	—	—	702,350	106,497	2,012,263
e. Beach sand nourishment	1,851,795	1,490,308	20,182,583	896,764	557,404	7,754,833	1,172,864	1,022,707	13,752,160	3,921,423	3,070,419	41,687,576	—	—	—	3,921,423	3,070,419	41,687,576
f. Demolition	2,749	1,323	19,022	14,870	2,751	48,707	3,270	1,604	22,999	20,889	5,678	90,728	—	—	—	20,889	5,678	90,728
g. Miscellaneous													6,000	3,800	52,740	6,000	3,800	52,740
3. Government administration	127,141	36,987	582,081	54,124	12,105	203,013	123,002	29,729	488,669	304,267	78,821	1,273,763	120	79	1,055	304,387	78,897	1,274,818
4. Engineering services	—	—	—	—	—	—	—	—	—	—	—	—	1,029,725	462,846	6,722,731	1,029,725	462,846	6,722,731
Sudtotal	6,484,177	1,886,343	29,686,195	2,760,337	617,344	10,353,666	6,273,091	1,516,180	24,922,105	15,517,605	4,019,867	64,961,966	1,035,845	466,722	6,776,526	16,553,450	4,486,589	71,738,492
5. Phyical contingency	972,627	282,951	4,452,924	414,051	92,601	1,553,050	940,964	227,427	3,738,316	2,327,642	602,979	9,744,290	155,377	70,008	1,016,479	2,483,019	672,987	10,760,769
Sudtotal	7,456,804	2,169,294	34,139,119	3,174,388	709,945	11,906,716	7,214,065	1,743,607	28,660,421	17,845,247	4,622,846	74,706,256	1,191,222	536,730	7,793,005	19,036,469	5,159,576	82,499,261
6. VAT	731,059	—	731,059	311,215	—	311,215	707,260	—	707,260	1,749,534	—	1,749,534	690	—	690	1,750,224	—	1,750,224
GRAND TOTAL	8,187,863	2,169,294	34,870,178	3,485,603	709,945	12,217,931	7,921,315	1,743,607	29,367,681	19,594,781	4,622,846	76,455,790	1,191,912	536,730	7,793,695	20,786,693	5,159,576	84,249,485

Table 7-4-5-4 Project Cost by Year (Three-Contract Method)

Unit ×10³ Rp
×10³ Yen 1988 prices

Description	Summary		1st year		2nd year		3rd year		4th year		5th year		6th year	
	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)	L.C (Rp)	F.C (Yen)
1. Land compensation	600,000	—	—	—	—	—	600,000	—	—	—	—	—	—	—
2. Civil works	14,619,338	3,944,846	—	—	—	—	553,000	22,600	6,020,058	716,786	6,147,674	1,967,232	1,892,606	1,234,428
a. Preparatory works	553,000	22,600	—	—	—	—	553,000	22,600	—	—	—	—	—	—
b. Groins	8,289,312	702,987	—	—	—	—	—	—	4,348,061	352,076	3,493,924	312,697	447,327	38,214
c. Offshore breakwater	1,126,364	32,865	—	—	—	—	—	—	1,126,364	32,865	—	—	—	—
d. Submerged offshore breakwater	702,350	106,497	—	—	—	—	—	—	—	—	702,350	106,497	—	—
e. Beach sand nourishment	3,921,423	3,070,419	—	—	—	—	—	—	524,744	326,167	1,951,400	1,548,038	1,445,279	1,196,214
f. Demolition	20,889	5,678	—	—	—	—	—	—	—	—	—	—	—	—
g. Miscellaneous	6,000	3,800	6,000	3,800	—	—	—	—	20,889	5,678	—	—	—	—
Subtotal	15,219,338	3,944,846	6,000	3,800	—	—	1,153,000	22,600	6,020,058	716,786	6,147,674	1,967,232	1,892,606	1,234,428
3. Government administration	304,387	78,897	120	76	—	—	23,060	452	120,401	14,336	122,953	39,345	37,853	24,688
4. Engineering services	1,029,725	462,846	223,822	48,413	236,161	89,436	60,110	55,339	153,265	85,890	170,826	86,204	185,541	97,564
Subtotal	16,553,450	4,486,589	229,942	52,289	236,161	89,436	1,236,170	78,391	6,293,724	817,012	6,441,453	2,092,781	2,116,000	1,356,680
5. Physical contingency	2,483,018	672,988	34,491	7,843	35,424	13,415	185,426	11,759	944,059	122,552	966,218	313,917	317,400	203,502
Subtotal	19,036,468	5,159,577	264,433	60,132	271,585	102,851	1,421,596	90,150	7,237,783	939,564	7,407,671	2,406,698	2,433,400	1,560,182
6. VAT	1,750,224	—	690	—	—	—	132,595	—	692,307	—	706,982	—	217,650	—
GRAND TOTAL	20,786,692	5,159,577	265,123	60,132	271,585	102,851	1,554,191	90,150	7,930,090	939,564	8,114,653	2,406,698	2,651,050	1,560,182

Table 7-4-5-5 Summary of Major Equipment and Plants

Equipment	Description	Number
Grab dredger	Bucket Capacity 8 m^3, 1,000 ps	5
Anchor boat	with 10 t crane, 180 ps	8
Carrier boat	700 m^3	10
Tugboat	1,200 ps	8
- do -	300 ps	3
Traffic boat	40 ps	6
Flat barge	500 WT	3
Pump dredger	1,000 ps 250 m^3/h	3
Bulldozer	D-7 LGP	11
Backhoe	1.2 m^3	3
- do -	0.7 m^3	3
Dump truck	15 t	3
- do -	10 t	35
Ordinary truck	10 t	3
Wheel loader	CAT, 1.0 m^3	9
- do -	CAT, 1.5 m^3	1
Crushing plant	20 ton/hour	3
Crawler crane	40 t	10
Amphibious soft-terrain excavator	SH-30	10
Concrete plant	0.5 m^3, 18 m^3/h	3
Vibrator	8,000 - 10,000 vpm D = 46 mm	26
Tractor shovel	1.7 m^3	5
Concrete mixer	0.3 m^3	6
Wheel carrier	3 t HD-30	11
Crawler drill	CD-6	3
Compressor	17 m^3/min	3
Hydraulic breaker	UB-11, 980 kg	3

7-5 Conclusion

7-5-1 General

The construction schedule and cost estimate of the Urgent Bali Beach Conservation Project adopts two kinds of contract methods. One is a one-contract method and the other is a three-contract method. The two methods are compared in this chapter.

7-5-2 Comparison

(1) Construction Period

1) As regards the total construction period, the construction period of the one-contract method is two months longer than that of the three-contract method which is set equal to the longest period among the three contracts.

2) The construction period at Kuta Beach is the same under both methods.

3) But at Nusa Dua Beach, the construction period of the one-contract method is 8 months longer than the peroid of the three-contract method due to waiting time of the beach sand nourishment works.

4) As regards the construction period of Sanur Beach, the period of the one-contract method is 4 months longer than that of the three-contract method due to the waiting time of the beach sand nourishment works.

(2) Project Cost

1) The project cost of the one-contract method is Rp. 12,804,029,000 lower than that of the three-contract method. Thus the three-contract method would cost 17.9% more than the one-contract method.

2) The construction cost of the one-contract method is Rp.

9,762,000 lower than that of the three-contract method. Thus the three-contract method would cost 18.3% more than the one-contract method.

3) The cost of the offshore breakwaters for the three-contract method is Rp. 713,230,000 higher than for the one-contract method, because of the need to build a new jetty for seaborn traffic. This is equivalent to a 87.3% increase over the one-contract method.

4) The cost of the beach sand nourishment works for the three-contract method is Rp. 10,372,766,000 higher than for the one-contract method. This is equivalent to a 33.1% increase over the one-contract method. A comparison of the project cost between the one-contract method and the three-contract method is shown in Table 7-5-2-1.

5) The cost of the preparatory works for the three-contract method is 14.7% higher than that for the one-contract method, and this is caused by the building of offices at each site.

(3) Major Equipment and Plants

A comparison of the major equipment and plants between the one-contract method and the three-contract method is shown in Table 7-5-2-2.

1) Under the three-contract method, more equipment is required because of carrying out works at the three sites separately and independently.

2) The capacity of the wheel loaders for the three-contract method is smaller but the number of wheel loaders is increased.

3) The capacity of the crawler cranes for the three-contract method is the same, but the number of cranes is increased.

(4) Engineering Services

1) The engineering service fee for the three-contract method is Rp.

819,690,000 more than for the one-contract method. This is equivalent to a 13.9% increase over the one-contract method.

2) The increased costs under the three-contract method include higher salary costs because of the increased number of supervisors and the subsequent increase in the number of support personnel.

3) The report printing cost of the local currency portion of the thee-contract method is also higher owing to the increased number of contracts.

7-5-3 Results

The total construction period of the two methods is almost equal. However, the construction period of Nusa Dua and Sanur Beaches under the three-contract method is shorter than under the one-contract method, especially at Nusa Dua Beach. Therefore, in view of the construction period, the three-contract method is better than the one-contract method.

From the point of view of the project cost, the one-contract method is better than the three-contract method.

From the point of view of the construction equipment and plants, the three-contract method uses much more equipment and plants than the one-contract method. There is no harm in increasing the numbers of equipment and plants, but this would disturb the tourists on the beach during the construction period.

Therefore, a smaller number of equipment and plants is better and wiser.

From the point of view of the engineering services, certainly the one-contract method is better than the three-contract method, because of the easy control of the supervision works and the lower cost.

Table 7-5-2-1 Comparison of Project Costs

Unit × 10^3 Rp
× 10^3 Yen 1988 prices

Description	One Contract Method			Three package Method			(2)/(1) (%)
	Cost			Total			
	L.C (Rp)	F.C (Yen)	(1) Total (Rp)	L.C (Rp)	F.C (Yen)	(2) Total (Rp)	
1. Land compensation	600,000	—	600,000	600,000	—	600,000	100.0
2. Civil works	11,814,765	3,379,185	53,378,741	14,619,338	3,944,846	63,140,943	118.3
a. Preparatory works	446,300	22,600	724,280	553,000	22,600	830,980	114.7
b. Groins	7,529,798	876,515	18,310,933	8,289,312	702,987	16,936,052	92.5
c. Offshore breakwater	273,062	44,253	817,374	1,126,364	32,865	1,530,604	187.3
d. Submerged offshore breakwater	516,700	126,350	2,070,805	702,350	106,497	2,012,263	97.2
e. Beach sand nourishment	3,030,960	2,299,500	31,314,810	3,921,423	3,070,419	41,687,576	133.1
f. Demolition	11,945	6,167	87,799	20,889	5,678	90,728	103.3
g. Miscellaneous	6,000	3,800	52,740	6,000	3,800	52,740	100.0
Subtotal	12,414,765	3,379,185	53,978,741	15,219,338	3,944,846	63,740,943	118.1
3. Government administration	248,295	67,584	1,079,578	304,387	78,897	1,274,818	118.1
4. Engineering services	900,348	406,723	5,903,041	1,029,725	462,846	6,722,731	113.9
Subtotal	13,563,408	3,853,492	60,961,360	16,553,450	4,486,589	71,738,492	117.7
5. Physical contingency	1,944,511	578,024	9,054,206	2,483,019	672,987	10,760,769	118.8
Subtotal	15,507,919	4,431,516	70,015,566	19,036,469	5,159,576	82,499,261	117.8
6. VAT	1,429,890	—	1,429,890	1,750,224	—	1,750,224	122.4
GRAND TOTAL	16,937,809	4,431,516	71,445,456	20,786,693	5,159,576	84,249,485	117.9

Table 7-5-2-2 Comparison of Major Equipment and Plants

Equipment	Description	One contract method	Three Package method			
			Σ	Items		
				Kuta	Nusa	Sanu
Grad dredger	Bucket Capacity 8m³, 1,000ps	3	5	2	2	1
Anchor boat	with 10t crane, 180 pcs	5	8	3	3	2
Carrier boat	700 m³	8	10	4	3	3
Tugboat	1,200 ps	6	8	4	2	2
- do -	300ps	1	3	1	1	1
Traffic boat	40 ps	6	6	2	2	2
Flat barge	500 WT	1	3	1	1	1
Pump dredger	1,000 ps 250m³/h	2	3	1	1	1
Bulldozer	D-7 LGP	7	11	4	4	3
Backhoe	1.2m³	1	3	1	1	1
- do -	0.7m³	2	3	1	1	1
Dump truck	15 t	3	3	1	1	1
- do -	10 t	25	35	12	7	16
Ordinary truck	10 t	2	3	1	1	1
Wheel loader	CAT, 1.0 m³	2	9	3	3	3
- do -	CAT, 1.5 m³	4	1	-	-	1
- do -	CAT, 3.1 m³	2	0	-	-	-
Crushing・Plant	40 ton/hour	1	0	-	-	-
- do -	20 ton/hour	0	3	1	1	1
Crawler crane	40 t	1	10	3	3	4
- do -	16 t～ 20 t	6	0	-	-	-
Amphibious soft-terrain excavator	SH-30	9	10	4	2	4
Concrete Plant	0.5 m³, 18m³/h	2	3	1	1	1
Vibrator	8,000 - 10,000 vpm D=46 mm	17	26	7	7	12
Tractor shovel	1.7m³	12	5	3	1	1
Concrete mixer	0.3 m³	4	6	2	2	2
Wheel carrier	3 t HD-30	2	11	5	2	4
Crawler drill	CD-6	2	3	1	1	1
Compressor	17 m³/min	2	3	1	1	1
Hydraulic breaker	UB-11, 980 kg	2	3	1	1	1

CHAPTER 8

ECONOMIC ANALYSIS

CHAPTER 8 ECONOMIC ANALYSIS

8-1 General

The beach conservation project aims at protecting the tourism industry in Bali. Since the prosperity of tourism in Bali, more specifically the number of tourist arrivals to Bali, is determined by the attractiveness of the beaches, the conservation of Bali's beaches means the protection of the tourism industry in Bali, and consequently guarantee the welfare of the Balinese.

The results of this assessment clarify the viability of this Project. The investment is very efficient, and the execution of this project is strongly recommended.

8-2 Identification of Economic Benefit

The economic benefit accruing to the beach conservation project is defined as the difference in the tourism industry's earnings between the "with the project" and the "without the project" cases.

The project contributes to the economy of Bali in various ways, but only one item is quantified for the evaluation of the economic benefit. The main benefits of the project are presented below:

- to minimize the deterioration of major tourism resources and, consequently, to prevent the Bali tourism industry from facing a drastic reduction of tourist arrivals and earnings,

- to minimize the private investment for beach conservation works which the private sector would have to provide in case the government does not take any countermeasures against erosion,

- to conserve the value of the local properties.

The first item is the only benefit which is measured for this project evaluation, and this can be measured in terms of the tourism industry's earnings. The more valid the relationship between the quality of the beaches and the number of tourist arrivals to Bali is, the more clearly the magnitude of beach erosion on the tourism industry in Bali can be quantified.

The second item concerns future expenditure plans. However, it is found that the private sector has no actual plan to construct groins and/or breakwaters at present. Thus, the estimation of this benefit item is excluded in this analysis.

The third item is concerned with the production value of the land. It is certain that beach erosion will lessen the value of the land along the beach since production/sales opportunities at this land will be lost. Tourism is the dominant industry in the study area, and thus this expected damage can also be measured in terms of the reduction of tourist expenditures. Thus this item is not considered in the analysis in order to avoid double accounting.

There are other benefit items as follows:

- Reduction in damages from disasters.
- Promotion of regional economic development through development of the tourism industry.
- Other intangible benefits.

But these benefits items are difficult to evaluate in strictly monetary terms, and thus are not included in this analysis.

Besides the above benefit items, the project impact on the fishery industry is also examined. The fishery activities, it is reported by the department of fishing, will not be affected by beach erosion and conservation works since the major fishing areas are located far from the coral cliff. No other impacts are expected from the ongoing beach erosion on Bali Island.

8-3 Estimation of Economic Benefit

Four steps are taken to estimate the economic benefit;

- Forecast of foreign tourist arrivals.
- Estimation of the magnitude of reduction in tourist arrivasls.
- Estimation of average expenditure by tourists.
- Actual calculation of economic benefit.

(1) Forecast of foreign tourist arrivals

Bali Tourism Development Corporation (BTDC) has just completed a study of the total tourist arrivals to Bali in 1988 including future projections, and the results of the BTDC study are quoted for this evaluation. Fitures of foreign tourist arrivals to 4 & 5 star hotels in Bali are adopted for this study because others are low budget travellers. The results are as follows:

Table 8-3-1 Forecast of International Tourist Arrivals to Bali

('000 persons)

Items	1984 (actual)	1993	1995	2000	2010
No. of Int'l Tourist Arrivals to Bali*	223.3	456.8		750.0	1,180.0
Of which, to 4 & 5 star hotels *	167.5	342.0		562.5	885.0
Kuta **	15.8	20.0	-	30.7	67.0
Nusa Dua *	62.0	209.0	-	358.9	438.0
Sanur**	89.7	113.0	-	173.8	380.0

Source: "Up-to-date Nusa Dua Master Plan Study, 1988, Bali Tourism development Corporation", and "Statistical Year Book of Bali 1986", Statistical Office of Bali Province.

Note : * estimated in BTDC's study

** calculated by the Study Team based on the hotel occupancy rate and number of hotel rooms.

(2) Estimation of the magnitude of reduction in tourist arrivals

The magnitude of the probable reduction of tourist arrivals to Bali in the "without the project" case is estimated based on the tourists' preference which is clarified by the JICA survey (March 1988). This indicates as a whole that about 41% of the tourists to Bali put the beach at the top of the tourist attraction list, and would not visit Bali Island if the beach were severely eroded and sufficient space could not be provided for sun-bathing on the beach. The composition shares of this kind of answer are summarized by beach below;

Kuta	80.1%
Nusa Dua	9.8%
Sanur	21.1%

The figures show that erosion in Kuta has a significant negative influence on the tourist decision on whether they will come to Bali or not. These responses can also be applied to those tourists who plan to visit Bali but do not have enough information about the present beach condition. All these points are incorporated in estimating the project benefit.

(3) Estimation of average expenditure by tourists

Past data of the average expenditure by tourists in Indonesia is available and a regression function provides the figure for the year 1988. Data are available from 1980 to 1986.

The regression function adopted here is;

$$Y = -77964.389 + 39.639 \times X$$
$$R^2 = 0.808$$

where, X ; year
Y ; average expenditure by tourists to Indonesia

With this regression function, the average expenditure per tourist is estimated for each year, of which 68% is assumed to be spent in Bali according to the comparison of the average length of stay in Bali and in Indoneisa.

Table 8-3-2 Average Expenditure per Tourist in Indonesia and in Bali

(US$)

Area	1988	1993	1995	2000
In Indonesia	838	1,036	1,115	1,317
In Bali	569	704	758	896

Source: Ministry of Finance; Central Bureau of Statistics

However, the figure for the year 1988 is adopted for the entire period of the benefit forecast.

(4) Actual calculation of economic benefit

The tourism industry's earnings is the only subject of the quantitative measurement, and the difference between the "with the project" case and the "without the project" case is defined as the project benefit. The project aims at ceasing further erosion of the beach and providing enough beach sand to recover the conditions of around 10 years ago. The beach will be further eroded in the "without the project" case.

The difference in the tourism industry's earnings under the two cases is calculated based on the following function;

$$B = \Sigma \left[T(with) \times E(i) - T(without) \times E(i) \right]$$

where,

B ; Project benefit equivalent to the difference in the tourism industry's earning between the "with the project" and the "without the project" cases.

T(with) ; Number of tourist arrivals in the "with the project" case, which is equivalent to the forecast of international tourist arrivals.

T(without); Number of tourist arrivals in the "without the project" case.

E(i) ; Average expenditure per foreign tourist in Indonesia in year i.

Of the factors above, T(without) is formulated as follows;

T(without) = T(with) x [1 - P (refusal)] x P(actual)

where,

P(refusal); Probability at which tourists would refuse to visit Bali in case the beach is severely eroded, which is set at 0.41 for all the beaches according to the intervies survey results: 80.1% for Kuta, 21.1% for Sanur, and 9.8% for Nusa Dua.

P(actual) ; Ratio of those who answered 'not to come to Bali in the "without the project"' case, but who may actually visit Bali anyway against those who answered 'not to come to Bali the "without the project"' case, which is set at 0.5 according to the interview survey.

Both figures of P(refusal) and P(actual) are assumed to remain unchanged for the entire period of the benefit analysis.

The results of the benefit calculations are summarized below;

Table 8-3-3 Economic Benefit of the Project

(Unit: Rp. mn)

Project	1995	2000	2005
Kuta	9,028	11,186	17,819
Nusa Dua	5,554	8,160	9,071
Sanur	12,790	15,847	25,243
Total	27,372	35,193	52,133

The first year the project generates benefit is 1996, the year after the completion of the entire construction works. The figures for other years are estimated by interpolating the figures for 1996, 2000, and 2005.

For the purpose of eliminating other exogenous factors intervening in the benefit estimation, the amount of project benefit is kept constant for the entire period of the project life.

8-4 Estimation of Economic Cost

Two kinds of contract methods are considered: the one-contract method and the three-contract method.

The economic cost of the project is defined as the sum of all materials' real production costs. Thus transfer items such as taxes and duties are excluded from the nominal prices of the materials.

The rates of taxes and duties shown below are excluded from the nominal material costs;

(Unit: %)

Items	Percentage of Taxes and Duties	
	Local Portion	Foreign Portion
1. Fuel	10	-
2. Cement	10	-
3. Local steel	10	-
4. Plywood/timber	10	-
5. Labour	2.5	-
6. Local equipment	Various level	-
7. Land compensation	13.4	-
8. Engineering costs	15	10
9. Overhead and profit	18	16.8

Source: Directorat Jenderal Bina Marga

After this price adjustment to economic prices, conversion factors for each construction work component are calculated. In case of the three-contract method, the component share of each input material such as local equipment, overhead, etc. differs from that under the one-contract method, and consequently the conversion factors for the three-contract method are different from the original figures of the one-contract method. The conversion factors are shown below:

Items	One-Contract Method	Three-Contract Method		
		Kuta	Nusa Dua	Sanur
Groin	0.933	0.938	0.917	0.938
Breakwater	0.927	1	0.927	0.928
Beach Sand Nourishment	0.940	0.933	0.938	0.934
Miscellaneous Work	0.914	1	0.914	0.914

The project costs at market prices are converted into economic costs by multiplying by the conversion factors. The economic costs of the Project are shown in Table 8-4-1.

Table 8-4-1 Economic Costs of the Project

Unit: Rp.mn)

Contract	Beach	Construction Cost	Maintenance Cost	Total Cost
One-Contract Method	Kuta	34,860	7,000	41,860
	Nusa Dua	8,542	1,820	10,363
	Sanur	26,271	5,180	31,451
	Total	69,673	14,000	83,673
Three-Contract Method	Kuta	33,752	7,000	40,752
	Nusa Dua	11,721	1,820	13,541
	Sanur	28,274	5,180	33,454
	Total	73,746	14,000	87,746

In the case of the one-contract method, the total economic construction cost of the Project amounts to 69,673 million Rp. in 1988 prices. In addition, 14,000 million Rp. is required for the maintenance cost for the 20 years of the benefit flow period.

In the case of the three-contract method, the total economic construction cost reaches 73,746 million Rp. and the maintenance cost amounts to 14,000 million Rp. for the same period.

A comparison of the total economic costs required for each method shows the following features;

i) As for the total cost of the three beaches, the one-contract method requires less investment cost, and the difference reaches 4,000 million Rp. This difference is attributable to the differences in the construction costs for Nusa Dua Beach and Sanur Beach.

ii) As for the cost for Kuta Beach, the one-contract method is slightly more expensive.

The maintenance costs will beign the year after the completion of the construction works. There is no difference in the maintenance costs under the two different contract methods.

8-5 Economic Viability of the Project

The economic viability of the Project is examined by two kinds of indicators. First is the level of investment efficiency, which is measured by the following indicators;

- internal rate of return (IRR)
- benefit-cost ratio (B/C)
- net present value (NPV)

The second is the number of employment opportunities created by the Project.

These indicators are calculated based on the economic cost and benefit streams. The opportunity cost of capital is assumed at 12%, which is commonly used in Indonesia for project appraisal. The results are shown in Table 8-5-1. The table shows the superiority of the one-contract method over the three-contract method.

Table 8-5-1 Summary of Economic Analysis

Contract	Beach	Total Economic Cost	Total Economic Benefit	EIRR (%)	B/C (discount rate=12%)	NPV (discount rate=12%)	Labour Opportunity (person • years)
One-Contract Method	Kuta	41,860	189,200	21.0	1.70	13,131	
	Nusa Dua	10,363	121,509	43.2	4.43	15,897	
	Sanur	31,451	268,033	33.4	3.09	30,628	
	Three Beaches as a While	83,673	578,741	29.5	2.57	59,656	
Three-Contract Method	Kuta	40,752	189,200	22.4	1.78	14,050	4,222
	Nusa Dua	13,541	121,509	31.5	3.03	13,462	520
	Sanur	33,454	268,033	33.9	2.98	30,051	2,637
	Three Beaches as a While	87,746	578,741	28.9	2.45	57,563	7,379

Note: 1. The project life is 20 years after the completion of the construction works.
2. The opportunity cost of capital is set at 12%.

Sensitivity analysis is carried out on the superior method (the one-contract method) to evaluate the risks associated with changes in the economic cost and benefit streams. For instance, the price level in the future depends on unforeseen and unforeseeable events and on various exogenous factors. Possible unforeseen fluctuations in the cost and benefit flow present a risk in the investment. In this study, the sensitivity of the IRR, B/C and NPV to these exogenous factors is tested.

The sensitivity analysis also examines how much the delay of the construction works affects the IRR. Since a one-year delay of the construciton works causes a further erosion 29,000 cubic meters of beach sand, the total project cost is expected to increase by the value of this sand volume. The magnitude of this additional cost on the IRR is also examined.

Table 8-5-2 below shows the results of the sensitivity analysis. These indicators prove the rationale of the Project execution since the economic viability of the project is very stable, proving the viability of the investment efficiency for a cost increase or benefit decrease by 20%, and for a simultaneous increase of cost and decrease of benefit by 20%.

Table 8-5-2 Sensitivity Analysis for the Project

Cases	IRR (%)	B/C	NPV (Rp. mn)
<u>Kuta</u>			
Cost up by 20%	17.6	1.41	9,364
Benefit down by 20%	16.9	1.40	6,738
Cost up & Benefit down by 20%	13.9	1.13	2,971
Two Year Delay	17.0	1.40	7,011
<u>Nusa Dua</u>			
Cost up by 20%	38.3	3.69	14,971
Benefit down by 20%	37.2	3.55	11,792
Cost up & Benefit down by 20%	32.7	2.96	10,866
Two Year Delay	37.5	3.62	12,557
<u>Sanur</u>			
Cost up by 20%	29.1	2.58	27,697
Benefit down by 20%	28.2	2.47	21,572
Cost up & Benefit down by 20%	24.3	2.06	18,641
Two Year Delay	28.9	2.54	26,485
<u>Three Beaches as whole</u>			
Cost up by 20%	25.4	2.14	52,033
Benefit down by 20%	24.6	2.05	40,102
Cost up & Benefit down by 20%	20.9	1.71	32,478
Two Year Delay	25.2	2.10	50,850

Note: B/C and NPV are measured at a 12% discount rate.

8-6 Conclusion

This assessment study substantiates that the Bali Beach Conservation Project will greatly contribute to the Balinese economy, and the investment efficiency is remarkably high, showing an IRR and B/C of 29.5% and 2.57 respectively. And this study also shows that any uncertainty concerning the cost and benefit estimation, even in the case of an increase of cost and decrease of benefit by 20% simultaneously, can be absorbed and the feasibility of the project remains valid. Thus the execution of the Project is strongly recommended in terms of national resource and budget allocation. The results also shows that the sooner the Project is implemented, the more efficient the investment will be.

Assessment by beach shows a high investment efficiency for all the beaches.

The level of the IRR and other investment assessment indicators is remarkably high compared with those for other infrastructure projects. This is attributable to the following special characteristics of this project;

- This project aims at protecting the tourism industry. The beach conservation project can minimize the loss of tourist arrivals to Bali by securing the beauty of the beach, and consequently guarantees the tourism industry's huge earnings, especailly from foreign tourists. Their total expenditures have more significance on the Bali economy compared with other industries such as agriculture in terms of investment efficiency.

- Bali is the center of Indonesian tourism and receives more than 200,000 foreigners per year. An increasing number of tourist arrivals is expected in the future. Thus the beach erosion will have an even greater effect on the future number of tourist arivals to Bali, and the contribution of the Project may increase in the future.

Comparing the one-contract method with the three-contract method, the one-contract method is superior in terms of investment efficiency.