# CHAPTER 9

# ADMINISTRATION

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## 9-1 Present System of the Coastal Administration

Though there are presently many coastal erosion preservation facilities, some of them have been constructed by the private sector and they are only partial countermeasures. Thus, most of these facilities are constructed to protect only individual properties and are not planned comprehensively so as to take into account a sufficient length of coastline.

No legislation or regulations are recognized concerning coastal conservation at the national level. However, there are regulations at the provincial level. The "Statement of the Government"(*) issued 22 November 1971 shows guidelines for building construction. It stipulates that building construction in the vicinity of coastal areas is restricted.

Many government agencies such as Department of Public Works, Department of Transport, Department of Tourism and Department of Environment have administrative relation to the sea. But the coastal conservation is administrated by the Directorate General of Water Resources Development, Department of Public Works (DPU) with the cooperation of the Institute of Hydraulic Engineering (IHE), Agency for Research and Development at the national level and by the Regional Office at the provincial level. The organization of DPU is described in Fig. 9-1-1.

When government organization besides DPU execute some construction works such as port and harbour works near the beach, they generally consult with DPU even if there is no legal obligation to do so, because DPU has many engineering staff and long experience.

When a private land owner intends to build a structure on the beach adjacent to his land in order to protect his own land, he can construct any kind of structure without approval from the government unless he violates local regulations. The government has no legal basis to regulate such construction even if the structure may possibly have an unfavourable effect on neighbouring beaches. Actually, when private land owners intend to construct some facilities, they consult

with DPU on the technical aspects for the erosion protection works, because beach erosion control plans require high technical expertise in many cases. DPU usually can give technical advice if requested, is not consulted for simple works.

DPU has experience and expertise in coastal engineering, but such experience and expertise are limited to a very narrow sphere due to the budgetary constraints and scarcity of data. Engineers in DPU and IHE have no experience to comprehensively analyze the coastal erosion problems ranging over a long length of coastline. This seems to be one of the big reasons that some facilities are having adverse effects on adjacent beaches and other facilities.

## 9-2 Project Implementation System of DPU

With regard to project planning including master plans, feasibility studies and final plans, Directorate of Rivers, Directorate General of Water Resources (DGWR) is in charge and the Institute of Hydraulic Engineering (IHE), Agency for Research and Development(**) is in charge of constultation from the engineering viewpoint. Actually IHE is responsible for investigation, planning, design and monitoring because it has many high-level engineering staffs and investigation instruments to collect data. The coastal Engineering Section of IHE established in 1975 is directly responsible for projects concerning coastal problems.

Projects are implemented by the regional office of DPU and the provincial Department of Public Works at the project site. Project teams are organized which are temporary organizations specially for the project implementation and are dissolved after the completion of the project. The project manager is selected usually from the managing staff of a regional office or provincial department and is appointed in the name of the minister of DPU. The organization for project implementation is generally set up as shown in Fig. 9-2-1. The project manager prepares the yearly plan including organization, implementation program and budget consulting with the head of the regional office and submits it to the minister for approval. He is responsible for all of the matters concerning implementation of the project. Construction works are implemented by constractors on a

contract basis under the supervision of the regional office, DPU.

After completion of construction works, the project manager reports to the minister, and the minister commits the responsibility for the maintenance of the structures to the governor of the provincial government. The governor is thus in charge of the maintenance of the structures. Usually the governor uses regional office and provincial department staff for the maintenance of the structures.

## 9-3 Recommendations

Why should coastal works be carried out by public bodies? Coastal ares suffer from sea disasters such as coastal erosion, high tides, tsunami and hurricanes. It is very difficult to construct countermeasure facilities using private finances because there is no guarantee that all the people concerned will participate. Considering the prevention of coastal erosion, there are many cases when privately constructed facilities have an adverse effect on adjacent coastal stretches due to blockage of the longshore sediment transport. All the people concerned are definitely unable to join in such projects due to financial and other reasons. In the case of flood mitigation works, no benefit is expected if all the poeple concerned do not participate. With regard to roads, if the network is not long enough, they are not really effective.

Levying charges is very difficult for these works, because the individual benefit is not well specified. That is the reason that river, coast and road works should be handled by the government through public financing.

So far as coastal areas are concerned, they must be well administered in order to protect these areas from disasters and to maintain a good environment. Preparation of laws and regulations is urgently ncessary. The administrator must be designated by law and administer all aspects of the coastal area.

The main roles of the administrator are:

1) To collect data on topography,*1 transition of shoreline position, waves and longshore current,
2) To protect coastal areas from disasters such as coastal erosion, high tides, tsunami and hurricans,
3) To maintain coastal facilities in good condition, and
4) To restrict actions which may adversely effect these areas.

The Minister, Department of Public Works should be appointed as the administrator because since DPU historically worked for coastal works, and the department has much know-how, many engineers and long expertise.

## 9-4 Proposed organization for Project Implementation and Operation and Maintenance

Since this project is very big scale and should be completed within three years, the organization and number of staff members shall be large. It is recommended to set a head office and three site offices at the job sites, Kuta, Nusa Dua and Sanur. The proposed administrative sections at the head office are planning, construction, logistics and finance, and administration. The site offices shall supervise the construction. The proposed organization chart is shown in Fig. 9-4-1.

The staff members, especially engineers, shall be well trained and experienced because this project is the first large-scale coastal erosion prevention project for the Government of Indonesia.

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*1 In the case of data collection, long-term periodic topographical surveys includling sounding up to ten meters in depth in shallow seas and twenty meters in depth in deep seas are necessary. Such surveys are required to identify the cause of erosion in order to plan coastal erosion prevention works. If it is costly to carry out peridic topographical surveys, periodic aerial photos are also useful. Otherwise, seasonal photos fixed points are recommended to identify the transition of the shoreline and the erosion of cliffs.

An operation and maintenance office shall be necessary after the completion of the works. The organization shall consist of construction, operation and maintenance, logistics and finance, and administration sections. The office shall be maintained by the Provincial Department of Public Works Bali together with the regional office of DPU.

The role of the operation and maintenance office shall be maintain the beach. The office shall:

1) control coral mining and the removal of sand from the beach, *2
2) restrict actions which may have an adverse effect on the beach, *2
3) carry out periodic monitoring, *3 and
4) provide supplemental lsand as necessary.

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*2 A patrol system shall be introduced in order to check unauthorized coral mining, sand removal and facility construction. Also an information system shall be introduced between the patrol workers and the office. The people should be appointed and paid by the office, and their role is to inform the office if they find some offensive actions. The patrols should be carried out at least once a week.

*3 Monitoring should be carried out after the completion of the construction works. Monitoring is expected to cover the whole stretch of beach concerned, but should at least cover the following.

Kuta Beach (refer Fig. 6-2-1)
Since the wave energy is very strong at the north of groins No. 2, No. 3, No. 4 and No. 5 because there is no reef there, shoreline surveys to grasp the sand balance at each pocket beach shall be executed once a year. Photos of the beaches shall be taken from a fixed point on each jetty.

Nusa Dua Beach (refer Fig. 6-3-1)
Due to the construction of the U-shaped groin, water circulation on the reef may be bad. The sea water quality may deteriorate somewhat. Careful attention should be paid to the southern area of U-shaped groin. An annual shoreline survey shall also be carried out.

Sanur Beach (refer Fig. 6-4-1)
An annual shoreline survey shall be carried out at the pocket beaches from groin No. 4 to No. 6, the northern part of No. 4 and the sourthern part of No. 6.

The levelling points should be fixed in order to graps the sand balance and shoreline variation. IHE set many points when the shoreline survey was carried out in the past. The topographical survey for this study was also executed based on the above points supplementing new points for the points which were lost. The most important thing to continue the shoreline survey is to fix the levelling points.

The perpetual maintenance cost should be prepared by the government to carry out the above mentioned activities. Annual government expenditure for the maintenance is not so high if the maintenance is well executed, but the government shall be compelled to prepare an enormous budget if the maintenance is not properly carried out.

(*) SALINAN dari Surat
Keputusan Gubernur Kepala Daerah. Propinsi Bali. Denpasar.
22 November 1971

(**) The Institute of Hydraulic Engineering has been established with the aim of developing and supporting scientifically hydraulic engineering within the Department of Public Works and is direclty responsible to the Agency for Research and Development of DPU.
(the guide brochure published by The Institute.)

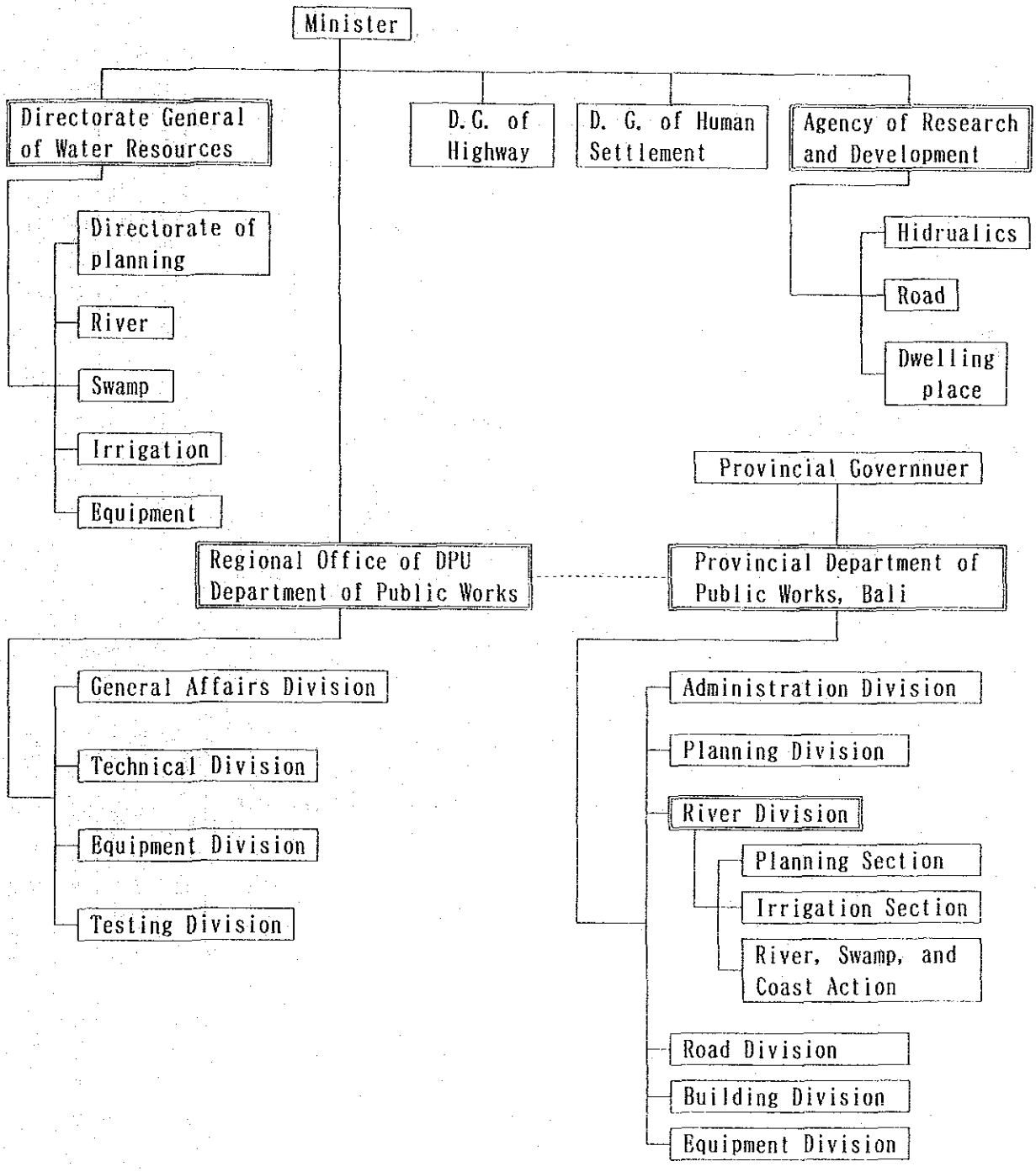
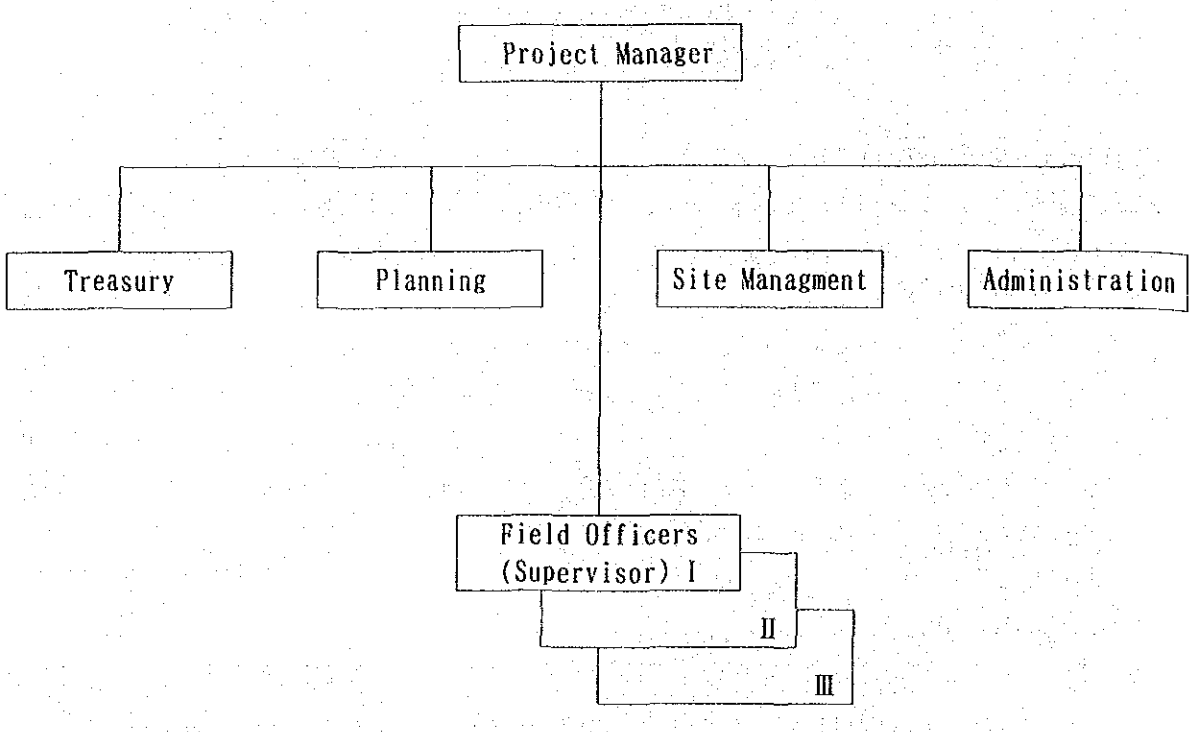



Fig. 9-1-1 Organization of Department of Public Works (Schmatic Figure)




(x) Improvement and Maintenance Project for Rivers in Bali.
(Proyek Perbaikan dan Pemeliharaan Sungai, Bali).

Fig. 9-2-1 Organization for Project(x) Implementation

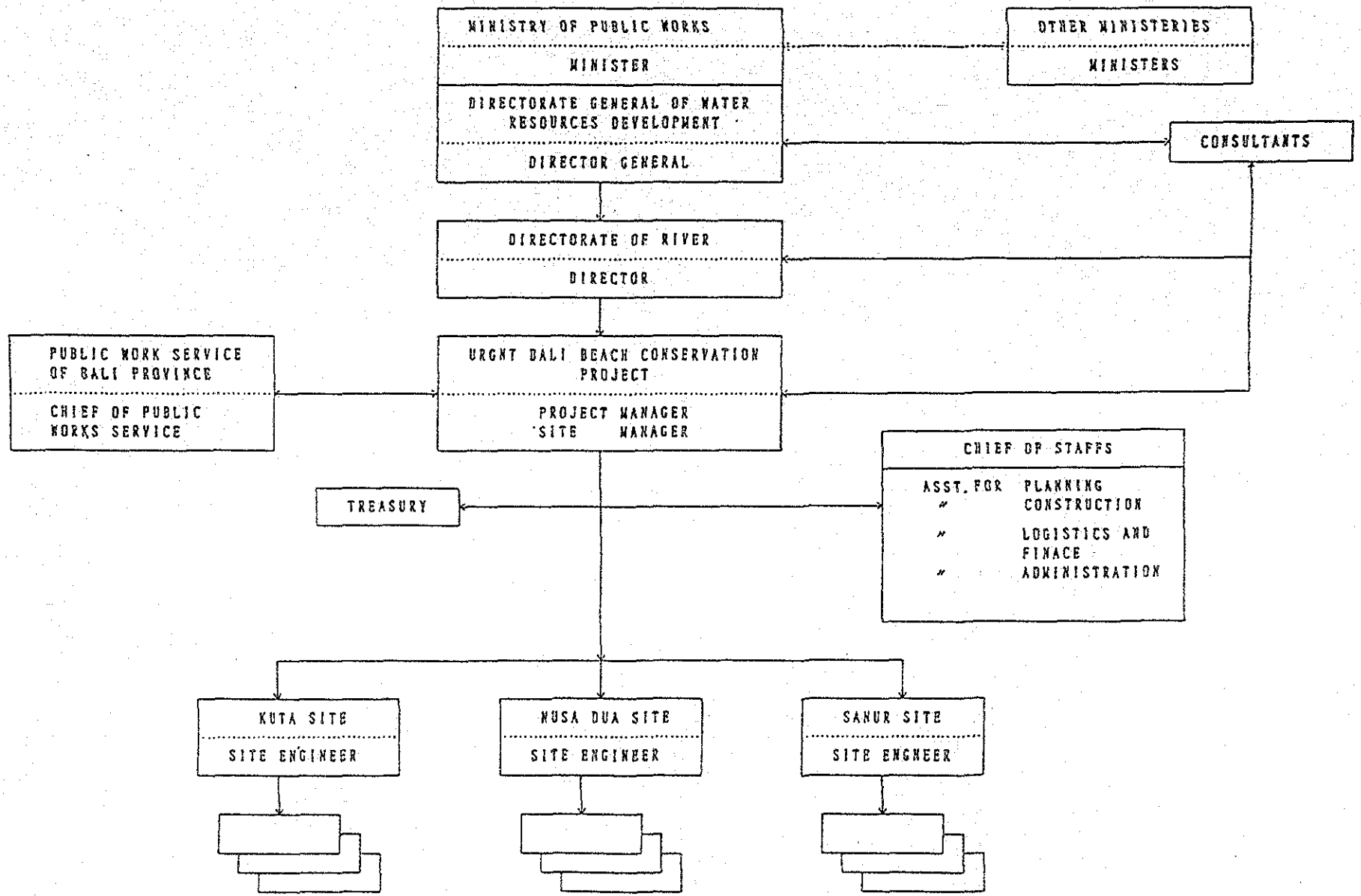



Fig. 9-3-1 Proposed Organization Chart for Implementations of the Project

# CHAPTER 10

# ENVIRONMENTAL IMPACT STUDY

# CHAPTER 10 ENVIRONMENTAL IMPACT STUDY

## 10-1 Study Results

### 10-1-1 Marine Ecology

The species of flora and fauna at the four study areas observed by the field reconnaissance are common, and do not include any endangered species.

It is obvious that the plants and the wildlife will be affected by the project. Nevertheless, the concerned areas are quite limited, and the birds and the wild animals can easily move to adjacent area in their habitat without difficulty.

Therefore, it can be concluded that the implementation of the project will not affect the ecology at the site significantly.

### 10-1-2 Landscape

Landscape change by the implementation of the project can be studied by the photo-montage method, as shown in Fig. 10-1-2-1.

(1) Kuta

The landscape at present is composed of sea, trees, artificial facilities such as groins, walls, cottages, etc., which give the impression of artificiality and dirt (Ref. to Photo 10-1, 10-3, at Pertamina Cottages).

Beach with sand nourishment, which will cover the artificial and dirty facilities will give a more natural and beautiful view (Ref. to Photo 10-2, 10-4).

Therefore, it can be concluded that the implementation of the project will improve the environment.

(2) Nusa Dua

The landscape at present is composed of sea, sand and erosion protection facilities such as groins, offshore breakwaters, and the U-shaped breakwater, mainly, which gives the visual impression of

variety (Ref. to Photo 10-5 at Club Med).

A beach with sand nourishment, which will cover up the sand-bags, can provide a more natural view, and extension of the U-shaped breakwater will not add significant pressure on the present view (Photo 10-6).

Therefore, it can be concluded that the implementation of the project will provide a better environment.

(3) Sanur

The landscape at present is composed of sea, sand and erosion protection facilities, mainly, which give the impression of poverty (Ref. to Photo 10-7 at Werdha Pura).

Sand nourishment and groin extension will create a richer beach (Photo 10-8).

Thus, it can be concluded that the implementation of the project will provide a better environment.

(4) Tanah Lot

In line with the planning and design by D.P.U., the placing of concrete blocks and reinforcement of the rock cliff by mortar are now in the final stage.

The landscape after completion of the above project will be better with colour and shape considered carefully.

The above analysis refers to typical sections of the four study areas, but the same conclusions can be drawn for the entire areas of the four beaches.

That is, the environment of the typical beaches of south Bali will be greatly improved by the increase of beach width, the improvement of the present erosion protection facilities and the establishment of new appropriate erosion protection facilities.

It is hoped that many tourists from throughout the world will continue to come to Bali, the most favored place in mysterious Indonesia, and the contribution of tourism to the national economy is greatly appreciated.

### 10-1-3 Sea Water Quality

The implementation of the project may affect the marine ecology due to the existence of the facilities and the slower sea-water current. However, the work is in a rather limited area, the term of the work is short, and the open spaces between facilities still seems wide enough to provide sufficient sea-water current.

Therefore, the project may not present only serious problems concerning in sea-water quality.

## 10-2 Further Considerations

It may be prudent to ensure the alleviation of the environmental impact by the following measures, whenever deemed necessary;

(1) Sea-water protection fence

When casting in-situ concrete, alkaline particles, etc. may pollute the sea-water, which can be protected by a fence.

(2) Use of heavy equipment

The use of heavy construction equipment should be minimized. However, when heavy equipment is necessary, it should be used during periods when there are relatively fewer tourists at the beach.

(3) Drainage system

Apart from the facilities in this project, the drainage system from the cities should be improved in order to avoid sea-water pollution.

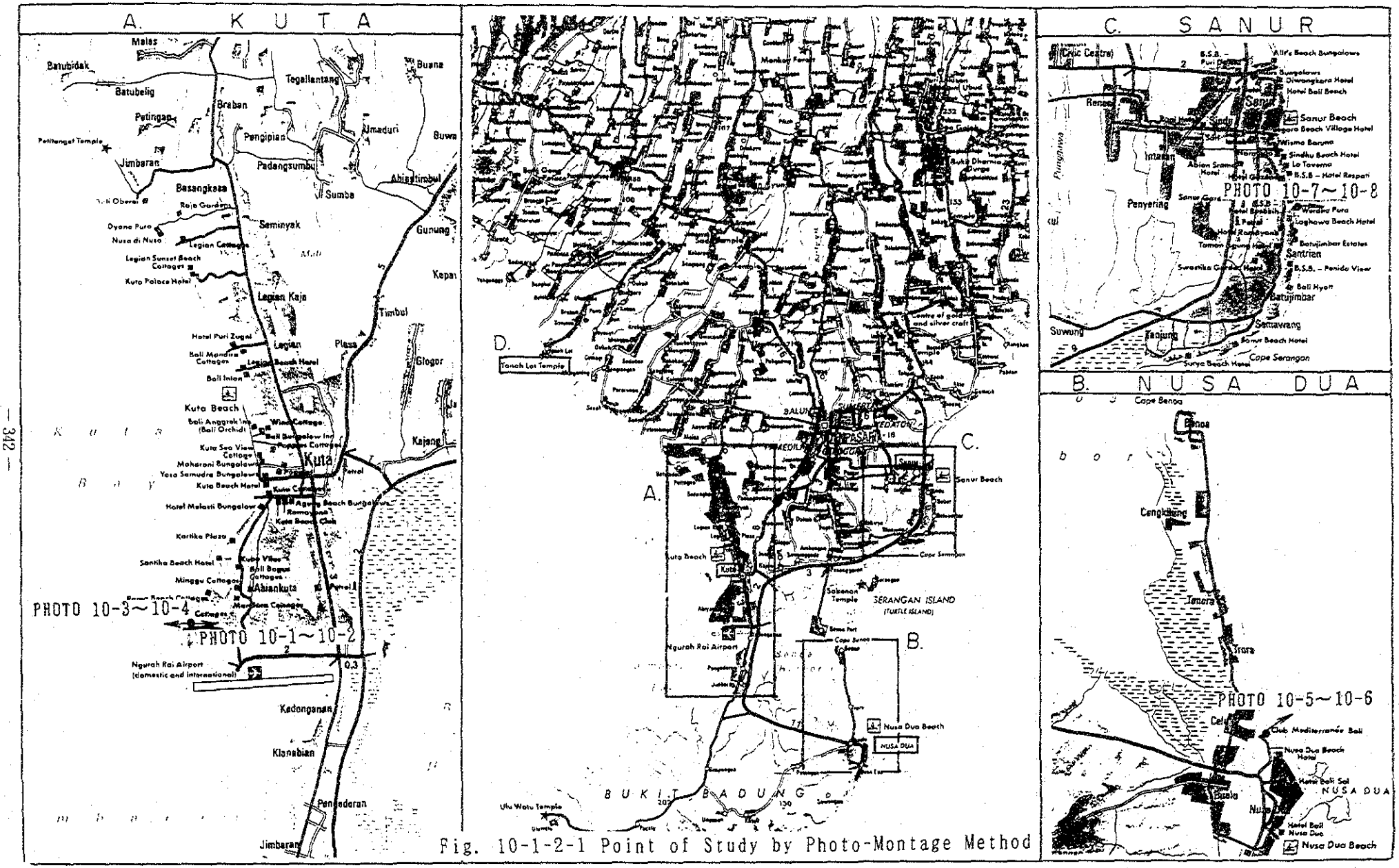



Fig. 10-1-2-1 Point of Study by Photo-Montage Method

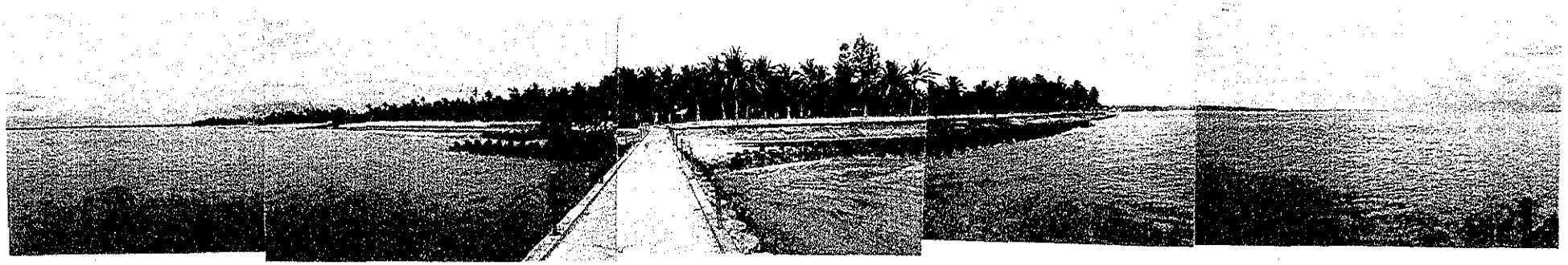


Photo. 10-1 Landscape at Present at Pertamina Cottages (1)



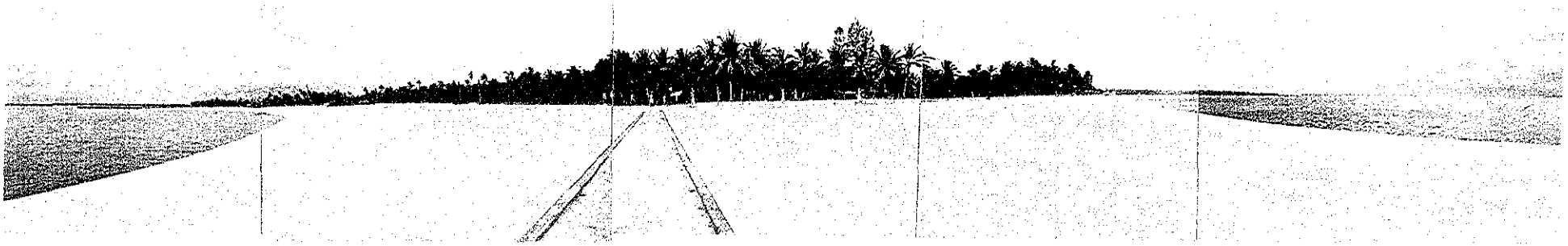


Photo. 10-2 Landscape after Development at Pertamina Cottages (1)

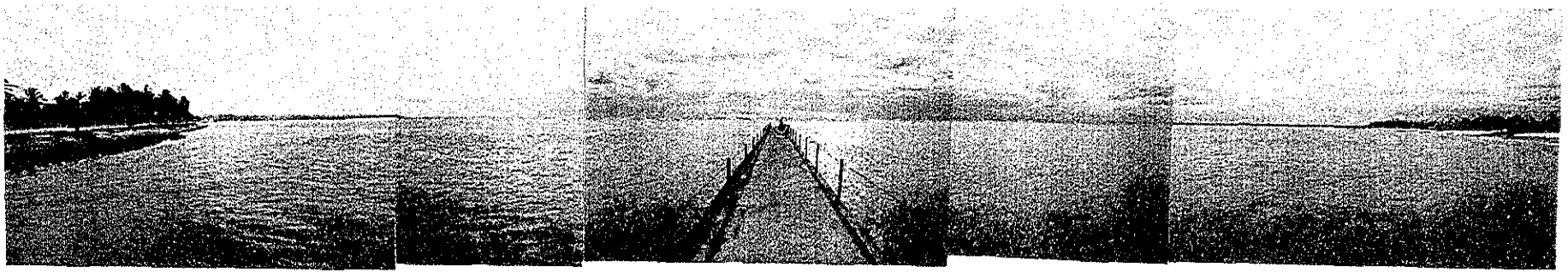


Photo. 10-3 Landscape at Present at Pertamina Cottages (2)

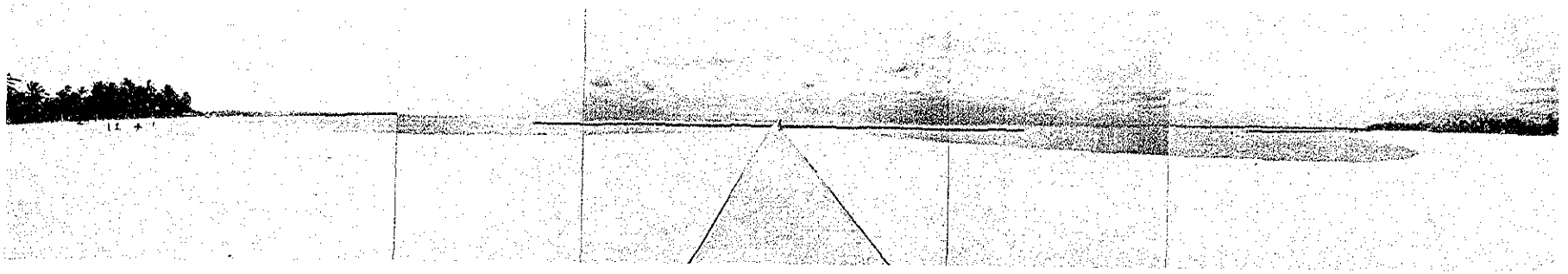


Photo. 10-4 Landscape after Development at Pertamina Cottages (2)

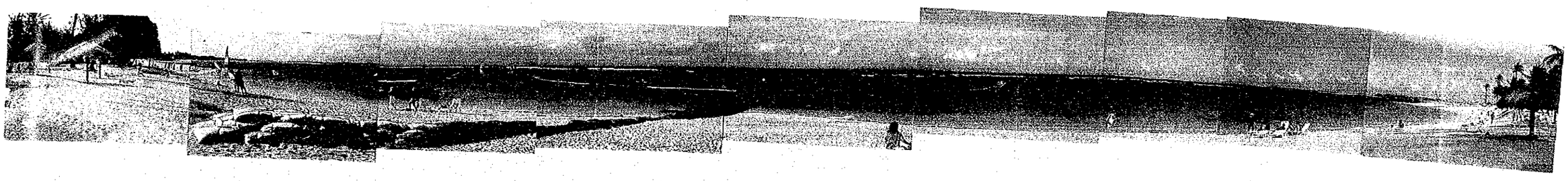


Photo. 10-5 Landscape at Present at Club Med.

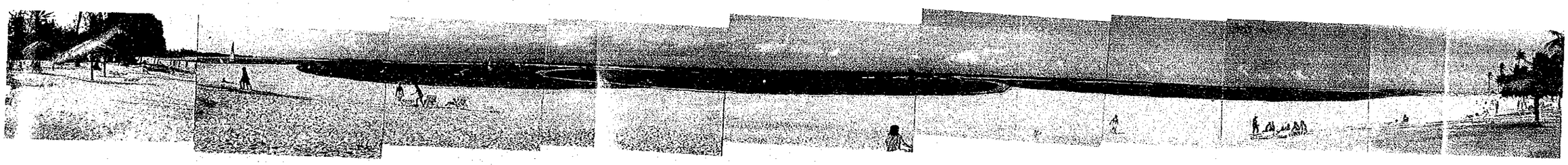


Photo. 10-6 Landscape after Development at Club Med.

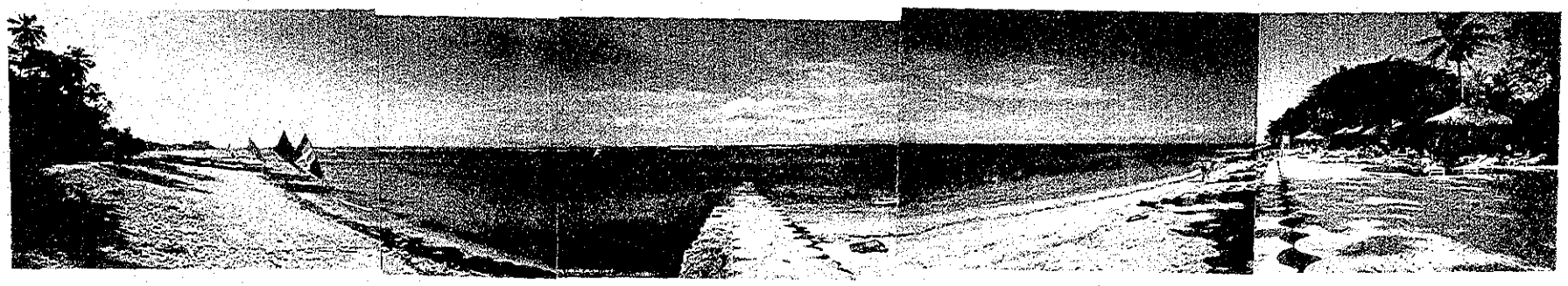


Photo. 10-7 Landscape at Present at Werdha Pura

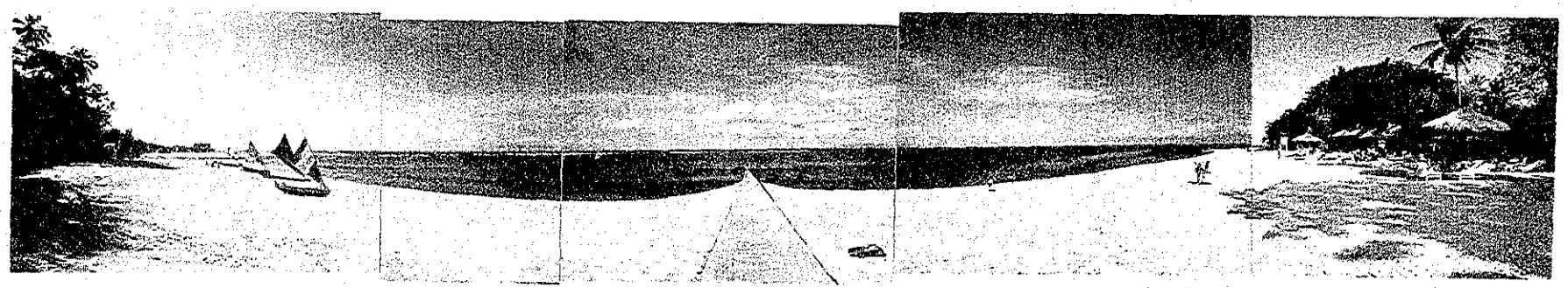


Photo. 10-8 Landscape after Development at Werdha Pura

# CHAPTER 11

# CONCLUSIONS AND RECOMMENDATIONS

# CHAPTER 11 CONCLUSIONS AND RECOMMENDATIONS

## 11-1 Conclusions

### (1) National Policy

1) Coastal erosion has advanced throughout Indonesia recently, and shore protection is now one of the main public policy issues to be successfully addressed.

2) Since the second five-year plan, 'Repelita 2', the government has noted the role of tourism in national and regional economic growth. The government also recognizes the value of tourism as an earner of foreign exchange and a labour intensive service industry. Hence, the government is promoting the development of potential tourist areas by providing basic infrastructures and general services.

### (2) Necessity of the Urgent Bali Beach Conservation Project

1) The project shall be implemented from the viewpoints of disaster prevention and economic development in accordance with the national policies. The project contributes to the protection of the assets and the conservation of the safety and security of the residents living there.

2) Bali's beaches are the main attraction for tourists going to Bali Island, and the beaches have been developed as international tourism points.

However, unfortunately, the magnitude of the coastal erosion has increased recently, that is, the shore line has been retreating, and the beach sand has been lost. The resources for tourism have been decreased and the environment is deteriorating.

Therefore, countermeasures to the erosion are needed on an urgent basis.

3) The beaches of Bali have also been used as a charming domestic resort for the Indonesian people traditionally. The demand of

domestic tourists seems likely to increase in the future following the gradual increase in personal income.

Efforts shall also be made to cater to 'day-trip' or 'short-stay' domestic tourists by the provision of comfortable beaches.

(3) Goals of the Project

1) The target year

The target year of the project is set as 1995, as early as possible, considering the present condition of the proceeding erosion.

2) Conservation areas

The urgent conservation areas are determined appraising the following items: the magnitude of erosion, beach use, the present hinterland use, land use plans, and the profitability of the project.

(4) Urgent Plan

In this project, the sand nourishment is planned as the minimum required width and length to protect the existing structures along the coastline from collapse and to protect property from scouring due to wave actions. Sand fill will be protected by artificial structures such as groins.

The urgent plan for the three beaches is summarized as follows.

1) Kuta beach

The basic concept of the Kuta beach conservation plan is to recover the lost beach by sand nourishment up to a minimum width of 50 m, and to maintain the beach by a series of headlands.

- Sand nourishment

  Location : from Pertamina Cottages to Kuta Sea View Cottages

  Scale : beach length, 2.7 km

  beach width, average 50 m

  Sand volume: 783,000 $m^3$

- Groins

  4 sets of headlands using T-shaped groins are planned to stabilize the filled sand and to form pocket beaches between these headlands by reducing the wave impact. 1 small groin is

planned to maintain the filled sand at the northern end of the sand nourished area.

2) Nusa Dua beach

In order to reduce the erosion and to maintain this beach in good condition for conservation and touristic use, the sand nourishment and countermeasures are planned as follows.

- Sand nourishment

  Location : from Club Med. Hotel to Nusa Besar

  Scale : beach length, 2.35 km
  beach width, average 50 m

  Sand volume: 229,000 $m^3$

- Extension of existing facilities

  Extensions of the existing U-shaped offshore breakwater and of the existing groin are planned.

- Modification of existing offshore brerakwater

  The height of the existing offshore breakwater will be lowered to mean sea water level, the same level as the existing U-shaped breakwater.

3) Sanur beach

The basic concept of the beach conservation plan is to recover and develop the lost beach by nourishment up to 50 m of Beach width and to maintain it by a series of headlands.

- Sand nourishment

  Location : (1) ..from Bali Beach Hotel Pier to 700 m North
  (2) ..from Sindhu Hotel to Sanur Beach Hotel

  Scale : (i) ..beach length, 0.7 km
  beach width, average 30 m
  (2) ..beach length, 4 km
  beach width, average 30 m

  Sand volume: (1) .. 96,000 $m^3$
  (2) ..352,000 $m^3$

- Groins
  〔1〕..In the northern area, an L-shaped groin and a straight groin are planned.
  〔2〕..In the southern area, 3 sets of headlands are planned. In the middle area, 3 sets of groins are planned to stabilize the filled sand.
- Submerged offshore breakwater
  A submerged offshore breakwater is planned at the coral reef gap to reduce the wave impact against the beach and to stabilize the filled sand.

4) Tanah Lot

The existing conservation plan using armor stones and concrete blocks around the island is suitable in order to protect the island from erosion by waves.

(5) Construction

1) Work Schedule

The formalities of this project from the preparation of the general agreement between the Indonesian Government and the donor government through the completion of the urgent construction works are planned as follows.

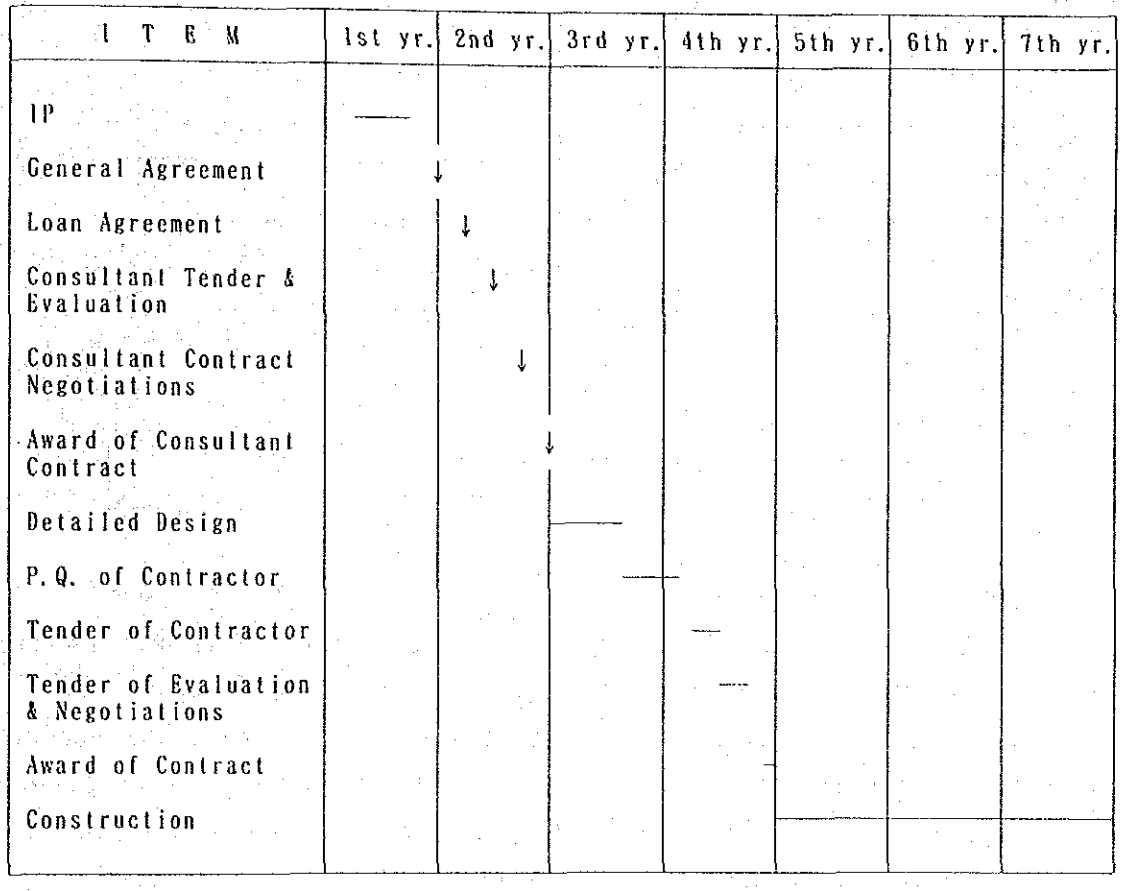



Fig. 11-1-1 Work Schedule for Project Implementation

2) Project Cost

Project cost is estimated as follows at 1988 prices based on a one-contract method.

Table 11-1-2 Project Cost (One-Contract Method)

1988 prices

| Description | Cost | | | Remarks |
|---|---|---|---|---|
| | L.C ($10^3$Rp) | F.C ($10^3$¥) | Total ($10^3$Rp) | |
| 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 | |

(6) Economic Analysis

The economic analysis examines the economic viability of the project based on the economic benefit and the economic cost of the project from the viewpoint of its contribution to the national economy. The analysis identifies the primary benefit of the project as the difference in tourist revenues under the "with the project" and the "without the project" cases.

The viability is checked by the Internal Rate of Return (IRR), the benefit cost ratio (B/C) and the Net Preset value (NPV). The IRR of the project is 29.5% under the one-contract method. All the calculated economic indices show unusually high values, proving that the inveestment is highly efficient, and of great value to the national economy.

Furthermore, the sensitivity analysis proves that the investment is viable, even when the costs increase 20% and the benefits decrease 20% simultaneously.

## 11-2 Recommendations

The following recommendations are proposed concerning various matters which were noticed while conducting the Study.

(1) The beaches of the study areas are seriously eroded and this project should be started as soon as possible.

1) According to the Interview Survey of the tourists at Kuta Beach, 80% of them were unsatisfied or disappointed due to the narrow beach width and beach erosion. Once the worldwide reputation of Bali Beach is lost, it will be difficult to recover.

2) The delay of implementation will cause a further loss of sand and consequently additional cost would be required.

3) The IRR is very high, so this project is very feasible from the economic point of view.

(2) Determination of the urgent conservation project, fund raising plan, detailed design and construction should be carried out based on this study.

(3) At present, there is no one organization which comprerhensively administrates and operates the coastal area. So, there are some difficulties with the protection and conservation of the coastal area as a whole.

The coastal area must be well administered in order to protect the area from disasters and to maintain a good environment.

Preparation of law/regulation is urgently necessary. An administrator must be designated by law to administer all aspects of the coastal area.

The main roles of the administrator shall be as follows.

1) To collect the basic data such as oceanography, hydraugraphy and topography.
2) To protect the coastal area from disasters such as coastal

erosion, high tide, tsunami and hurricane.

3) To maintain the coastal facilities in good condition.
4) To restrict actions which may adversely affect the area.

(4) Since this project is of a very large scale and should be completed within three years, numbers of staff members shall be very large and the organization shall be managed effectively.

The staff members, especially the engineers, must be well trained and experienced because this project is the first large-scale coastal erosion prevention project to be carried out by the Government of Indonesia.

(5) An operation and maintenance office shall be necessary after the completion of the project works.

The role of operation and maintenance office is to maintain the beach, and the main items are as follows.

1) To control coral mining and sand removal from the beach.
2) To restrict actions which may adversely affect the beach.
3) To carry out topographical surveys along the beach and on the reef every year.
4) To nourish supplemental sand if necessary.

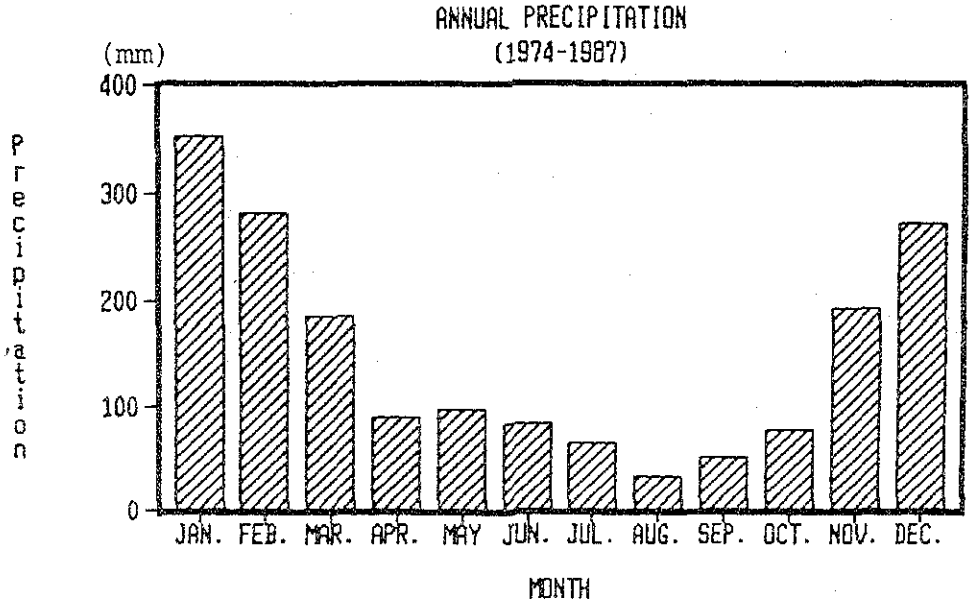
(6) The reef mining is not desirable, because the wave height on the reef would increase much more than without reef mining.

(7) The execution of the project works should be executed based upon the proposed work schedule in order to complete the construction of the facilities within three years.

(8) The construction works of the project should be executed in such a way that the regular tourist activities are not disturbed.

(9) The construction works of the project should be implemented considering the protection of the excellent natural condition and the conservation of traditional, historical and cultural resources in the project areas.

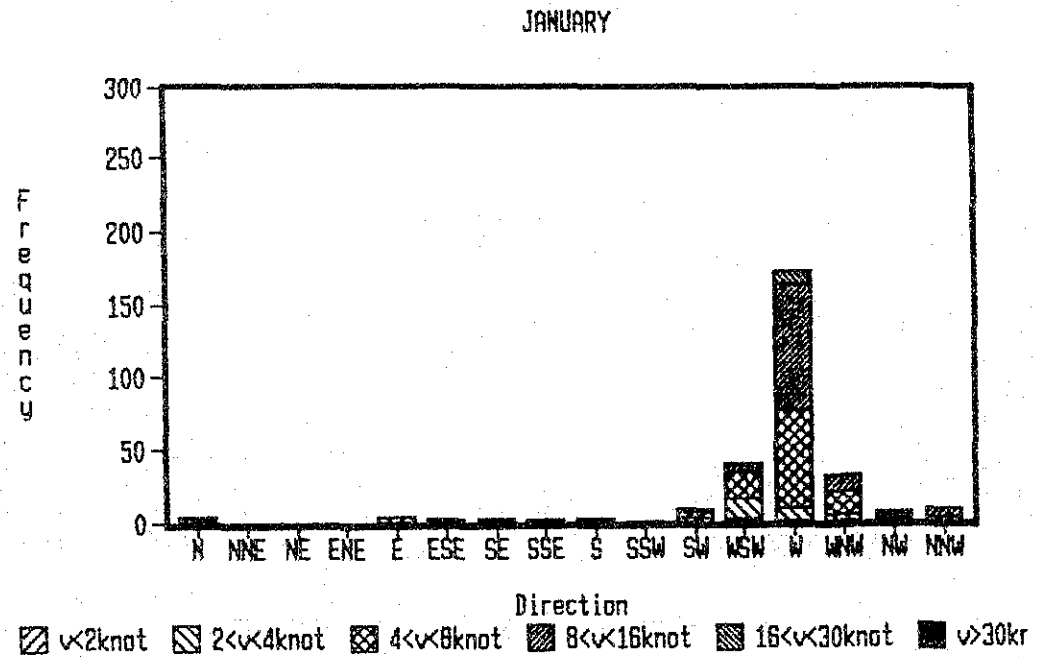
# APPENDICES




(mm)

| | JAN. | FEB. | MAR. | APR. | MAY | JUN. | JUL. | AUG. | SEP. | OCT. | NOV. | DEC. | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | 400 | 258.2 | 39.2 | 2.8 | 75.2 | 73.4 | 140.4 | 10.2 | 2.1 | 0.6 | 197.1 | 355.8 | 129.6 |
| 1986 | 407.1 | 256.5 | 62.2 | 138.1 | 35 | 72.7 | 7.6 | 72.5 | 52.6 | 8.5 | 231.5 | 159.6 | 125.3 |
| 1985 | 221.1 | 336.3 | 260.6 | 32.2 | 11.4 | 116 | 224.5 | 21.6 | 7.8 | 7.4 | 239.4 | 134 | 134.4 |
| 1984 | 461.3 | 430 | 706.4 | 84.2 | 169.3 | 18.7 | 51.5 | 61.1 | 165.2 | 77.8 | 114.9 | 362.2 | 225.2 |
| 1983 | 305 | 87.9 | 134 | 178.8 | 290.1 | 2.7 | 44.8 | 0.8 | 2.7 | 138.3 | 320.8 | 456.3 | 163.5 |
| 1982 | 334.5 | 195.2 | 130.5 | 164.2 | 2.4 | 0.8 | 0 | 5.2 | 0 | 0.9 | 7.5 | 52.2 | 74.5 |
| 1981 | 617.2 | 293.3 | 30.7 | 7.3 | 62.8 | 115.5 | 327.2 | 39.8 | 89.8 | 78.6 | 360.6 | 355.3 | 198.2 |
| 1980 | 309.3 | 186.4 | 145.9 | 162.6 | 2.5 | 7.4 | 34.5 | 3.4 | 1 | 11 | 75.6 | 455 | 116.2 |
| 1979 | 352.6 | 109 | 205.6 | 1.2 | 349.4 | 122.6 | 4.8 | 1.9 | 23.5 | 56.4 | 16.5 | 159.5 | 116.9 |
| 1978 | 433.4 | 222.5 | 115.6 | 68.2 | 185.7 | 247.5 | 55.4 | 136.4 | 157.4 | 42.3 | 166.9 | 340.4 | 181 |
| 1977 | 390.5 | 433.5 | 211.1 | 31.5 | 26.6 | 5.2 | 0.2 | 0 | 26.6 | 7.6 | 0.7 | 275.3 | 117.4 |
| 1976 | 335.2 | 118.8 | 149.7 | 20.8 | 13.8 | 335.2 | 6.3 | 0 | 0 | 44.6 | 97.2 | 127.4 | 104.1 |
| 1975 | 172.5 | 653.2 | 205.3 | 337.6 | 61.4 | 5 | 8.8 | 84.4 | 49.2 | 263.6 | 402.3 | 302.7 | 212.2 |
| 1974 | 178.5 | 342.3 | 194 | 22.5 | 76.6 | 61.1 | 0 | 17 | 151.7 | 348 | 449.1 | 258.8 | 175 |
| ANNUAL | 351.3 | 280.2 | 185.1 | 89.4 | 97.3 | 84.6 | 64.7 | 32.5 | 52.1 | 77.5 | 191.4 | 271 | 148.1 |
| | 117.6 | 147.6 | 164.7 | 96.6 | 110.4 | 100.1 | 99.1 | 41.6 | 63 | 105.6 | 149.3 | 126.8 | 110.2 |

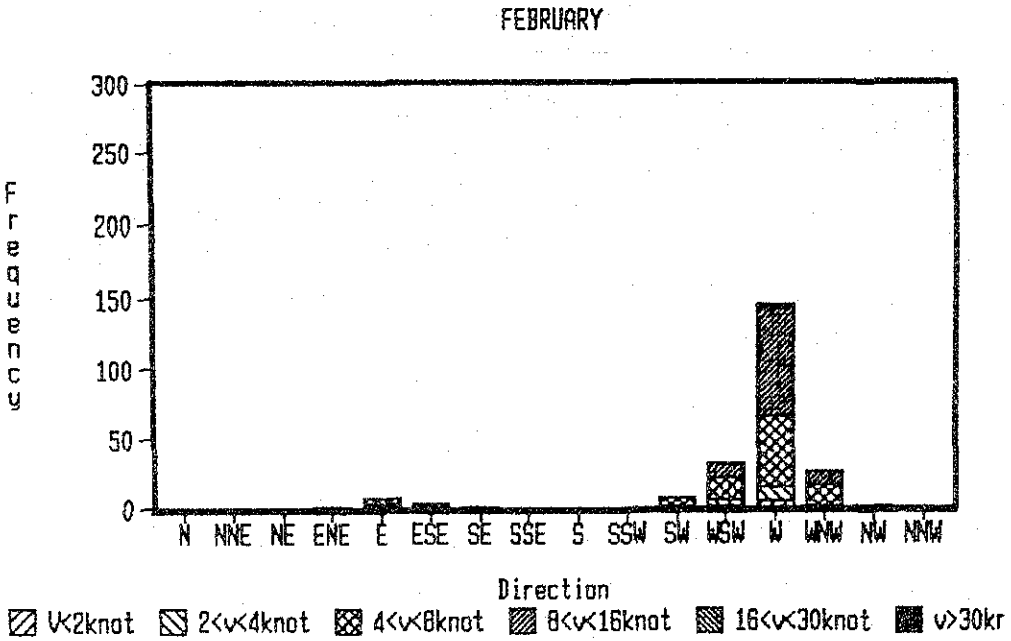
APP. Fig. 2-2-1 Annual Precipitation (1974～1987)




JANUARY

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 49 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 2 | 1 | 1 | 0 | 0 | 57 |
| 2knot<v<4knot | 75 | 0 | 0 | 0 | 0 | 3 | 1 | 2 | 2 | 2 | 0 | 3 | 14 | 9 | 4 | 0 | 0 | 115 |
| 4knot<v<8knot | 24 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 4 | 18 | 66 | 16 | 2 | 3 | 135 |
| 8knot<v<16knot | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 88 | 11 | 4 | 5 | 118 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 9 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 148 | 4 | 0 | 0 | 0 | 4 | 3 | 3 | 2 | 3 | 1 | 8 | 39 | 173 | 32 | 6 | 8 | 434 |

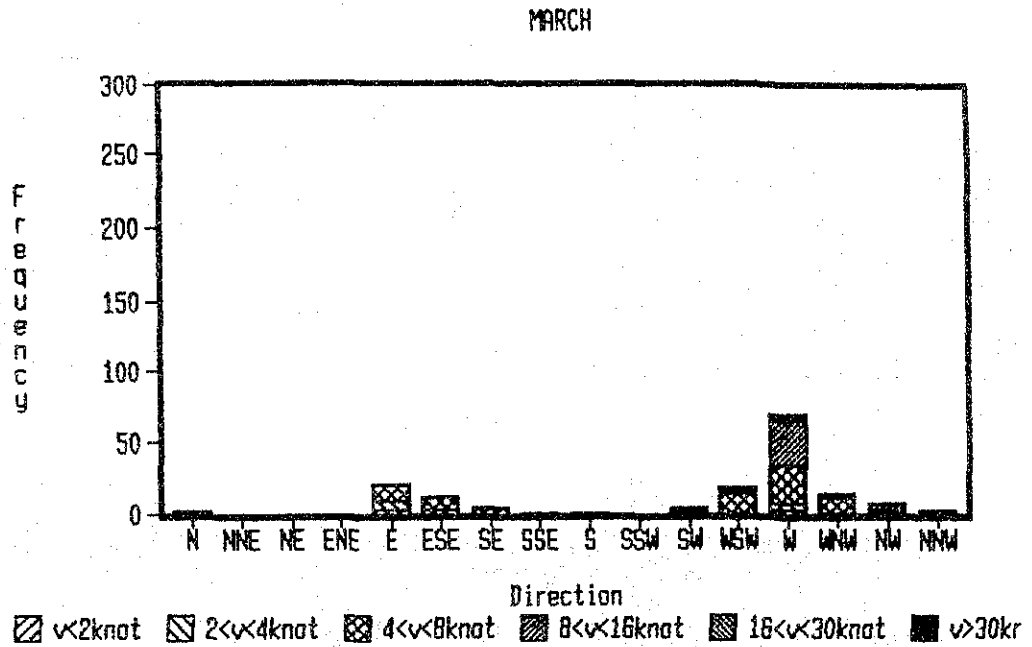
APP. Fig. 2-2-2 (1) Wind Frequency




FEBRUARY

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 68 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 76 |
| 2knot<v<4knot | 92 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 4 | 10 | 1 | 1 | 0 | 113 |
| 4knot<v<8knot | 16 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 5 | 16 | 51 | 14 | 0 | 0 | 106 |
| 8knot<v<16knot | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 77 | 10 | 0 | 0 | 98 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 177 | 0 | 0 | 0 | 1 | 6 | 3 | 1 | 0 | 0 | 0 | 6 | 31 | 144 | 25 | 1 | 0 | 395 |

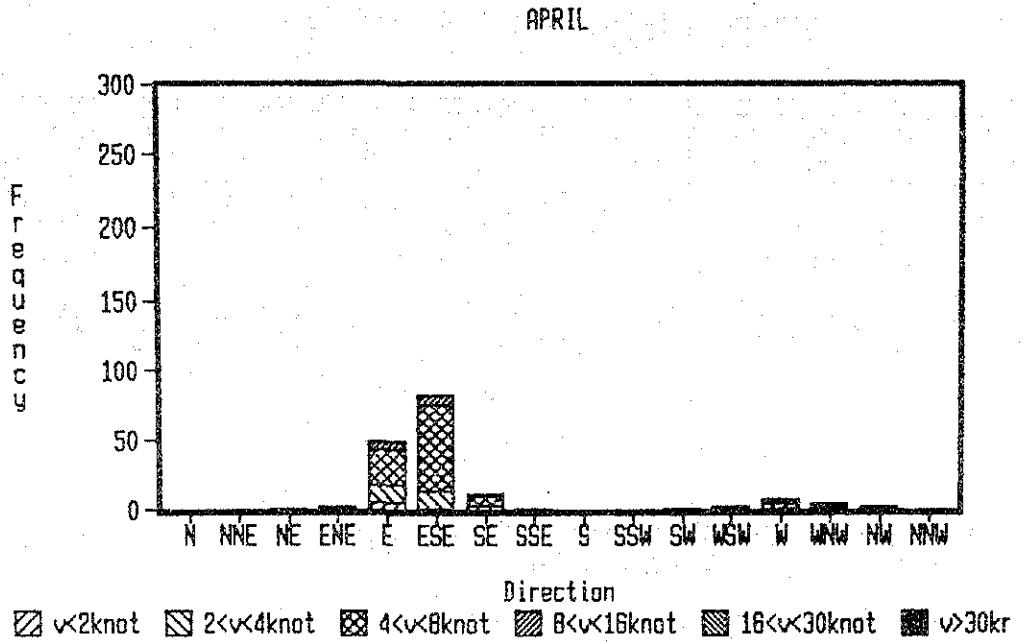
APP. Fig. 2-2-2 (2) Wind Frequency




MARCH

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 128 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 134 |
| 2knot<v<4knot | 135 | 0 | 0 | 0 | 0 | 5 | 3 | 0 | 0 | 1 | 0 | 2 | 0 | 4 | 1 | 1 | 1 | 153 |
| 4knot<v<8knot | 16 | 0 | 0 | 0 | 0 | 11 | 8 | 4 | 1 | 0 | 0 | 1 | 14 | 25 | 10 | 2 | 2 | 94 |
| 8knot<v<16knot | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 4 | 32 | 3 | 4 | 0 | 49 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 4 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 280 | 2 | 0 | 0 | 0 | 20 | 12 | 4 | 1 | 1 | 0 | 4 | 18 | 68 | 14 | 7 | 3 | 434 |

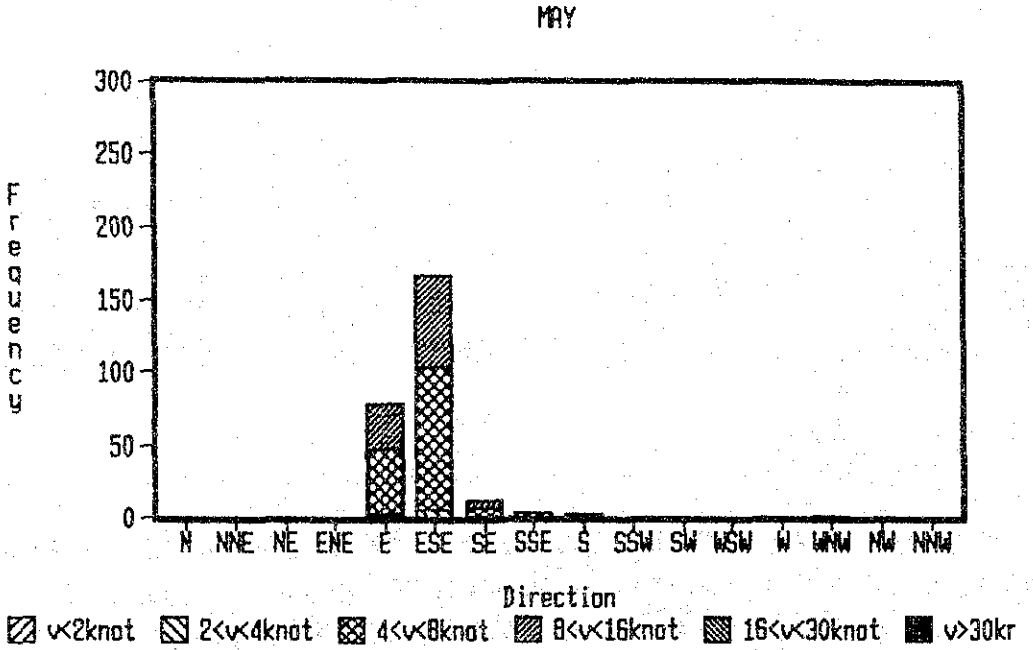
APP. Fig. 2-2-2 (3) Wind Frequency




APRIL

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 83 | 0 | 0 | 0 | 0 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 91 |
| 2knot<v<4knot | 131 | 0 | 0 | 0 | 0 | 12 | 12 | 3 | 0 | 0 | 0 | 0 | 1 | 3 | 2 | 1 | 0 | 165 |
| 4knot<v<8knot | 43 | 0 | 0 | 0 | 1 | 26 | 62 | 7 | 1 | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 0 | 147 |
| 8knot<v<16knot | 0 | 0 | 0 | 1 | 1 | 6 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 17 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 257 | 0 | 0 | 1 | 2 | 50 | 82 | 11 | 1 | 0 | 0 | 1 | 2 | 7 | 4 | 2 | 0 | 420 |

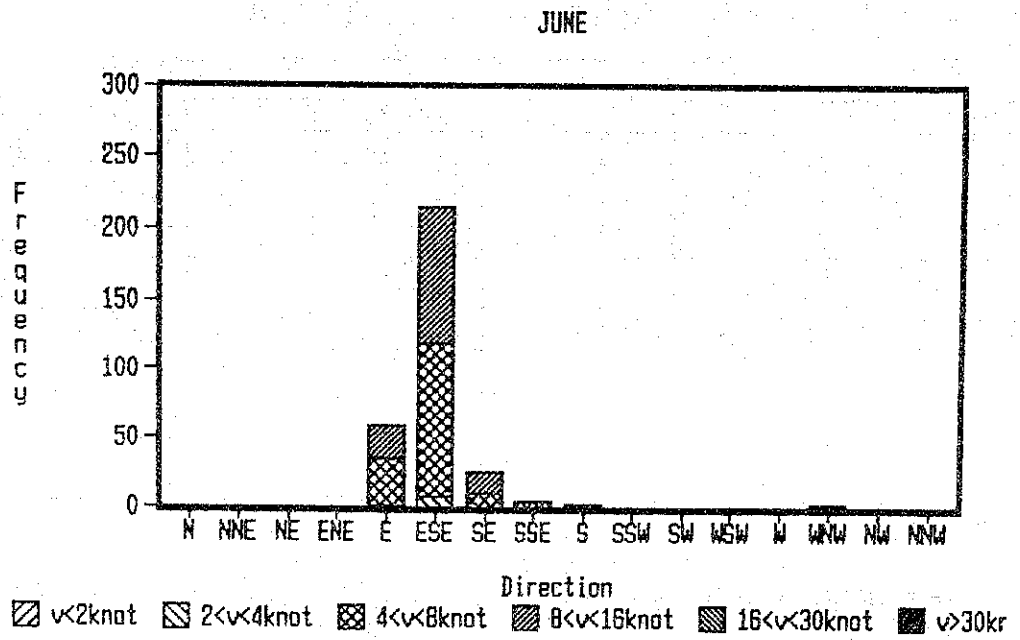
APP. Fig. 2-2-2 (4) Wind Frequency




MAY

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 38 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 |
| 2knot<v<4knot | 104 | 0 | 0 | 0 | 0 | 2 | 5 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 113 |
| 4knot<v<8knot | 33 | 0 | 0 | 0 | 0 | 44 | 97 | 5 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 182 |
| 8knot<v<16knot | 0 | 0 | 0 | 0 | 0 | 30 | 63 | 5 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 100 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 175 | 0 | 0 | 0 | 0 | 77 | 165 | 11 | 3 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 434 |

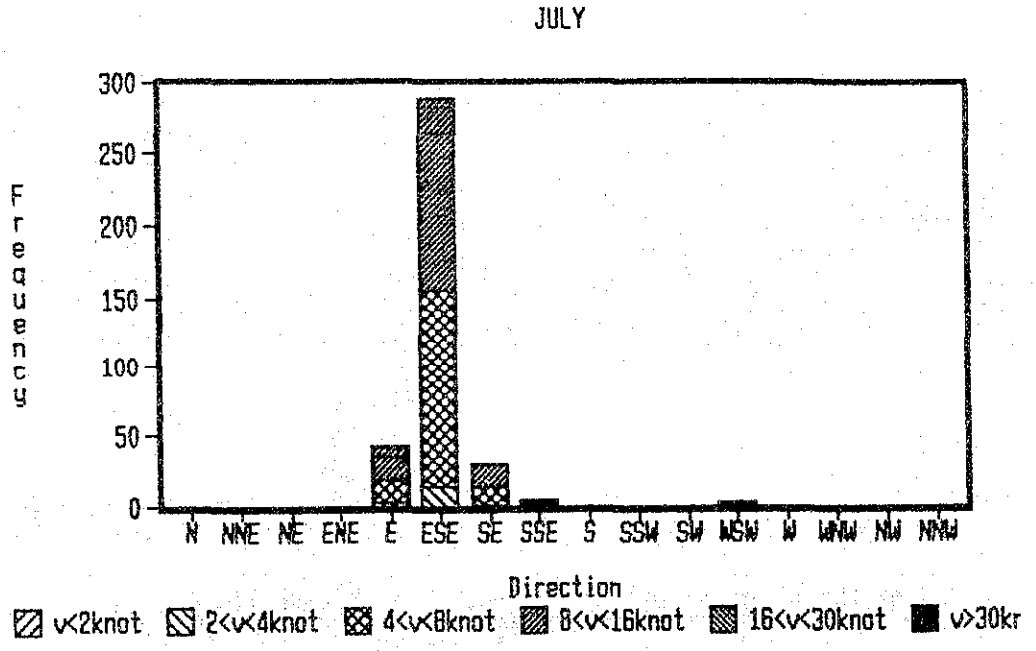
APP. Fig. 2-2-2 (5) Wind Frequency




JUNE

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 36 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 |
| 2knot<v<4knot | 58 | 0 | 0 | 0 | 0 | 1 | 8 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 69 |
| 4knot<v<8knot | 19 | 0 | 0 | 0 | 0 | 33 | 111 | 10 | 4 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 179 |
| 8knot<v<16knot | 0 | 0 | 0 | 0 | 0 | 24 | 97 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 136 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 113 | 0 | 0 | 0 | 0 | 58 | 216 | 25 | 4 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 420 |

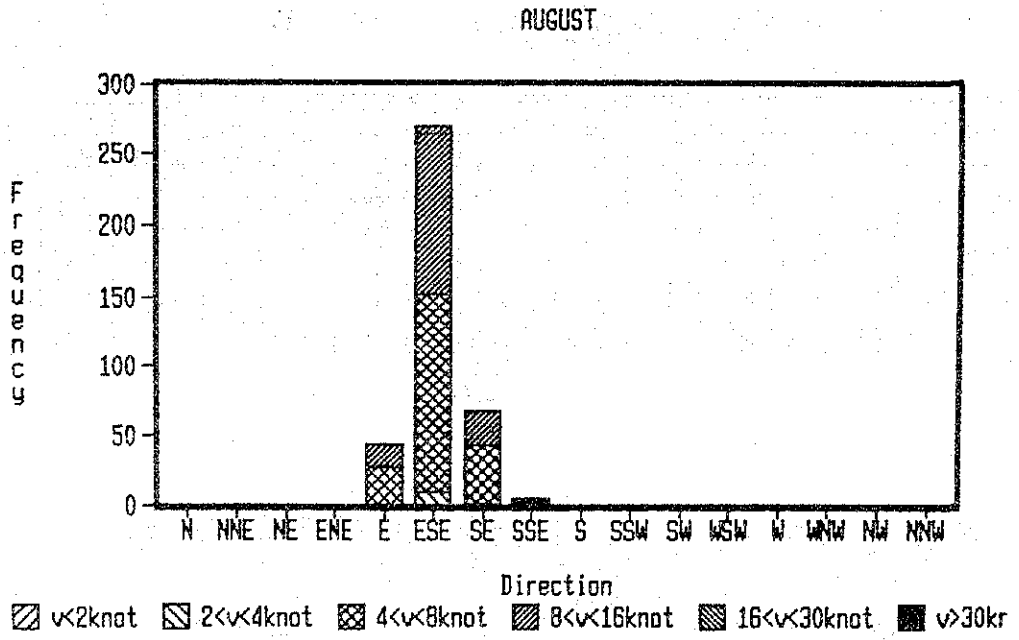
APP. Fig. 2-2-2 (6) Wind Frequency




JULY

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 |
| 2knot<v<4knot | 29 | 0 | 0 | 0 | 0 | 3 | 14 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 50 |
| 4knot<v<8knot | 22 | 0 | 0 | 0 | 0 | 16 | 141 | 13 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 195 |
| 8knot<v<16knot | 0 | 0 | 0 | 0 | 0 | 23 | 134 | 15 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 173 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 67 | 0 | 0 | 0 | 0 | 42 | 289 | 29 | 4 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 434 |

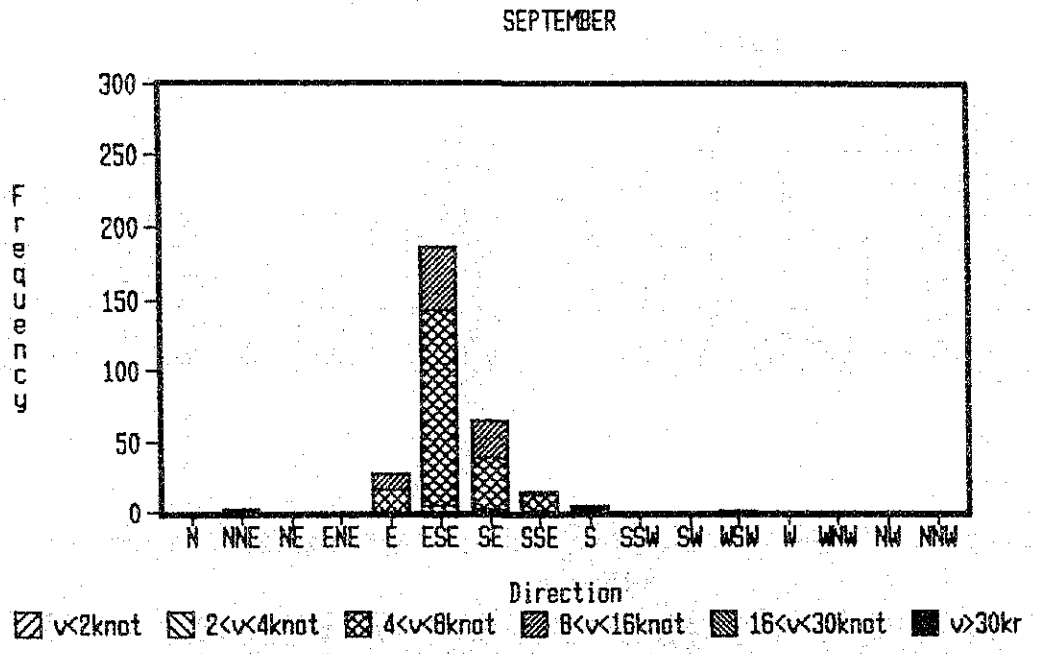
APP. Fig. 2-2-2 (7) Wind Frequency




AUGUST

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |
| 2knot<v<4knot | 32 | 0 | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 |
| 4knot<v<8knot | 11 | 0 | 0 | 0 | 0 | 27 | 143 | 41 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 224 |
| 8knot<v<16knot | 0 | 0 | 0 | 0 | 0 | 17 | 118 | 24 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 161 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 50 | 0 | 0 | 0 | 0 | 44 | 270 | 66 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 434 |

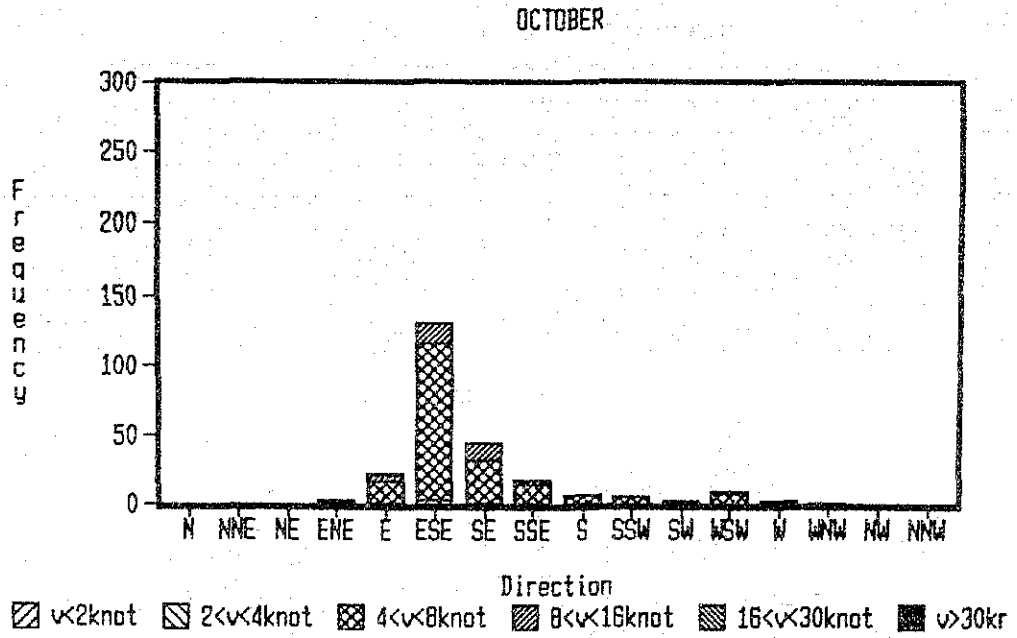
APP. Fig. 2-2-2 (8) Wind Frequency




SEPTEMBER

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| 2knot<v<4knot | 72 | 0 | 0 | 0 | 0 | 0 | 4 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 81 |
| 4knot<v<8knot | 36 | 0 | 1 | 0 | 0 | 15 | 138 | 37 | 11 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 240 |
| 8knot<v<16knot | 0 | 0 | 1 | 0 | 0 | 12 | 44 | 25 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 85 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 122 | 0 | 2 | 0 | 0 | 27 | 186 | 64 | 14 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 420 |

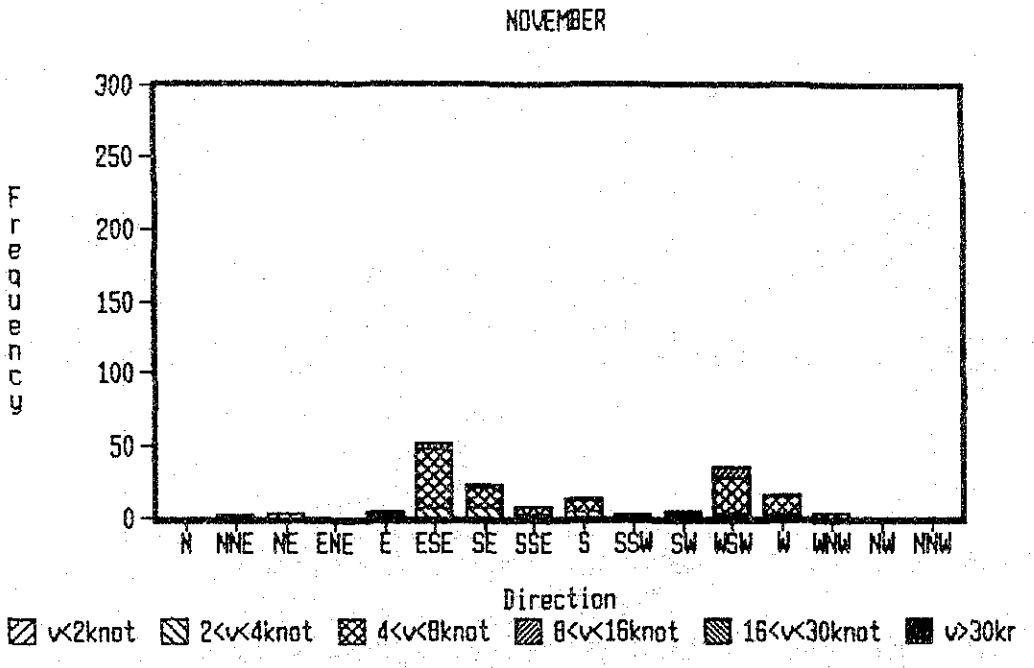
APP. Fig. 2-2-2 (9) Wind Frequency




OCTOBER

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 |
| 2knot<v<4knot | 122 | 0 | 0 | 0 | 1 | 1 | 3 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 130 |
| 4knot<v<8knot | 38 | 0 | 0 | 0 | 2 | 15 | 113 | 31 | 13 | 5 | 5 | 2 | 8 | 1 | 1 | 0 | 0 | 234 |
| 8knot<v<16knot | 0 | 0 | 0 | 0 | 0 | 5 | 14 | 12 | 3 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 36 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 194 | 0 | 0 | 0 | 3 | 21 | 130 | 44 | 17 | 6 | 5 | 2 | 9 | 2 | 1 | 0 | 0 | 434 |

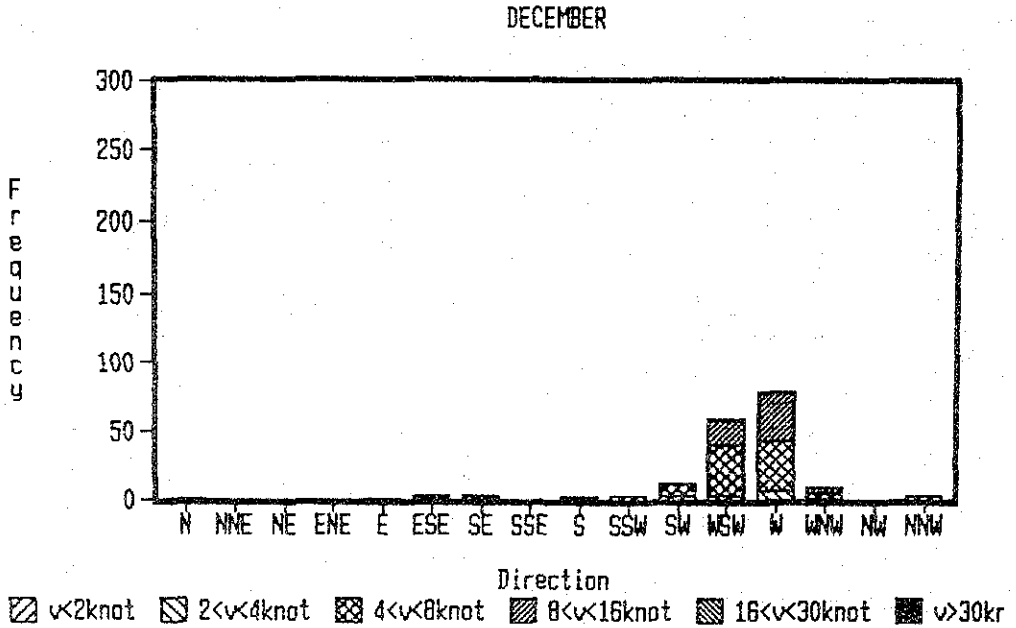
APP. Fig. 2-2-2 (10) Wind Frequency




NOVEMBER

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 65 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 67 |
| 2knot<v<4knot | 156 | 0 | 0 | 3 | 0 | 2 | 7 | 7 | 2 | 4 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 187 |
| 4knot<v<8knot | 36 | 0 | 1 | 0 | 0 | 2 | 41 | 14 | 6 | 8 | 1 | 2 | 24 | 12 | 3 | 0 | 0 | 150 |
| 8knot<v<16knot | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 2 | 0 | 1 | 0 | 0 | 8 | 1 | 0 | 0 | 0 | 16 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 257 | 0 | 2 | 3 | 0 | 4 | 51 | 23 | 8 | 13 | 2 | 4 | 35 | 15 | 3 | 0 | 0 | 420 |

APP. Fig. 2-2-2 (1) Wind Frequency




DECEMBER

| | Calm | N | NNE | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | W | WNW | NW | NNW | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| v<2knot | 104 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 104 |
| 2knot<v<4knot | 129 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 0 | 3 | 3 | 7 | 1 | 0 | 0 | 148 |
| 4knot<v<8knot | 27 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 3 | 8 | 37 | 37 | 4 | 0 | 3 | 124 |
| 8knot<v<16knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 18 | 34 | 3 | 0 | 0 | 56 |
| 16knot<v<30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| v>30knot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 260 | 1 | 0 | 0 | 0 | 1 | 3 | 3 | 0 | 2 | 3 | 12 | 59 | 79 | 8 | 0 | 3 | 434 |

APP. Fig. 2-2-2 (12) Wind Frequency

APP. 3-1-3 Reconnaissance Sheet

Table 3-1-3(1) Reconnaissance Sheet(1)

THE URGENT BALI BEACH CONSERVATION PROJECT
SHEET ON TOURIST & TOURISM SURVEY
(TOURIST)

This reconnaissance is carried out to collect the basic data on existing conditions of seashore utilization for this study.

Conducted by : Japan International Cooperation Agency

In assosiation with : Pekerjaan Umum (Public Works)

Question 1.

(1) SEX

A. Male B. Female

(2) AGE

A. Younger than 10 B. 10'S C. 20'S D. 30'S
E. 40'S F. 50'S G. Older than 60

(3) COUNTRY OF RESIDENCE

A. Asia ( ) B. Australia C. America
D. Europe ( ) E. Others ( )

(4) NATIONALITY

A. Asia ( ) B. Australia C. America
D. Europe ( ) E. Others ( )

(5) OCCUPATION/PROFESSION

( )

Question 2.

(1) HOW MANY TIMES HAVE YOU BEEN TO BALI?

A. First B. 2~4 C. More than 5

(2) PURPOSE OF VISIT BALI

A. Holiday B. Business C. Official mission
D. Others ( )

(3) INTENDED LENGTH OF STAY IN BALI

A. Within 5 days B. 6~10 days C. 11~20 days
D. Longer than 20 days

(4) ACCOMODATION IN BALI

A. Sanur B. Nusa Dua C. Kuta D. Tanah Lot
E. Denpasar F. Others

(5) DOMINANT REASON TO SELECT BALI

A. Bathing B. Surfing C. Wind Surfing
D. Diving E. Fishing F. Yachting
G. Para-sailing H. Mountaineering I. Golf
J. Touring K. Others ( )

Table 3-1-3(2) Reconnaissance Sheet(2)

Question 3.

(1) How do you think the landscape of this area?

2 1 0 -1 -2

so nice nice medium bad so bad

(2) How do you think the sea wall?

(2)-1 How do you think the existence of the sea wall?

2 1 0 -1 -2

so nice nice medium bad so bad

(2)-2 How do you think the shape of the sea wall?

2 1 0 -1 -2

so nice nice medium bad so bad

(2)-3 How do you think the colour of the sea wall?

2 1 0 -1 -2

so nice nice medium bad so bad

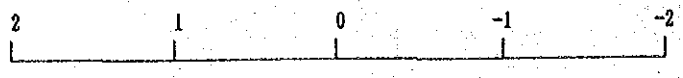
(2)-4 How do you think the decoration of the sea wall?

2 1 0 -1 -2

so nice nice medium bad so bad

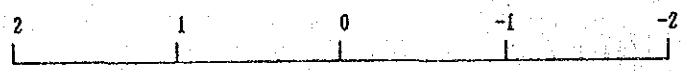
(3) How do you think the wave breaker?

(3)-1 How do you think the existence of the wave breaker?



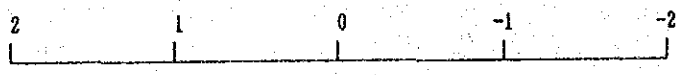

so nice nice medium bad so bad

(3)-2 How do you think the shape of the wave breaker?



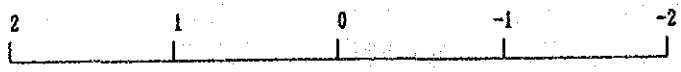

so nice nice medium bad so bad

(3)-3 How do you think the colour of the wave breaker?




so nice nice medium bad so bad

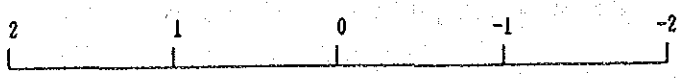
(3)-4 How do you think the decoration of the wave breaker?




so nice nice medium bad so bad

(4) How do you think the groin?

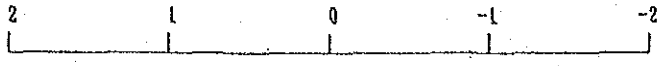
(4)-1 How do you think the existence of the groin?




so nice nice medium bad so bad

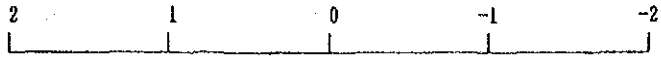
Table 3-1-3(3) Reconnaissance Sheet(3)

(4)-2 How do you think the shape of the groin?




so nice nice medium bad so bad

(4)-3 How do you think the colour of the groin?



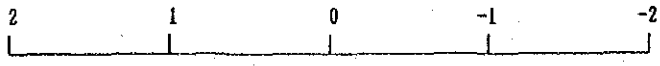

so nice nice medium bad so bad

(4)-4 How do you think the decoration of the groin?


so nice nice medium bad so bad

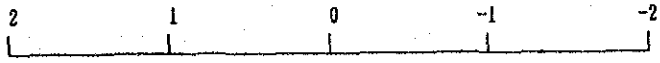
(5) How do you think the U-shaped offshore breakwater?

(5)-1 How do you think the existence of the U-shaped offshore breakwater?



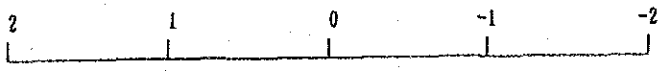

so nice nice medium bad so bad

(5)-2 How do you think the shape of the U-shaped offshore breakwater?




so nice nice medium bad so bad

(5)-3 How do you think the colour of the U-shaped offshore breakwater?



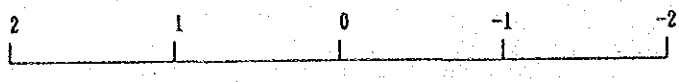

so nice nice medium bad so bad

(5)-4 How do you think the decoration of the U-shaped offshore breakwater?


so nice nice medium bad so bad

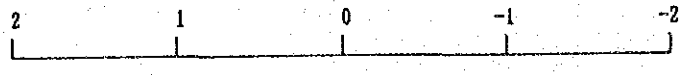
(6) How do you think the offshore breakwater?

(6)-1 How do you think the existence of the offshore breakwater?



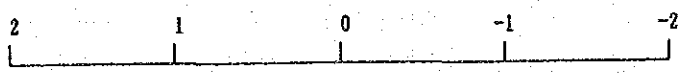

so nice nice medium bad so bad

(6)-2 How do you think the shape of the offshore breakwater?



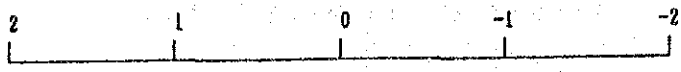

so nice nice medium bad so bad

(6)-3 How do you think the colour of the offshore breakwater?




so nice nice medium bad so bad

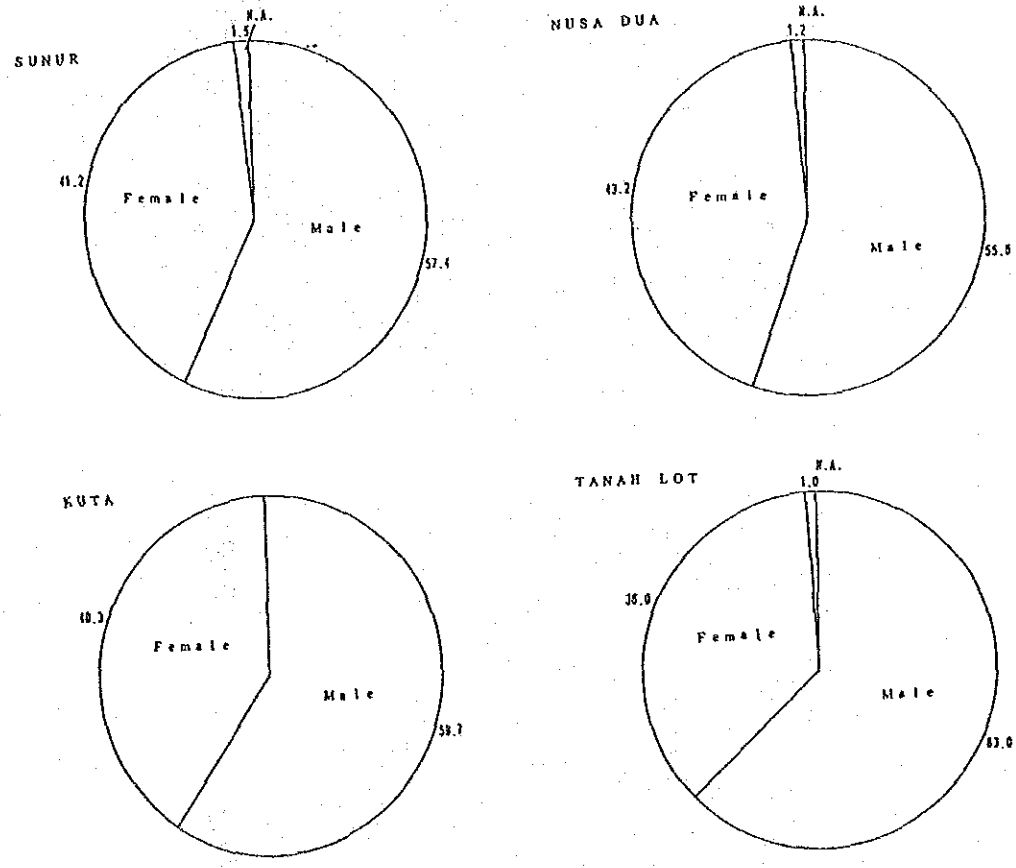
(6)-4 How do you think the decoration of the offshore breakwater?




so nice nice medium bad so bad

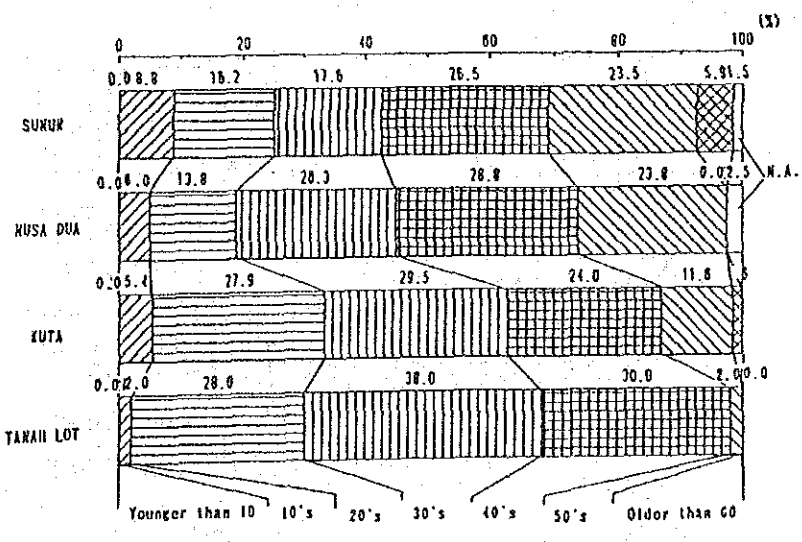
APP. Fig.3-1-3(1) Results of Reconnaissance(1)

Q. 1 (1) SEX

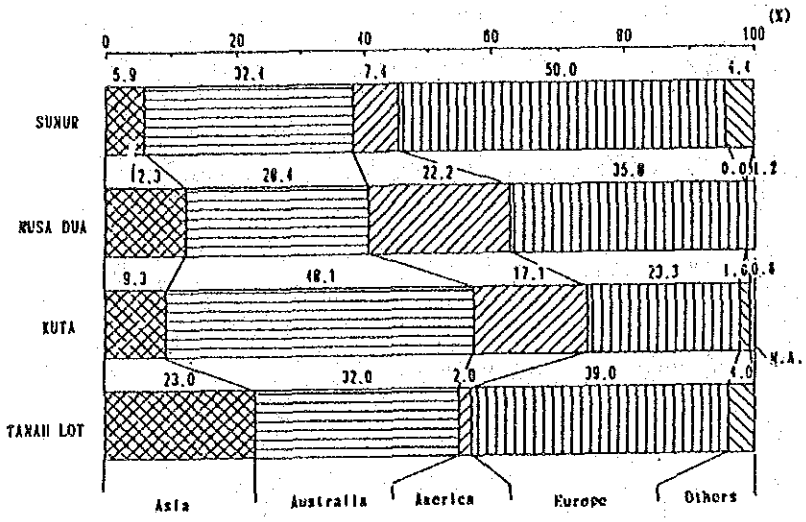



APP. Fig.3-1-3(2) Results of Reconnaissance(2)

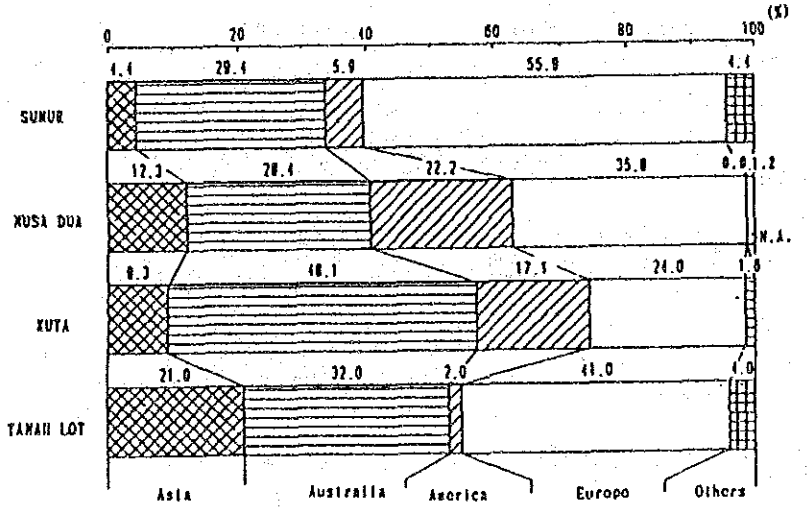
Q. 1 (2) AGE



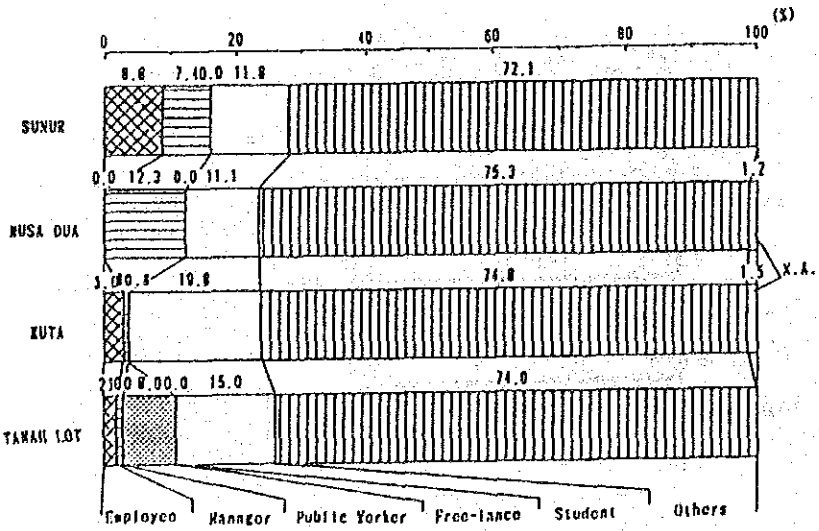
Q. 1 (3) COUNTRY OF RESIDENCE




Q. 1 (4) NATIONALITY

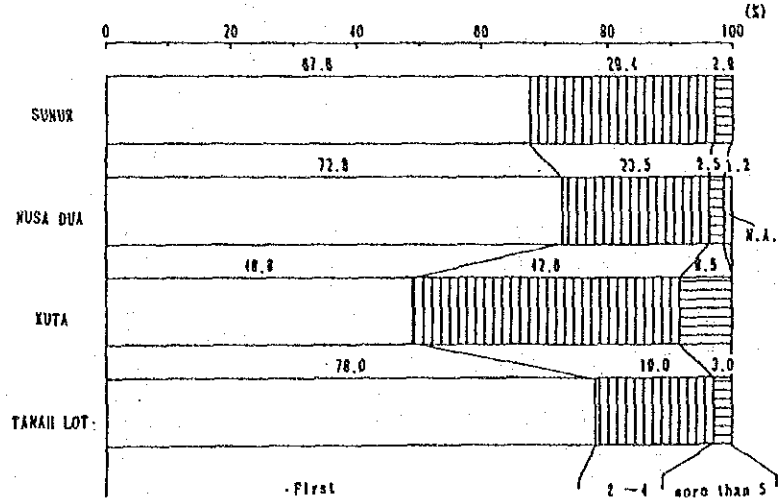



Q. 1 (5) OCCUPATION

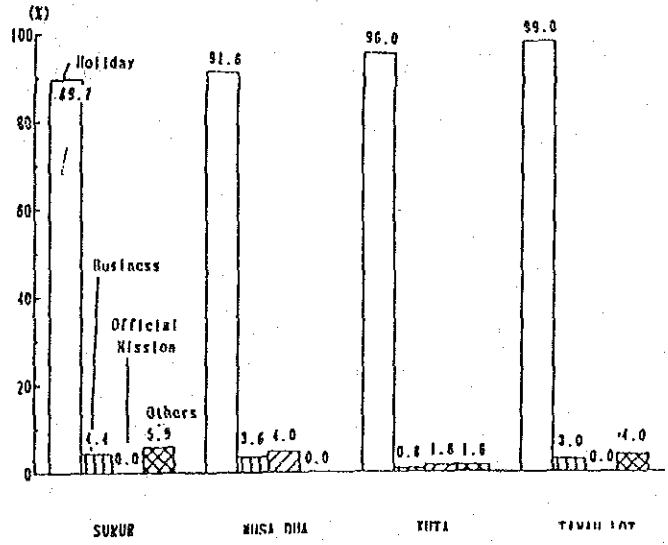


APP. Fig.3-1-3(3) Results of Reconnaissance(3)

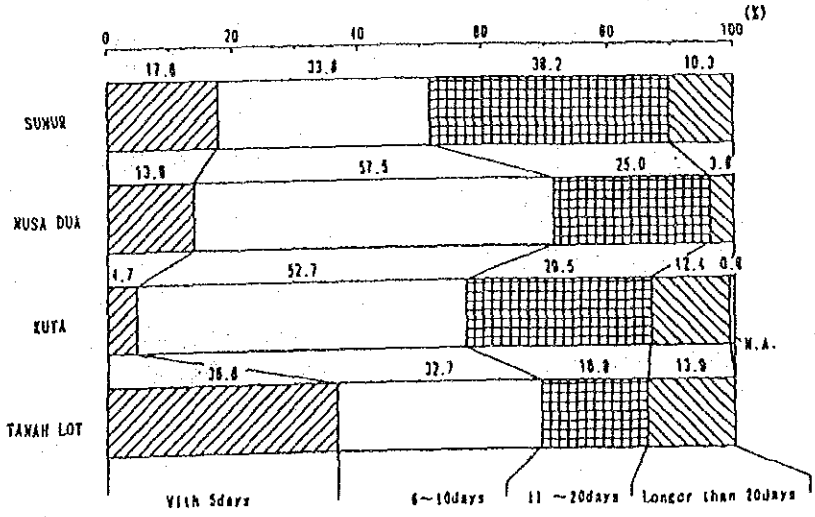
Q. 2 (1) TIMES OF VISITING BALI



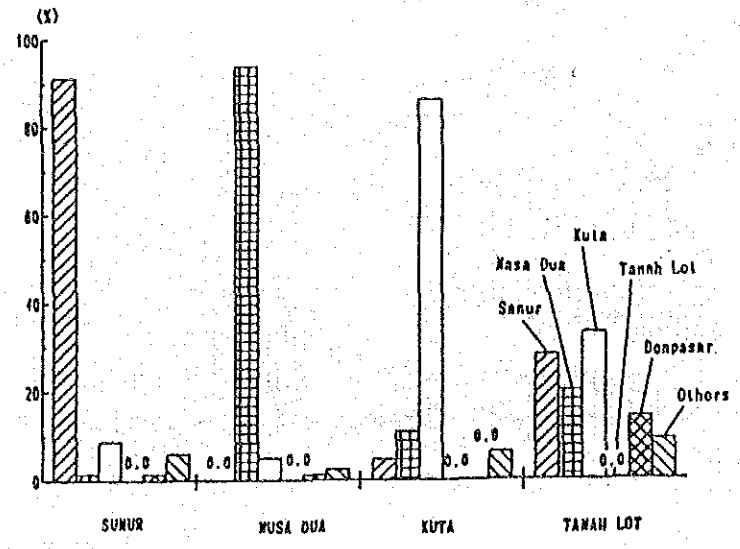

Q. 2 (2) PURPOSE OF VISITING BALI




Q. 2 (3) LENGTH OF STAYING BALI,

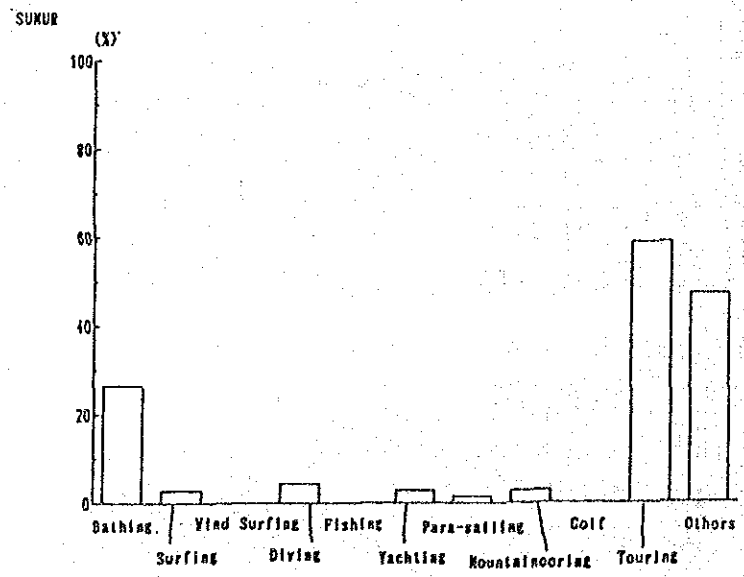


Q. 2 (4) ACCOMODATION

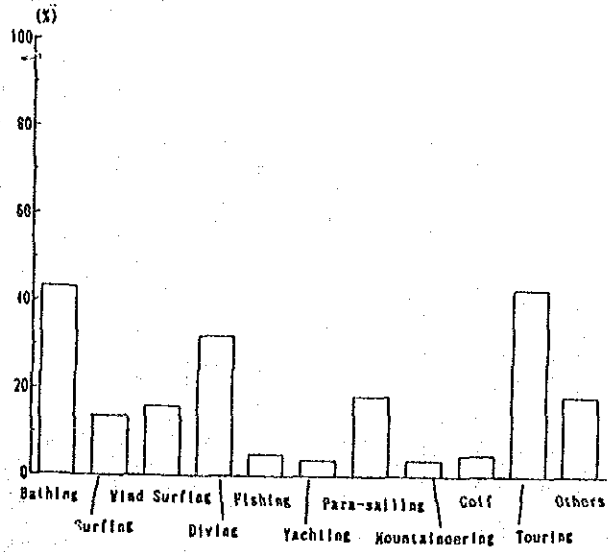



APP. Fig.3-1-3(4) Results of Reconnaissance(4)

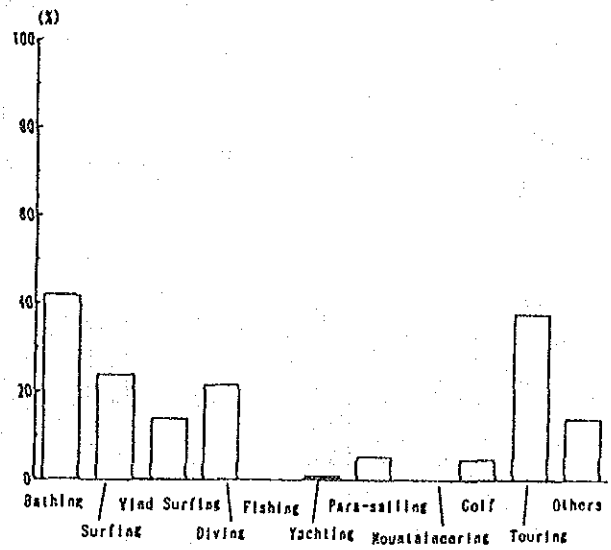
Q. 2 (5) REASON TO SELECT BALI



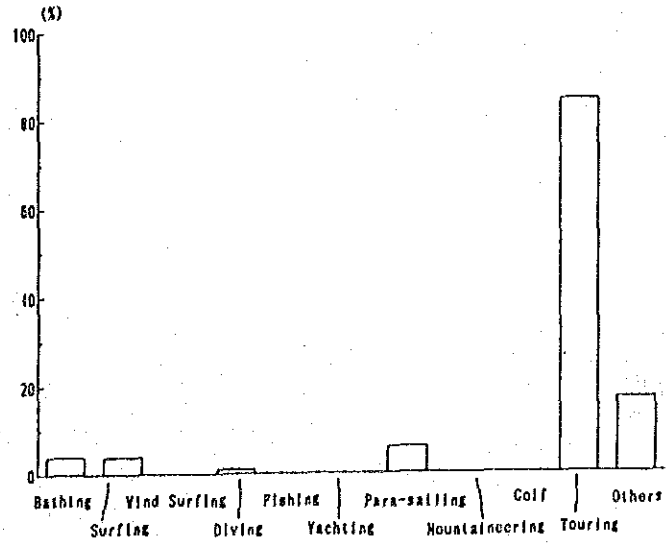
NUSA DUA




KUTA

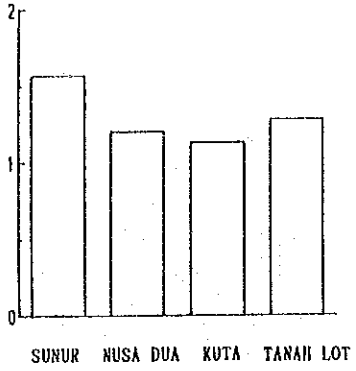


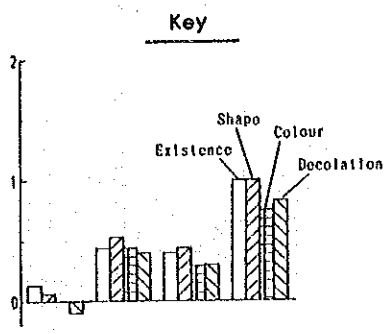

TANAH LOT



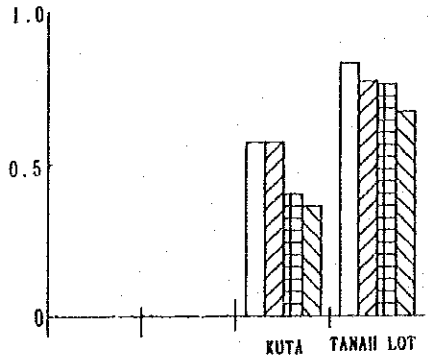
APP. Fig.3-1-3(5) Results of Reconnaissance(5)

Q.3(1) IMPRESSION OF LANDSCAPE

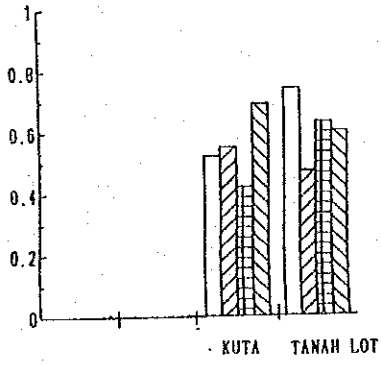


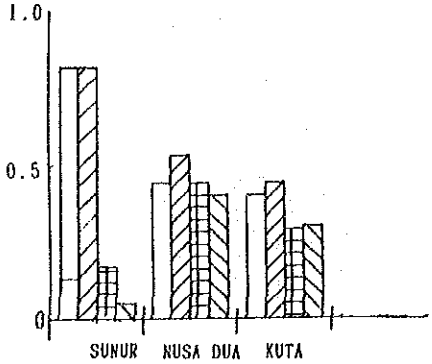

Q.3(2) SEA WALL



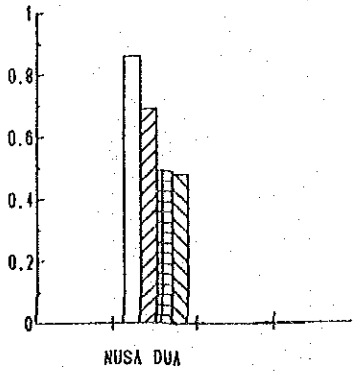

Q.3(3) WAVE BREAKER



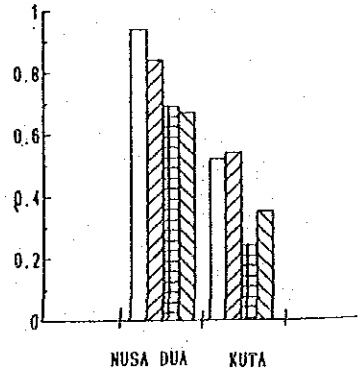

Q.3(4) GROIN




Q.3(5) U-SHAPED OFFSHORE BREAKWATER




Q.3(6) OFFSHORE BREAKWATER



| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Approx) | Remark by Observation |
|---|---|---|---|---|---|
| Groin | - | . Air Communication<br>. 1970 | . 200 m north of Air Port | . L = 60 m<br>. 4 nos of 2 tons Tetra-pod sectionally | . Buried stably in sand<br>. Tetrapods all along foot |
| | - | . Ditto<br>. 1970 | . 100 m south of Pertamina Cottage | . L = 20 m.<br>. 1 no of 2 tons tetra-pod sectionally | . Buried stably in sand<br>. tetrapods all along foot |
| | - | . Private<br>. Recently | . Northern edge of Pertamina Cottage | . L = 90 m<br>. 1 layers of concrete ① pipes | . Stable<br>. Many Tetrapods of foot |
| | - | . Ditto | . Southern edge of Santika Hotel | . L = 20 m<br>. 1 layer of concrete pipes | . Entirely collapsed<br>. Buried in sand |
| | - | . Ditto | . In fron of Kartika Plaza Hotel | . L = 20 m each at 3 lines<br>. 1 layer of concrete pipe | . Entirely collapsed<br>. Buried in sand |
| | - | . Ditto | . Northern edge of Santika Hotel | . L = 60 m<br>. Concrete pipes with concrete wall | . Entire portion damaged badly |

APP. Table 3-4-1-1 Existing Facilities ( KUTA Beach -1 )

| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Approx) | Remark by Observation |
|---|---|---|---|---|---|
| Offshore Break-water | - | • Public Works<br>• 1985 | • 300 m north of Pertamina Cottage<br>• 200 m offshore line | • L = 60 m<br>• 5 layers of concrete pipe<br>② | • Stable |
| Retaining wall | - | • Private<br>• Recently | • Infront of Pertamina Cottage | • L = 200 m<br>• Concrete wall | • Stable |
| | - | • Privately | • In front of Kartika Plaza Hotel | • L = 150 m<br>• Concrete pipe | • Entirely collapsed<br>• Buried in sand |
| Sand Nourishment | | Nil by Public Works | | | |

APP. Table 3-4-1-2 Existing Facilities ( KUTA Beach -2 )

| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Approx) | Remark by Observation |
|---|---|---|---|---|---|
| Groin | - | • Private<br>• Recently | • In front of Bali Sol Hotel | • L = 40 m<br>• Sand bag with 2 m wide on top | • Stable<br>• Buried in sand |
| | Krib no.1 | • Public Works<br>• 1985, 1987 | • In front of Nusa Dua beach hotel | • L = 90 m<br>• 9 layers of concrete pipes ① | • Stable |
| | - | • Private<br>• Recently | • In front of club med | • L = 20 m<br>• Sand bag with 2 m wide on top | • Stable<br>• Buried in sand |
| | - | • Ditto<br>• Ditto | • Ditto | • L = 20 m (up to U-shaped breakwater)<br>• Sand bag with 2 m wide on top | • Stable<br>• Buried in sand |
| | Krib no.3 | • Public Works<br>• 1988 | • 100 m north of U-shaped brakwater | • L = 110 m<br>• 4 layers of concrete pipes ② | • stable |
| | Krib no.2 | • Ditto<br>• 1986, 1987 | • 200 m north of Krib no.3 | • L = 100 m<br>• 4 layers of concrete pipes ③ | • Stable |

APP. Table 3-4-1-3 Existing Facilities ( Nusa Dua Beach -1 )

| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Apporx) | Remark by Observation |
|---|---|---|---|---|---|
| Groin | - | • Private<br>• Recently | • 150 m north of Krib no.2 | L = 60 m<br>• 3-4 layers of concrete pipe with 3 m wide of on top | • Stable |
| | - | • Ditto<br>• Ditto | • 250 m north of the above | • L = 40 m<br>• 3 layers of concrete pipes with 2 m wide on top | • Stable |
| | - | • Ditto<br>• Ditto | • 50 m north of | • L = 30 m<br>• 4 layers of concrete pipes with 2 m wide on top | • Stable |
| | - | • Ditto<br>• Under-construction | • 30 m north of the above | • L = 30 m<br>• 3-4 layers of concrete pipes | |
| | - | • Public Works<br>• Recently improved | • Benoa | • L = 60 m<br>• 6 layers of concrete pipes ④ | • Stable |
| | - | • Private<br>• - | • 150 m north of the above | • L = 50 m<br>• 2 layers of concrete pipes | • No more lids and fill materials exposed |

APP. Table 3-4-1-4 Existing Facilities (NUSA DUA Beach -2)

| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Approx) | Remark by Observation |
|---|---|---|---|---|---|
| Offshore Breakwater | Krib no.4 | • Public Water<br>• 1986 | • 300 m offshore of club med | • L = 300 m (4 nos)<br>• 7 layers of concrete pipes ⑤ | • Stable |
| | U-shape | • Ditto<br>• 1988 | • In front of club Med | • L = 120 m<br>• 4 layers of concrete pipes ⑥ | • Stable |
| | - | • Private<br>• Construction begun | • North of Krib no.2 | • Unknown | |
| Retaining wall | - | • Private<br>• Under Construction | • In front of club Med | • 3 layers of concrete pipes | |
| Sand Nourishment | - | • Public Works<br>• 1986, 1987 | • South of krib no.1 | • 15.000 $m^3$ & 10.000 $m^3$ | |
| | - | • Ditto<br>• 1986 | • Foot of krib no.1 | • 23.500 $m^3$ | |
| | - | • Ditto<br>• 1987 | • Between krib no.1-no.3 | • 28.150 $m^3$ | |
| | - | • Ditto<br>• 1988 | • South of krib no.3 | • 15.000 $m^3$ | |
| | - | • Ditto<br>• 1987 | • North of krib no.3 | • 10.000 $m^3$ | |

APP. Table 3-4-1-5 Existing Facilities ( NUSA DUA Beach -3)

| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Approx) | Remark by Observation |
|---|---|---|---|---|---|
| Groin | - | • Private<br>• - | • 100 m south of Hotel Sanur beach | • L = 20 m & 30 m<br>• 1-2 layers of concrete pipes with 1 m wide on top | • Slightly damaged (out alignment, poor connection) |
| | - | • Private | • In front of Hotel Sanur beach | • L = 10 m each (5nos)<br>• Sand bags | • Old bags and almost buried in sand |
| | - | • Private | • 400 m north of Hotel Santrian | • L = 10 m, 10m, 20m, 40m<br>• 1-3 layers of concrete pipes | • No more lids and in-fill exposed |
| | - | • Private<br>• - | • 200 m south of Hotel Werdhapura | • L = 10-20 m (some 10nos)<br>• 1-2 layers of concrete pipes | • Buried in sand stable<br>• some of lids off and in-fill exposed<br>• partially as retaining wall |
| | - | • Private<br>• - | • In front of Sanur Bungalow | • L = 20-30 m ( 6 nos )<br>• 1-3 layers of concrete pipes | • Mostly stable<br>• Some lids off and in-fill exposed, or slanted. |

APP. Table 3-4-1-6 Existing Facilities ( SANUR Beach -1 )

| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Approx) | Remark by Observation |
|---|---|---|---|---|---|
| Groin | - | • Public Works<br>• 1987 | • South of Sanur Bungalow | • L = 80 m<br>• 4 layers of concrete pipes (max) ① | • Stable |
| | - | • Private<br>• 1969 | • In front of Hotel Bali Beach | • L = 80 m<br>• Stone and mortar wall with 4 m wide on top | • Stable<br>• Some toes damaged |
| | Krib no.1A | • Public Works<br>• 1982 | • 250 m south of Hotel Bali Beach | • L = 30 m<br>• 3 layers of concrete pipes ② | • stable |
| | Krib no.1 | • Ditto<br>• 1981 | • 150 m south of krib no.1A | • L = 40 m<br>• 3 layers of concrete pipes ③ | • stable |
| | Krib no.2 | • Ditto<br>• Ditto | • 150 m south of krib no.1 | • L = 30 m<br>• 3 layers of concrete pipes ④ | • stable |
| | Krib no. 3 | • Ditto<br>• Ditto | • 150 m south of krib no.2 | • L = 40 m<br>• 3 layers of concrete pipes ⑤ | • Stable but some slanted |

APP. Table 3-4-1-7 Existing Facilities ( SANUR Beach -2 )

| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Approx) | Remark by Observation |
|---|---|---|---|---|---|
| Offshore Breakwater | W1 & W2 | • Public Works<br>• 1986,1987 | • 50-100 m offshore of Hotel Werdhapura | • L = 80 m, 50 m<br>• layers of concrete pipes (6) | • Stable |
| | - | • Private<br>• - | • Kp. Mertasari | • L = 70 m<br>• Concrete pipes wall with 2 m high | • Half of them slanted |
| Retaining wall | - | • Private | • 150 m south of Hotel Sanur Beach | • L = 50 m<br>• Concrete pipes wall with 3 m high | • Stable |
| | - | • Private<br>• - | • In front of Hotel Sanur Beach | • L = 120 m<br>• 5 layers of concrete pipes | • Stable |
| | - | • Private<br>• - | • In fron of Restou rant III | • L = 60 m<br>• 3 layers of concrete pipes | • Slightly damaged |
| | - | • Private | • 400 m north of Hotel Santrian | • L = 100 m<br>• 5 layers of concrete pipes | • Stable (some repaired) |
| | - | • Public Works<br>• - | • In front of Hotel Werdhapura | • L = 20m, 60m, 100m<br>• 2-3 layers of concrete pipes | • Buried in sand and stable<br>• Some damaged or collapsed |

APP. Table 3-4-1-8 Existing Facilities ( SANUR Beach -3 )

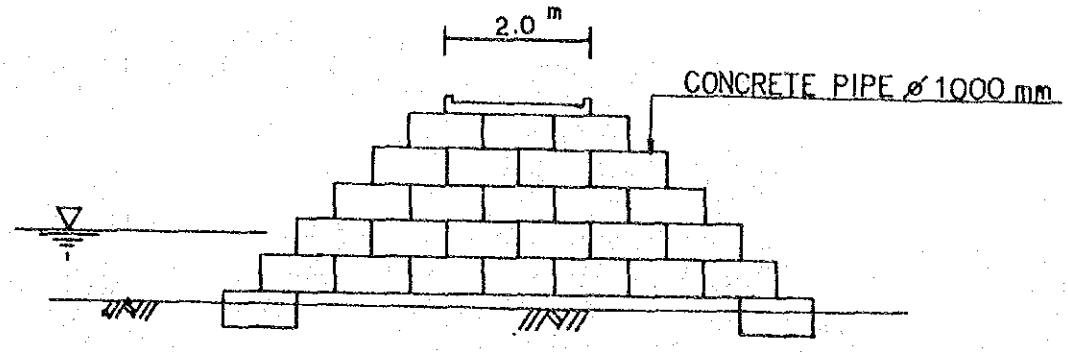
| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Apporx) | Remark by Observation |
|---|---|---|---|---|---|
| Retaining wall | - | . Private<br>. - | . In front of Samur Bungalow | .L = 80 m<br>. 3-4 layers of concrete pipes | . Stable |
| | - | . Private<br>. - | . At-foot of krib no.1 | . L = 150 m<br>. Stone and mortar wall with 2 m high | . Stable |
| | - | . Private<br>. - | . In front of Hotel Bali Beach | . L = 100 m<br>. Stone and mortar wall with 1.5 m high | . Stable |
| Sand Nourish-ment | - | . Publick Works<br>. 1987 | . In front of Hotel Werdhapura | . 6,500 $m^3$ | |

APP. Table 3-4-1-9 Existing Facilities ( SANUR Beach -4 )

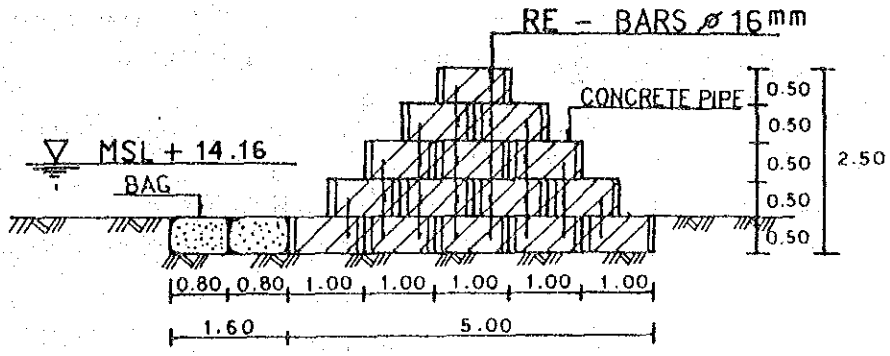
| Type of system | Name | Implemented Body and Completion Year (Approx) | Location (Approx) | Length and Structural Type (Fig.Approx) | Remark by Observation |
|---|---|---|---|---|---|
| Off-shore Breakwater | - | • Public Works<br>• 1987 | • 20 m offshore of Tanah Lot | • L = 50 m<br>• 2.3 tons Tetrapods (1350 nos) (1) | • Stable |
| Wall | - | • Ditto<br>• Under Construction | • Around Tanah Lot | • Concrete with stones in fron (1) | |

APP. Table 3-4-1-10 Existing Facilities ( TANAH LOT )

## KUTA BEACH



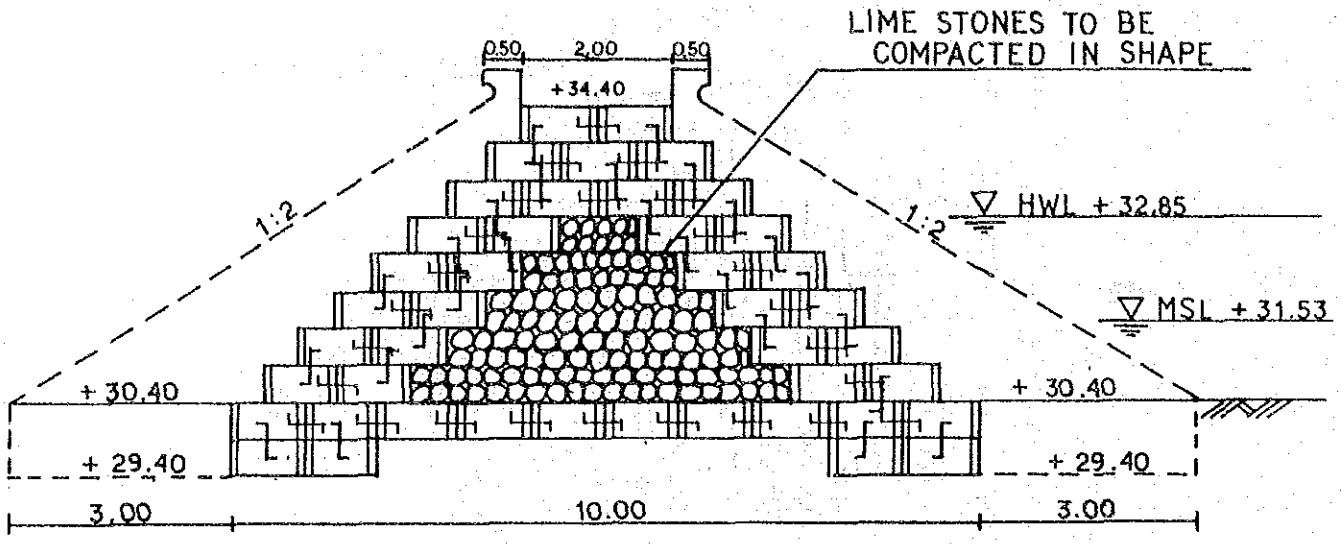

TYPICAL SECTION ①
SCALE = 1 : 100




TYPICAL SECTION ②
SCALE = 1 : 100

APP. Fig. 3-4-1-1 Design of Existing Facility (Kuta)

NUSA DUA BEACH




TYPICAL SECTION ①
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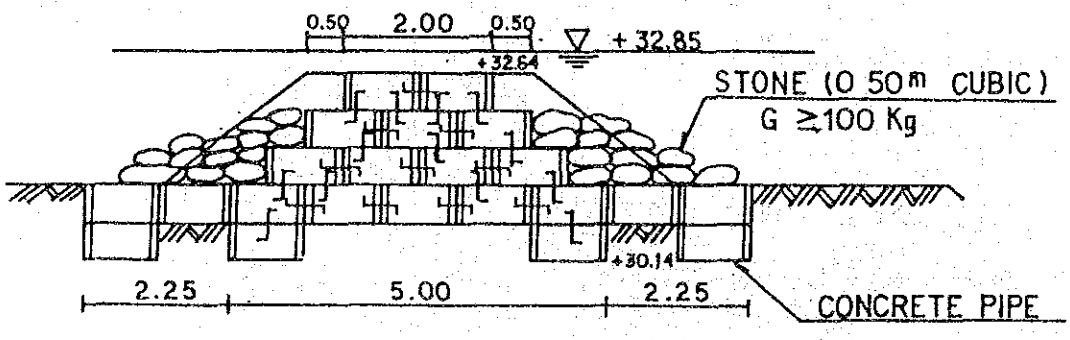
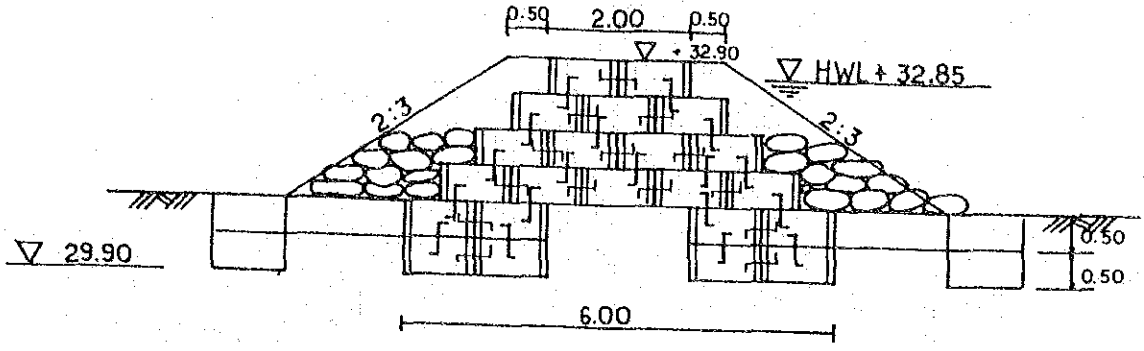


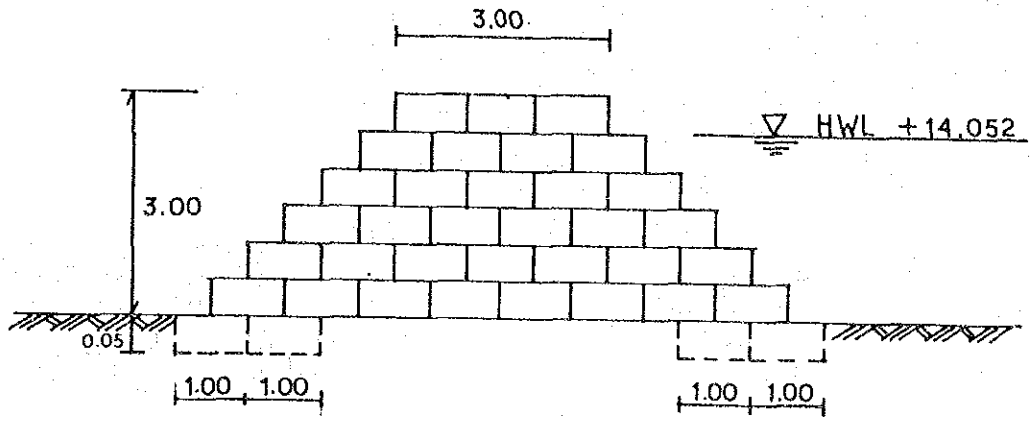

TYPICAL SECTION ②
SCALE = 1 : 100

APP. Fig. 3-4-1-2 Design of Existing Facility (Nusa Dua)

NUSA DUA BEACH



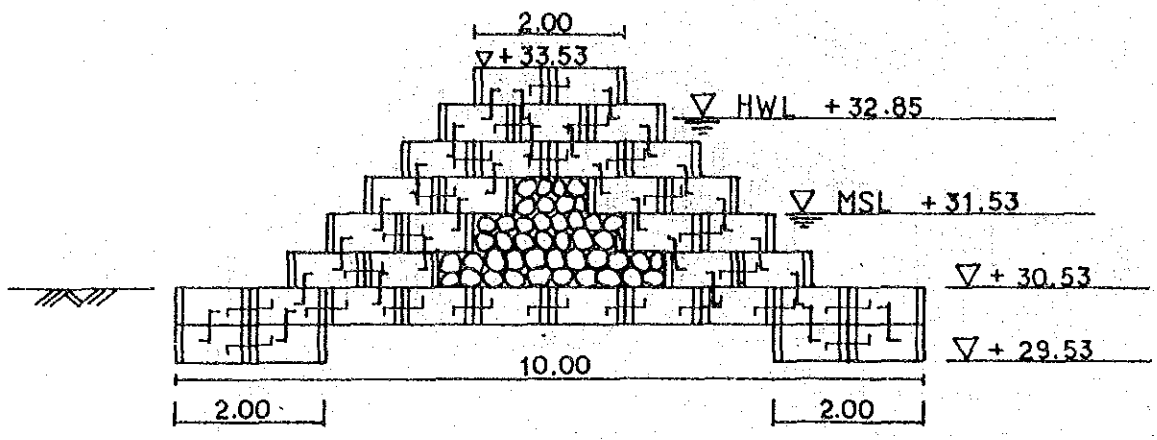

TYPICAL SECTION ③
SCALE = 1 : 100



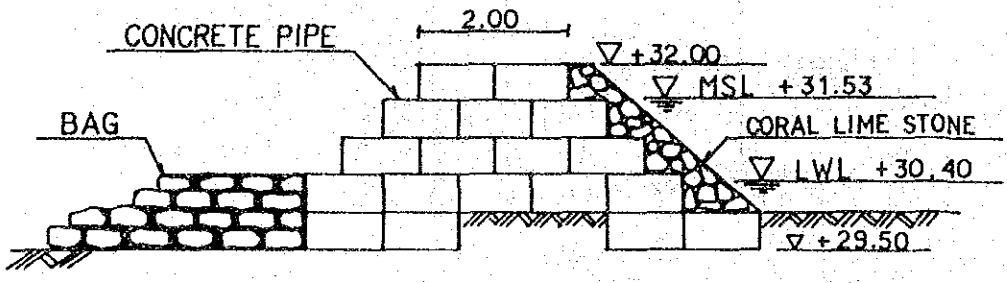

TYPICAL SECTION ④
SCALE = 1 : 100

APP. Fig. 3-4-1-3 Design of Existing Facility (Nusa Dua)

NUSA DUA BEACH




TYPICAL SECTION ⑤
SCALE = 1 100




TYPICAL SECTION ⑥
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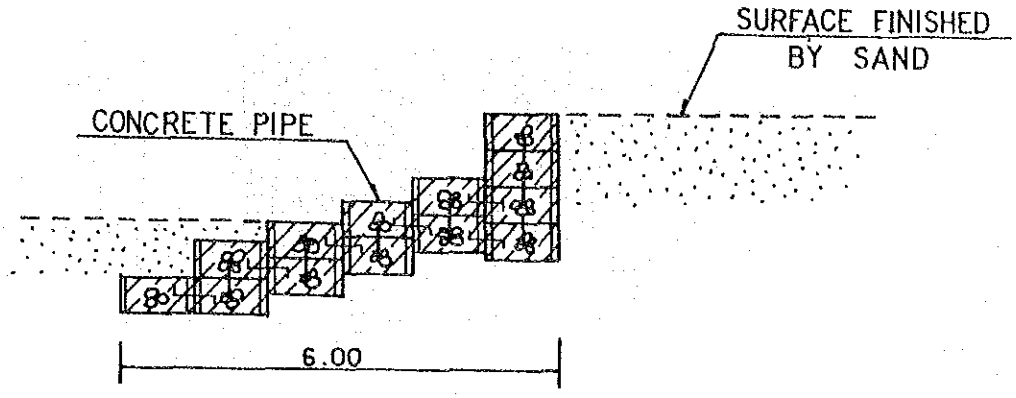
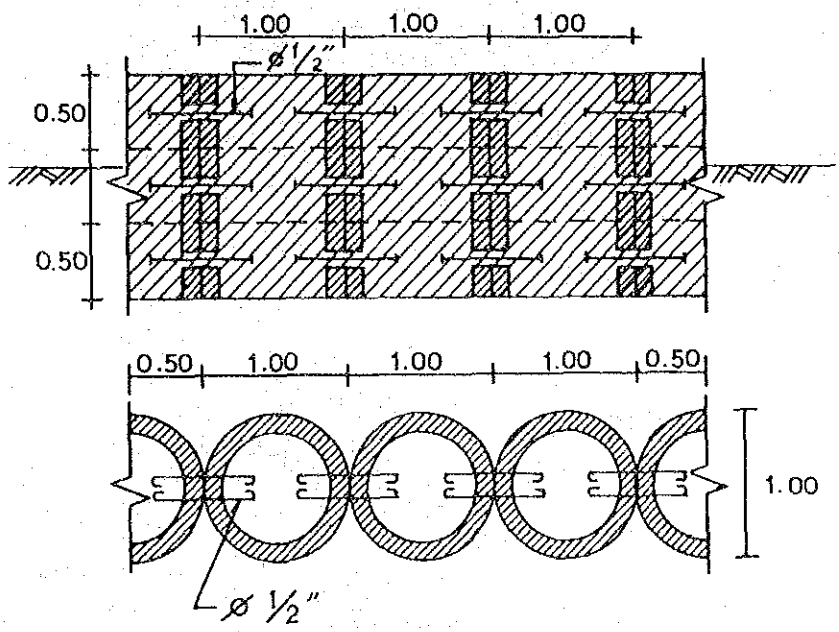
APP. Fig. 3-4-1-4 Design of Existing Facility (Nusa Dua)

## SANUR BEACH



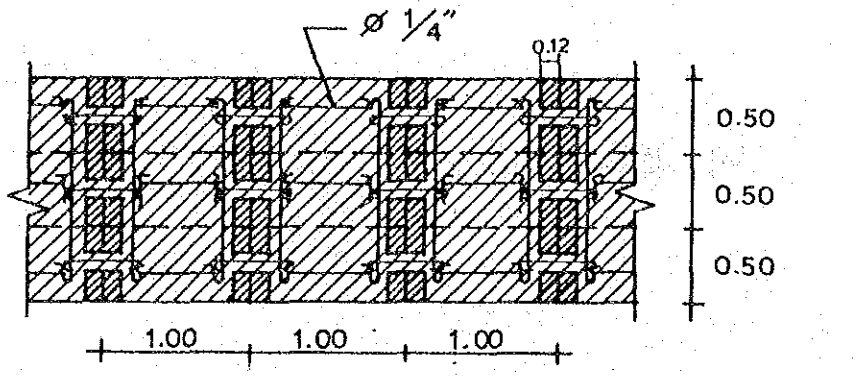

TYPICAL SECTION ①
SCALE = 1 : 100

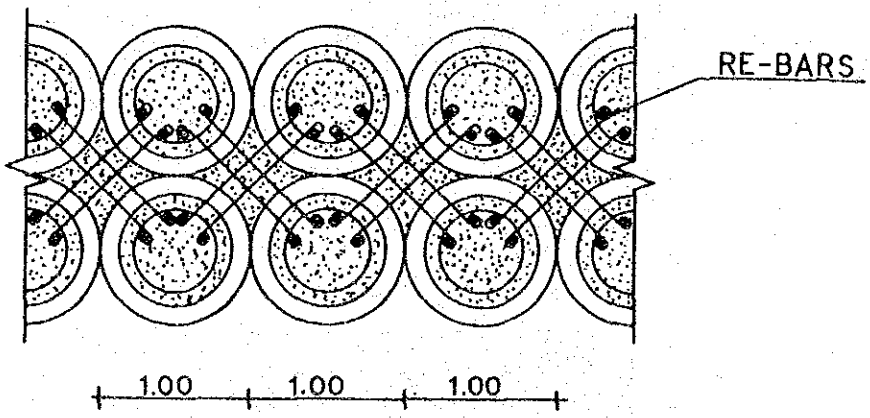



TYPICAL SECTION ②④⑤
SCALE = 1 : 50

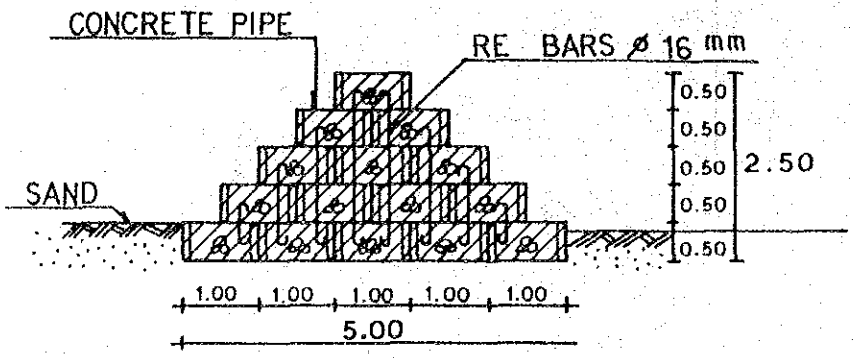
APP. Fig. 3-4-1-5 Design of Existing Facility (Sanur)

## SANUR BEACH



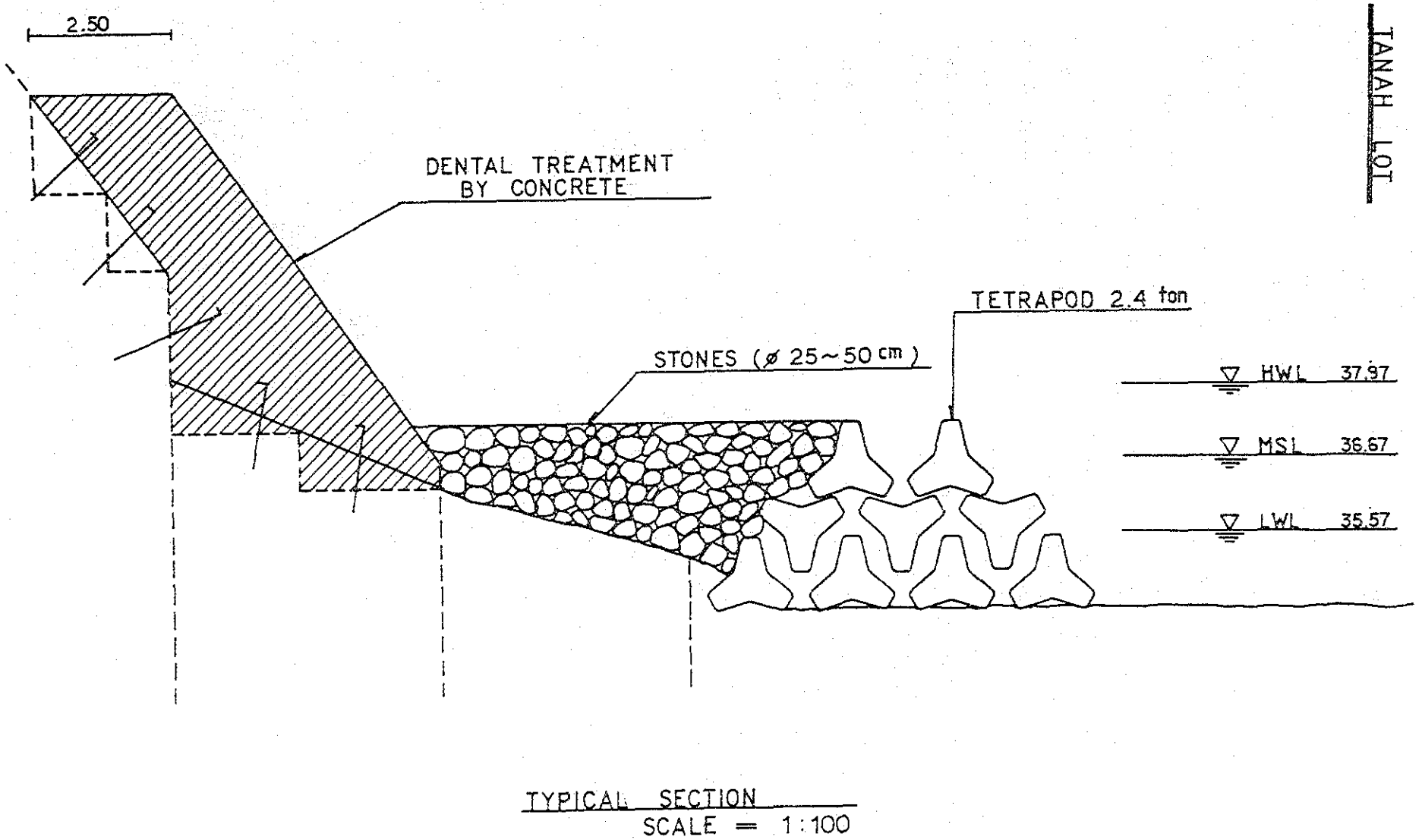




TYPICAL SECTION ③
SCALE = 1 : 50




TYPICAL SECTION ⑥
SCALE = 1 : 100

APP. Fig. 3-4-1-6 Design of Existing Facility (Sanur)




APP. Fig. 3-4-1-7 Design of Existing Facility (Tanah Lot)

## APP. 5-2-1 One-Line Computer Simulation

In response to variations in incident wave characteristics, sediment moves on and off shore, changing the nearshore bottom topography. During storms the beach seriously erodes, forming an offshore bar which protects the shoreline from further erosion. Following the storm the beach profile usually returns to its pre-storm shape under the action of normal waves.

In contrast imbalances in the longshore sediment transport result in more gradual but permanent changes in the nearshore topography. In this process the beach profile often remains essentially unchanged. On the basis of the observation that the beach profile is fairly stable over a long-term perspective, the use of a "one-line model" was proposed.

The fundamental assumption of the model is that the longshore sediment transport takes place homogenously down to a certain depth called the depth of closure D, and that the bottom remains unchanged beyond that depth (Fig. 5-2-1-1). In a variety of cases when the short-term shoreline fluctuations caused by cross-shore transport are small in comparison with the long-term changes, the one-line model gives a reasonable description of the overall shoreline evolution.

Assuming that the bottom profile translates in parallel to itself out to the depth of closure, mass conservation of sediment along a small segment dx of the shoreline is described as:

$$D \frac{\partial y_s}{\partial t} + \frac{\partial Q_s}{\partial x} = 0 \qquad (5\text{-}2\text{-}1\text{-}1)$$

where $y_s$ is the shoreline position, t is time, x is the coordinate measuring the distance along the shoreline, and Q is the longshore sediment transport rate.

The longshore sediment transport is supposed to be induced by waves incident obliquely to the shoreline. Also accounting for the diffraction behind the breakwater, we employ Ozasa-Brampton's expression for Q:

$$Q = \frac{k_1}{(\rho_s - \rho)g(1-p)}(ECg)_b (\sin\alpha_s \cos\alpha_b - k_2 \cot\beta \cos\alpha_b \frac{\partial H_b}{\partial x}) \quad (5\text{-}2\text{-}1\text{-}2)$$

where $k_1$ and $k_2$ are nondimensional constants, $\rho_s$ and $\rho$ are the density of sand and water, p is the sediment porosity, E is the energy density of breaking wave, Cg is the waves group velocity, g is the gravitational acceleration, $H_b$ is the breaking-wave height, $\alpha_b$ is the angle between breaking-wave crests and the shoreline (Fig. 5-2-1-2) and $\tan\beta$ is the average beach slope in the surf zone. The goal is thus to deter

mine the breaking wave energy.

$$(E_b = \frac{1}{8}\rho g H_b^2)$$

In practice Eq. (A-1-1) is solved through the finite difference scheme which replaces the infinitesimal segment dx by a finite one$\triangle x$

$$\triangle y_i = \triangle t \frac{Q_i - Q_{i+1}}{D \triangle x} \quad (5\text{-}2\text{-}1\text{-}3)$$

in which $\triangle t$ is a finite time segment and i refers to the discrete segment along the x-axis, and $\triangle y_i$ is the shoreline advancement over the time interval $\triangle t$.

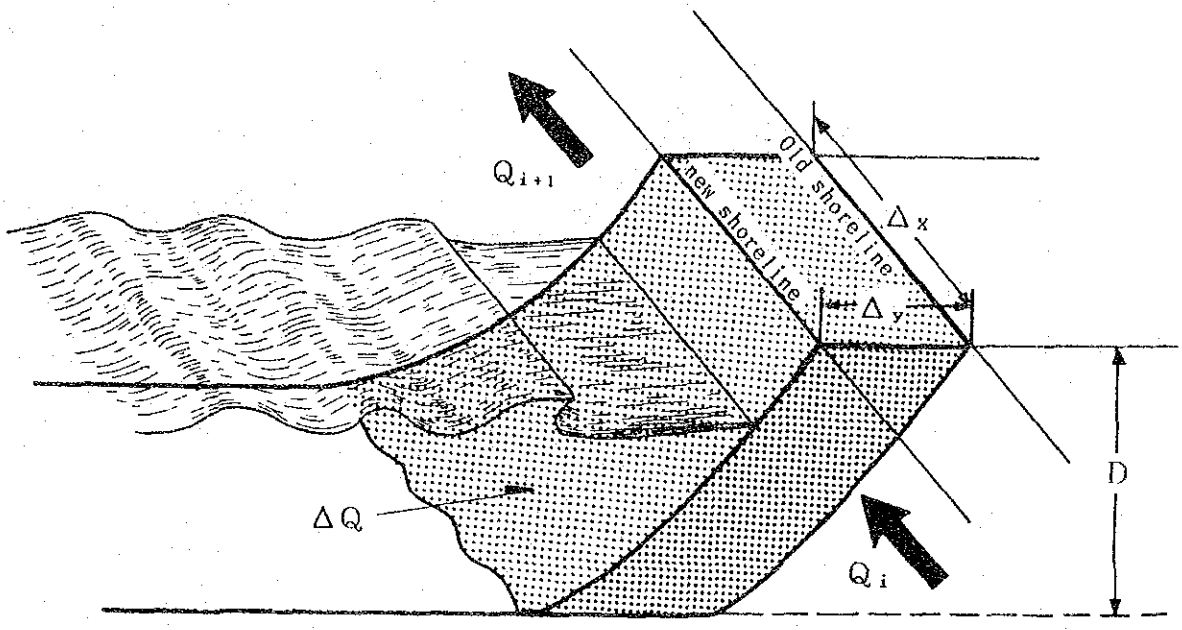
If a groin protrudes beyond the depth of closure D the longshore sediment transport is assumed to vanish there. If a groin is not long enough, the transport rate is calculated according to the ratio of the depth at the edge of the groin to D. The effects of a breakwater on the shoreline change through the change in wave propagation behind the breakwater. A seawall on the beach serves as the backward limit of the shoreline.

We will now discuss the parameters used in the calculations in section 5-2. The depth of closure D is set to be 4 m for Kuta, Nusa Dua and Sanur, from the bottom profile changes observed at a number of locations along the beaches. The porosity is taken as 0.4. The nondimensional constant $k_1$ is 0.02 at Kuta and Nusa Dua, 0.015 in Region A and 0.01 in Region B at Sanur. $k_2$ is 1.62 everywhere.

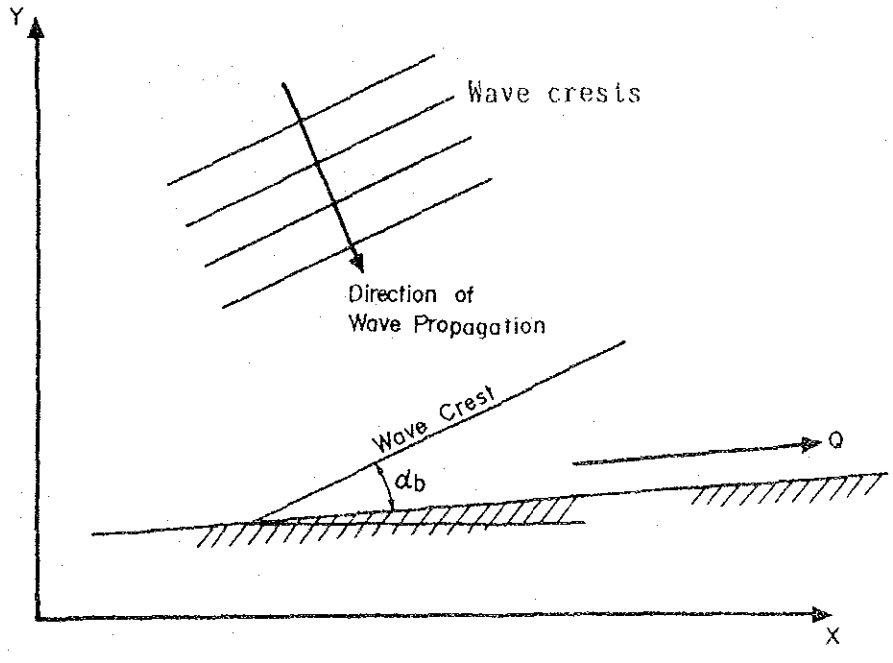
The number 0.02 for $k_1$ is about one-order smaller than what is usually used in Japan. Possible reasons for this discrepancy are as follows. In most Japanese beaches the typical grain diameter is around 0.2 mm. At Nusa Dua and Sanur it is about 1.0 mm and the sediment is more difficult to move. In evaluating the incoming wave, any attenuation of the swell was neglected. With this effect, the incoming wave enery would be one-order smaller, thereby making $k_1$ greater by one-order to get the same transport.

In the shoreline-change computations, $\triangle x = 50$ m and $\triangle t = 1$ month and in the nearshore-wave computations $\triangle x = \triangle y = 25$ m. The computer program is approximately 3,000 lines with the graphic display and requires 250n bytes, n being the number of mesh points along the coast. It takes $2 \times 10^{-3}$ sec(CPU) to compute 1 mesh $\times$ 1 time step with FACOM M760 (8 MIPS).

The offshore-diffraction-calculation program is 1,700 lines long and requires 2 M bytes. The computation speed is $2 \times 10^{-4}$ sec/mesh. The nearshore-wave-propagation program is 1,300 lines long and reguires 2M bytes. The speed is $2 \times 10^{-3}$ sec/mesh with the same machine.




APP. Fig. 5-2-1-1 Definition Sketch




APP. Fig. 5-2-1-2 Definition of Breaking-wave Angle

JICA