Studies on artisanal fishery in developing countries

av

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1. INTRODUCTION

1.1 Problems concerned with fishlanding places in developing countries

In most of the developing countries, the existing or potential inshore fishing grounds are in proximity to coastlines which present tremendous difficulties in the landing and embarkation of the vessels used in this type of local fishery operations. The equipment the fishermen use today is very simple, at many places they do not even use net for the fishing. The catch that fishermen gets is often just enough for their own village while people inland has not enough food.

Quite often the roadconnections are not well developed and so the possibilities of distributing the fish to the inland are not so good. To make the fish available inland it is even necessary to have the right kind of equipment to keep the fish fresh. It is also important to have in mind how the tradition to eat fish is in other parts of the country.

The catch has to be handled properly until it reaches the consumer. Other factors to think of before building landing places are: if there is an ice plant, storage possibilities, meteorological and hydrological data etc.

The factors mentioned above decide the possibilities of developing and improving a landing place.

1.2 The purpose of the report

By developing the artisanal fishery in the third world some functional and economical requirements are made. These requirements are affected by the societies and the peoples valuation.

The constructive design is affected by factors as topography, climate conditions, raw material and so on. Each constructive solution means a sacrifice of the resources. The value of these resources depends on access and demand. Access and demand depends on indigenous circumstances which depends on international circumstances as variation in trade conditions.

It is impossible to solve the problems by considering all the affecting factors. While solving problems one must thing of abstracting the factors which are most significant from the real situation. All other factors has to be ignored. All those relevant factors or variables are combined in a logical way so that they can make a model of the part of the reality which is connected with the problem.

The purpose of the report has been to structure the artisanal fishery in different variables and connect them in a logical way and make a model of the part of the reality. These variables can be affectable or not affectable depending on the aim of the project.

Controlled experiments are not possible in some cases. In artisanal fishery it is in that way. In these types of cases one must make a model of the real system and continue the experiments on it. A model is constructed by looking at the main quality of the reality. The condition of the reality can be showed in the model.

The the above mentioned model is constructed by using the system in an approach way. A system has got different parts which are dependent on each other. Those parts which are an integral part of a certain system can at the same time be an integral part of another system. Each system has to be defined. The definition decides what has to be studied. Parts of a system are made of elements.

The element affects other elements and is also affected itself by other elements. Quality of a system is decided by the elements quality as well as by the structure of the system.

We started by acquiring knowledge about artisanal fishery in developing countries today. We achieved this information by studying the literature about fishery and feasibility studies to get a methodology in the report. More information was achieved by taking with skilled people. By gathering all this information this report is structured in the following way:

To begin with we have described the situation today. In the next part we have made a model by putting together all the information and structuring the problem in three main factors. In each of these main factors part factors are studied in detail and how they affect each other.

At last we have tried to use the model and connect it with a realistic case in Bi´r Ali, a fish landing place in Peoples Democratic Republic of Yemen.

2. PRESENT SITUATION

2.1 Generally

The fish landing places in countries in the third world seldom have port facilities for the boats and for the handling of the fish. The landing places are often just a part of a shore where the boats are taken ashore and left without any protection.

The boats that are used are of canoe type, sometimes with an outboard motor, and the fishing gears are often of very primitive type. When the fishermen return from the fishing tour their families stand on the shore waiting to help with the unloading. The catch is then taken ashore in baskets from the boats which are anchored out in the water. When the catch is taken ashore then the fishermen drag the boat up on the shore, in many places mancraft is the only help they have for this job.

Part of the catch gets lost on its way from the sea to the consumer because it is not handled properly, there is for example no ice in the boat to chill the fish. The baskets that are used to carry the fish are often handmade, and sometimes when the catch is taken ashore from the boats the baskets gets broken. The fish is just thrown in the sand without any protection where it can be exposed to flies. So, the catch is reduced in one way or another. The rest of the catch will only be enough to feed the people in the village.

Many of the landing places do not have any natural protections and during the monsoon periods the fishermen have to stay onshore. Even when the winds are not so strong the fishermen have problems with the waves, for example when they have to pass through the zone where the waves brake and when the catches are taken ashore.

2.2 Seasons and weather conditions

The artisanal fishery around the coasts of Africa and Asia depends on seasonal variations because of the strong winds that blow part of the year.

The most common wind is the monsoon wind, which changes direction. In the spring-summer it blows from southwest and in the autumn-winter it blows from northeast. For example, in Karnataka, India, the southwest monsoon blows from May/June until early September. During this period the fishermen are not able to fish but when the northeast monsoon blows from October to December the artisanal fishing can be done.

The trade wind is not as common as the monsoon wind and it blows only from one direction. This wind blows especially on the west coast of Africa.

There are peak periods when the catch increases and if these peak periods coincide with the strong winds the need for a harbour increases.

2.3 The beach and shoreline

In areas with archipelago it is not difficult to find a landing place with natural protection. But in most places the shore is open and unprotected, and it is in these areas the biggest problems occur.

The beaches are of various kinds, some rocky, some stony or sandy. Rocky beaches are not so good to land on as they destroy the hull of the boats when they are taken on and off the shore.

A major part of the world´s beaches are composed of sand. Such beaches cause many problems. Most of these beaches are located on exposed shores where wave action can be rather heavy. They are generally subjected to tidal action and, not least, they are exposed to littoral drift.

The littoral drift is one of the problems one has to deal with on a sandy beach. Littoral drift is the movement of sedimentary material in the littoral zone by waves and currents. The littoral zone extends from the shoreline to just beyond the most seaward breakers. The wind and the tidal action causes currents which can be dangerous for the fishermen and causes also littoral drift.

Outside some of the beaches there are organic reefs which sometimes stabilize the shoreline and affect the navigation. One of the problems is how to pass the reefs. When it is low water the boats cannot pass and when the water level is high the waves break and the surfwaves that occurs are difficult for the boats to ride on.

The biggest problem is the waves caused by the wind and it is against this the protection has to be built.

2.4 Port conditions

There are few fishing harbours in relation to the requirements of the existing fishing fleet and the size of the present catches. Many places do not have a port, only a simple landing place directly on the beach. Existing ports are not always in good condition. Many of the ports have small basins and short narrow wharves with simple rough surfacing. The ports are often found to be poorly maintained and not equipped with facilities on land as ice-plants, repair yards etc. Cleaning of the premises seems to be done rarely and not always efficiently.

2.5 Fishing Boats and Gears

2.51 Boats

Wood is still by far the most commonly used boat building material. In some places there is a shortage of wood and in Guinea-Bissau for instance one tries to build canoes of ferrocement instead.

The artisanal fishermen use outrigged, out hollowed canoes, raft and vessels made of batten which they paddle or sail. Motorized vessels are used in some areas.

When the fishermen return from fishing trips they drag the boats up on the shore. This is very heavy work because they seldom use appliances.

2.52 Fishing Gears

The catch that fishermen gets depends very much on the equipment they use. The fishing tackles vary from place to place and are often simple, in some places they do not even use net.

Fishing methods can be gill-netting, handlining and fishing by cash net. At some places, for example the Ethiopian shoreline, the fishermen use gear that can be operated from shore because of the poor manoeuvrability of these boats and their dependence upon wind conditions. In many places because of adverse wind conditions fish catches are spoiled before they can be delivered.

2.6 Facilities on land

Facilities on land are not always sufficient.

Electric energy is needed for port operations, ice plants and chilling rooms. Diesel and lubricants is necessary for the fishermen´s vessels. Even if the villages are provided with electricity there can be no provision of lighting on the shore and hence boatmen must return to shore well before dusk. Most of them return in the fore-noon in order to ensure disposal of their catch in time.

At most of the fishing centres there is no boat building or repairing yard. In the absence of a jetty, the boats are anchored away from the shoreline. For repairs, they are often dragged up on the open beach.

The combination of shallow inshore water and absence of appropriate equipment makes dragging the boats ashore heavy work.

2.7 Hygenic aspects

2.71 Landing stages

Several of the landing stages on the coastline and in the rivermouths in most of the developing countries are inadequate for berthing fishing boats. Many of them are exposed and without protection from rough seas and adverse weather conditions. There is little mechanical equipment and the laborious work of unloading the fish has to be done by the fishermen themselves and their families. Only with much, and sometimes unnecessary, work the important and very valuable catches can be landed. It seems that a considerable quantity of the fish is lost due to inefficient handling, unclean baskets, the heat of the sun and exposure to flies. The remaining part of the fish is of good quality. The large number of people available makes it possible to land the catches quickly.

2.72 Ice production and plant

Ice production is still inadequate to meet the needs of the fishing industry, especially in the inland areas. The quantity of ice, used in the retail fish markets varies and sanitary conditions at these markets are poor. Fish are usually left uncovered with the result that flies are quickly attracted and the spoilage is high.

The fishermen should be adviced at least to cover their fish and keep the hygienic standard better than what it is today. As it is today the fish is often just layed directly in the sand.

Prices at inland centres are higher than prices at fishing centers, reflecting the costs associated with transporting the fish to inland markets. The fish goes through many middlemen before reaching the consumer which effects the price too.

Today, most of the ice is used to preserve prawns and quality fish during land transport from the district. Ice is rarely carried on fishing trips. The canoes are not equipped either to carry ice or for that matter to store fish under satisfactory conditions.

2.8 Labour

One of the problems in developing the small scale fishery in developing countries is the very low educational level of the people who are involved in the fishing sector. Even if there is an ice plant and other modern facilities, knowledge about maintenance is very low. It is hard to keep the plant working when nobody can take care of it.
The countries in the third world have often a good supply of low skilled labour.

2.9 Tradition

2.91 Food tradition

In many of the fishing villages in the third world people are conservative and it is difficult to change their eating habits. In many places it has not been possible to deliver the fish inland, so the people there are not used to consume fish.

2.92 Fishing tradition

As the fishermen are conservative it is also difficult to introduce new types of fishing equipment. Each place has its own local traditions.

For example at certain places fishermen are not willing to go fishing for longer trips than one day. They want to come back home before dusk because they do not want to spend the night on their boats.

2.10 Transportation

Mostly the road connections are not well developed from the fish landing places and in many areas the existing roads are not useable in the monsoon period because of the heavy rain. That has lead to that the fishing village has been isolated and the fish they produce has just been for their own village.

2.11 Summary

There are a number of problems in the small scale fishery. When planning a harbour or a landing place in developing countries, one should have those problems in mind and below are these problems in a nutshell.

- The fish is not handled in a right way during its way from the fishermen to the consumer.

- Road connections are not always good. Transportation inland has to be organized well.

- Fresh water is not always available for ice production

- By using salt water the ice production machinery corrods

- Shortage of fuel for the boats and electricity supply

- The knowledge of how to use the modern machinery and equipment is low
- People inland does not always prefer to eat fish
- None or small possibilities for fish processing
- Fishermen´s aversion to spend the nights on their boats
- People cannot always afford to pay for the processed fish
- Fishing boats and gears are often simple
- Port conditions are not always good. It takes a long time to unload the catch from the fishing boats
- Lack of co-operativ to maintain i.e. their workstores, distribution, store and repair yards.

3. INTRODUCTION MODEL

The factors we have described in the previous chapter tells how fishing is done today. In this chapter we will try to show how these factors influence on each other and how they can be improved. The intention of the improvements mentioned is to increase the living standard of the fishing population and to increase protein supply to the poorer part of the population.

We have tried to make a model where we have studied how the way of the fish from the sea to the consumer is effected by a number of factors. These are divided into three sections. Each section has a main factor, these are:

- Size of the Catch
- The Port
- Processing of the Fish

These main factors are affected by many other factors which one has to study before taking any further steps in developing the landing place.

The part factors can in some cases, but not always, be influenced. It depends on the level of improvements of the port.

In our model we have tried to develop the port with the help of small achievements on local level. Factors that we think cannot be influenced are:

- Season and weather conditions
- Fishing ground
- Availability of fish
- Fish species
- Fishing tradition
- Beach and shore line
- Wave, wind, current, seasons, water depth beach material

- Construction material
- Educational level
- Transportation
- Distance to urban area
- Demand
- Food tradition

Big resources are needed to improve these factors and as the fishermen often are very poor, these factors cannot be improved.

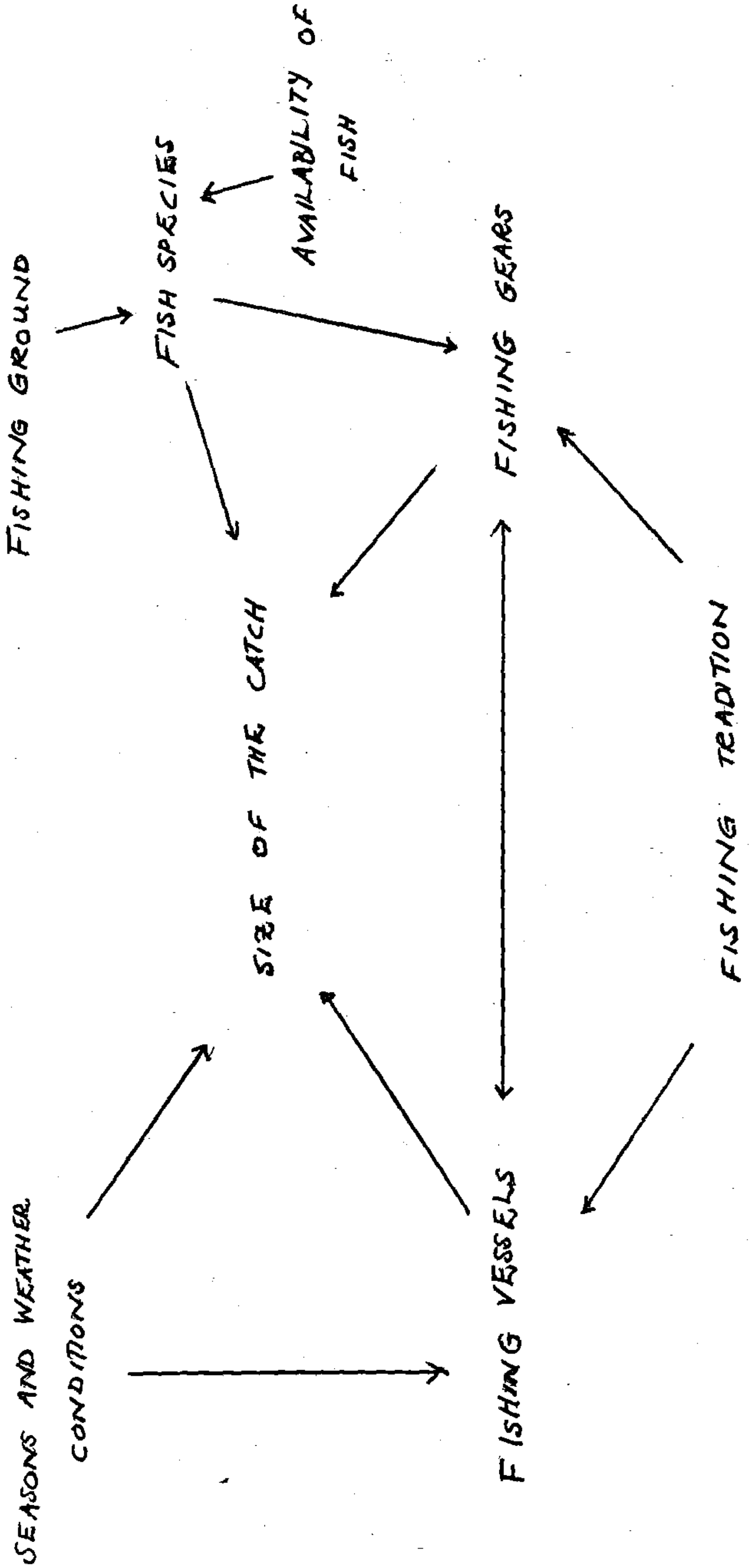
The factors that can be improved are:

- Fishing vessels
- Fishing gears
- Harbour dimension
- Size of available area
- Water, energy
- Ice plant
- Knowledge about processing
- Grade of processing

These factors are in our opinion the most important to consider when the improvements of the port are studied.

In the model below we have first shown how the main factors are affected by the part factors and then described these in detail.

3.1 Section one. Size of the catch.



3.11 Season and weather condition

The annual winds as the monsoon and trade winds create difficulties to the artisanal fishery. The fishermen cannot go out fishing during these periods, a seasonal fishing arise.

Today´s fishing tradition has arised from the weather conditions. If the fishermen shall be able to fish during bad weather the boats and the landing places have to be improved.

3.12 Fishing ground

The nearness to the fishing ground is of importance when one has to decide where and how to build the port. It also influence on the size of the vessels and the equipment to be used. When the distance increases the vessels have to be bigger and faster and the catch has to be taken care of in a better way.

The fishing grounds which are located near the landing place are well known by the fishermen but those which are at distance are unknown, because the vessels are too small and it is difficult for the fishermen to find the fishing grounds.

With help of a echo-sounder the fishermen would be able to find the fishing grounds. With the artisanal fishery it is not possible to fish on deep water so the fishing ground has to be near the coast.

3.13 Fishing species

About 85 % of the world´s catch comes from the sea. Almost two-thirds consists of surface-dwelling (pellagic) fish such as anchoreta, herring, mackerel and tuna. Bottom-living(demersal) fish such as cod, snapper and flunder, make up the remainder of the marine catch. Because of this the fishing grounds get different kind of species, to catch these different kind of gears are needed.

During peak period, when the catch increases, the fishermen ought to be able to fish. As it is today the fishermen are not able to fish if the bad weather and peak period coincides. Bigger vessels and better landing places are needed when such conditions occur.

Certain kind of species are more valuable than other, this is something the fishermen ought to have knowledge about.

3.14 Fishing Gear

The catch fishermen get depends on the equipment they use. The gears they use today in the artisanal fishery are often very simple, and the catch they get with these gears is hardly enough for the fishing population.

The gears are in need of improvements but improving or introducing a new sort of gear can meet difficulties. The fishermen have to be shown how to use it and that it will lead to an increase of the catch. Otherwise they probably will continue to use the traditional gears.

By introducing new material in the traditional gears it is possible to use the gears for a longer time and it will in some cases be cheaper to produce. For example, regarding fishing gear and methods, BBP has conducted tests over a 10-month period to improve the largest drift net, the most popular in Sri-Lanka for pelagic fishing (surface-dwelling).

These trials have clearly shown that nylon net of finer yarn are 25 % cheaper and 20 % more efficient than the traditional ones used in the country.

If new gears are introduced the demand of new and bigger vessels will in some cases increase. Before changing the gears it has to be examined whether the gears that are used are adjust to the environmental conditions.

3.15 Fishing vessels

The construction of the fishing vessels depends on the tradition. The vessels have always been built in the same way and since they work the people continue to build them in the same way.

With a change in the type of vessels, gears and facilities on board, the fishermen would be able to exploit more distant fishing grounds and spend more hours fishing. But the construction of the traditional vessel depends on the environmental conditions and before changing the vessel one has to check these conditions.

Traditional vessels can be improved by an outboard motor, which makes it easier for the fishermen to move. But there are problems with engines which have to be considered, for example:

- the price of fuel
- availability of the fuel both in the country and at the landing place
- repair possibilities
- availability of spare parts etc.

In certain cases it could be more advantageous to have a combination of sail and motor to keep the costs down.

There has to be chilling possibilities on board when the catch increases and the trips become longer.

If a protecting harbour is not to be built it is necessary to have other facilities on land for example winches and outhauler to make it easier to move the boats onshore. If the shore is rocky there has to be some kind of ramp so the hull is protected against the rocks.

FAO´s report "Small Harbour and Landing Places on Difficult Coasts" gives recommendations about vessels and equipment that can be used during different weather conditions on sandy beaches.

(i) Severe surf conditions (surf regulary between 1-2 m high) with storms of short warning.

Artificial protection is likely to be inadequate or uneconomic for the storm situation, so the boats must be able to land on heavy surf and be hauled right clear of the sea. For this purpose the multi-hull of approximately 12 m length with winch and outhaul appears to be the most likely solution.

(ii) Moderate surf (below 1 m) but with storm of short warning

Multi-hull would be suitable for this purpose also but if the fishing grounds are near to the landing point then light mono-hulls of 9-10 m could be handled with winches and outhauls.

Experiments with permeable wave screens should be made to reduce the storm surf to allow safe landings under these conditions and thus extend the range of fishing.

(iii) Moderate surf when storm are rare and with good warning

Mono-hulls as in (ii) are likely to be suitable or T-jetties for deeper craft in storm shelter is available within reasonable distances. Multi-hulls could be used if they were in other respects desirable.

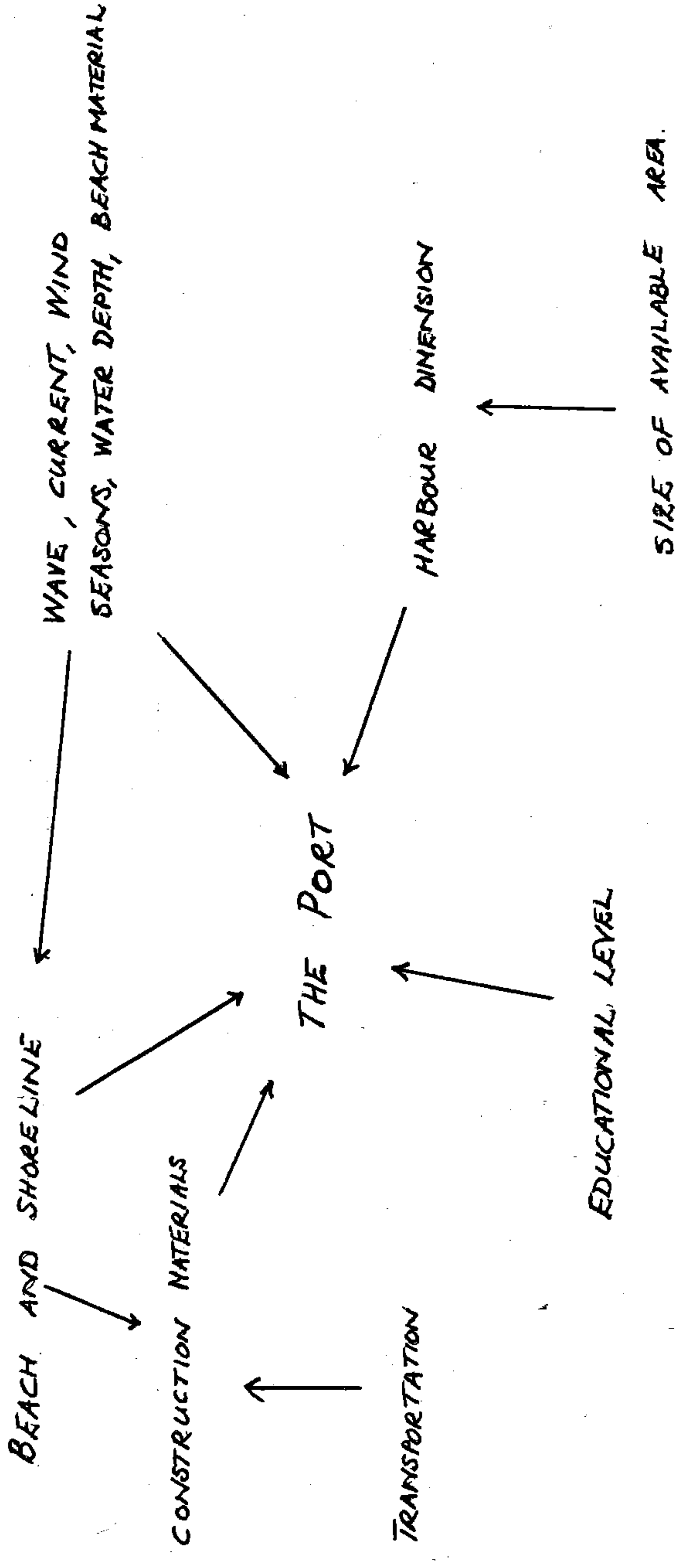
3.16 Fishing Tradition

The tradition and the culture vary from place to place so it has to be examined whether there are any traditional or cultural hindrances before improvements are done.

For example, fishermen in developing countries are very conservative, therefore it is difficult to introduce new fishing gears and methods. They have to be convinced that the catch will increase.

By giving people knowledge, the tradition can be changed.

3.2 Section Two; The Port



3.21 Beach and Shoreline

On a coast with archipelago there are no problems of finding a landing place. Islands make natural protection against wind and waves. But most of the coasts have not got archipelago, they are open and unprotected, wind and waves can expose the shore, and it is on those shores the biggest problems occurs.

Sandy Beach

One of the biggest problems one has to deal with on a sandy beach is the littoral drift. Solid structures are therefore not good unless they can be placed on alignments such as the T-head of a jetty where they do not disturb the material transportation to such an extent that shoalings of large magnitude will result. Accordingly most structures may have to be provided with open-work design with little wave protection to be expected.

If the maintenance costs for dredging, because of the littoral drift, is too high, one ought to think of improving the boats and equipment instead of building a protecting harbour.

Rocky Beach

Rocky beaches are not so good for landing on, and where they occur the landing facilities are tried to be put in some other place, a gap or a bay or an inlet. If there is an open rocky beach and there is no other place for landing, a ramp ought to be built so the boats can be taken on shore without destroying the hull, or, if the boats are going to stay in the water, some kind of protection against wave and currents is needed.

3.22 Harbour Dimensions

When the various stages of vessel and catch development has been estimated and evaluations made, the result will lead to staged predictions for the dimensions of

- approach channel and basin
- landing quay and shore establishments for handling, displaying, selling and sorting the catch
- berthing quays and services
- provisioning quay and supply facilities
- maintenance and repair facilities for vessels, gear and equipment etc.

The factors mentioned above change with the size of the port.

One also has to think of having available areas for future developing.

3.23 Construction Materials

To what level the landing place should be developed depends on the boats and the catches. It also depends on the beach, as we mentioned before solid structures should not be placed on a sandy beach. The nearness of fishing grounds and urban areas are also important and not least the nearness of construction materials. Too long distance to the material leads to an increase of transportation costs. The material must also be resistant to the environmental conditions.

On sandy beaches it can be very hard to get construction material, in some cases the sand continues inland and creates deserts and the material that is needed has to be imported.

Availibility of sweet water is of great importance for construction, e.g. concrete made of sea water is not of acceptable quality.

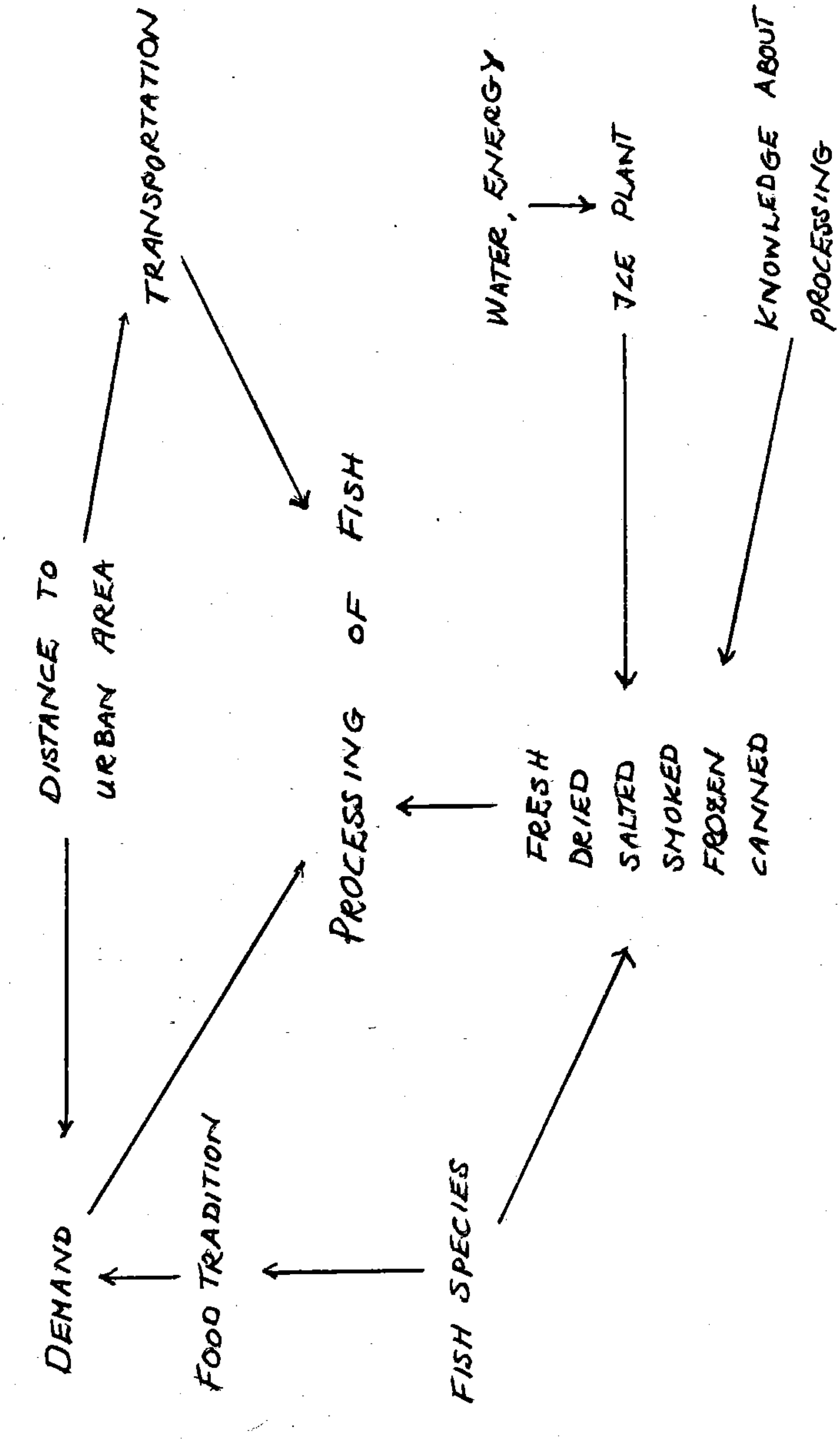
3.24 Educational level

One of the problems of developing the fishing fleet in developing countries is the very low educational level of people who are involved in fishing.

Building a port with modern facilities means that educated people are needed. Since the fishermen often are illiterates it will take a long time to educate them.

The fishermen are, as mentioned before, conservative and therefore it is difficult for them to adapt themselves to sudden alterations. Changes ought to be step by step and not as it is done now in some places where a new advanced port is built and only educated people from industrial countries can manage to maintain it.

3.3 <u>Section Three</u> Processing of the Fish



3.31 Transportation

Possibilities for inland transportation influence among other things on how the fish is going to be processed and the demand of fish inland. To build a big rather advanced port we presume that there already is a road net. If only the landing place is going to be improved, the road net is not as necessary as if an advanced port was developed. It is possible to transport the fish along the coast but then it is necessary to have a jetty for the boat that comes to fetch the fish.

If there is not any developed road net inland and no ice plant to take care of the fish, then one has to process the fish in some other way, for example drying, salting or smoking the fish. Sometimes the fish can later be distributed inland by lorries even if there are no roads.

As the situation is today the processing is in a way dependent on the tradition of the people and the tradition has been influenced by the transportation possibilities.

If it is possible to transport the fish to a port nearby for freezing then it is sufficient with an ice plant which produces ice to keep the fish fresh until it is transported further to the port for freezing.

Transportation is also dependent on factors such as the season. It can be difficult to transport the fish along the shore when the monsoon winds are blowing and it can be difficult to drive inland during the heavy monsoon rain as the roads are in bad condition.

Improving the road net is on national level in our opinion, so before the landing place is going to be developed there has to be a working road net.

3.32 Food tradition

In many countries in the third world it is difficult to change the foodculture and the tradition. It is important to study these things before deciding how the fish will be processed. After that the decision will be made about the improvements. To mention, by drying the fish the price will be kept low.

3.33 Fish species

It is worth to know what kind of species are available in the area. By knowing that it is easier to decide how to process the fish. For example there are species which are only suitable to be sold fresh. The fishermen ought to be informed about the species and what they shall do with them to get the best result.

Fish species influence also peoples food culture.

3.34 Demand

The demand is dependent on the peoples standard of living. One should think of keeping the price low after processing so that people can afford to buy the fish. The price gets higher when the fish is transported in land, specially during the summertime when more ice is needed to keep the fish fresh.

According to the final report of the Baluchstan fisheries development project, in some places in Pakistan the consumption of marine fish is higher during the winter months than the summer. In order to stay cool during the summer months less quantities of meat, mutton poultry and fish are eaten and vegetables are eaten instead.

3.35 Distance to urban area

As we have to deal with fresh products nearness to a market is important. Big fishing harbours need a bigger market so the nearness to urban areas is important. The existing landing places have often a market for their catches. By improving these landing places it will be possible to provide more people with fish, urbanization will be less important and it will give more job opportunities.

Capacity of the storage is depending on how far or how often the fish can be taken away.

3.36 Fish processing

Fish processing depends among other things on possibilities for transportation, distance to an urban area, fish species, food tradition, fish processing equipments, availability for fresh water, energy, freezing plant and so on.

If the communication net is not well developed, if it is far to urban area, if the equipment is simple, or if fresh water and energy is not available then perhaps drying the fish will lead to a better result. It is difficult to supply fresh fish to people inland if road connections are bad.

3.37 Water and Energy

Fresh water resources are of importance for the ice making and for the hygienic aspects. For certain activities brackish water can be used, e.g. cleaning of boxes and gutting the fish.

Without fresh water and proper equipment the only way of processing the fish is drying or smoking it.

Energy is not only needed for the vessels, the facilities at the port needs it too, e.g. ice plant and winches. As for the vessels it can be problems of getting fuel continuously to the port.

3.38 Ice Plant

At an ice plant it is necessary to have people who can handle the mashinery and maintain it. Problems occurs because the fishermen are low educated, at the same time problems can occur because of the difficulties to get spare parts.

One must also have the problems of corrosion and fuel availability in mind.

When constructing the plant one can not cast the concrete with sea water, because then the material will decompose after a while. Maintenance should not be overlooked either. There should even be storage capacity so the fish can be stored for a while.

As the bacterias in these countries are sensitive to cold it is possible to keep the fish fresh for a longer time by just keeping them in ice. The fish can be fresh for about a week in that way.

3.39 Hygienic and handling situation

By improving the hygienic and the handling of the fish a greater part of the catch can be taken care of. It can be done by bringing ice on boats, by using clean boxes for the fish and by quick unloading and handling in the port.

By giving the fishermen a higher price for the fish which has been handled in a better way they will be encouraged to take better care of their catches.

4. INTRODUCTION OF THE CASE

In this chapter we have tried to use our model on a real case at Bi´r´Ali in People´s Democratic Republic of Yemen.

While developing and improving the fishing village Bi´r´Ali, the main objectives have been to increase the living standard of the traditional fishermen and to supply increased quantities of higher quality fish.

According to the model the catch is the main factor in the first section. Part factors as season and weather conditions, species, fishing tradition, availability of fish and fishing ground are not affectable. While part factors as fishing boats and gears can be affected.

In our opinion the boats and gears are in good condition and regarding to the economic resources no improvements will be necessary. Instead we have tried to improve other part factors to achieve our goals.

In the second section, the main factor is the port. Part factors which can be influenced are the size of the port and the size of available area. Part factors as shore and coast line, construction material, transportation, educational level among port workers, waves, winds, water depth and seasons are not affectable.

4.1 Bi´r ´Ali

A fisheries project has been proposed at Bi´r ´Ali, situated 500 kms from Aden, the capital city of People´s Democratic Republic of Yemen (PDRY). Of the 800 inhabitants about 160 are engaged in the co-operative organized fishery. Present fish landings are estimated to 2200 tons. Of the landings, 90% is traditionally dried and 10% is marketed fresh. A great deal of the fish is spoiled before it is dried or chilled.

Our aim is not to develope an advanced and big harbour. The alternative with the jetty was no good either as the costs would be too high. A suitable solution in our opinion would be a pier. By building the pier the fishing trips will be longer as on- and off-loading of the catch will be easier and take less time for the fishermen. For future development of the port there is enough area available.

For the third and last section the main factor is the processing of fish. Demand, food tradition, species, distance to an urban area and transportation are part factors which are not affectable. Part factors as water and energy availability, iceplant, knowledge about processing and the grade of processing are things that we can do something about.

To receive the fish of better quality it is in our opinion necessary with an ice plant. From the two existing wells enough sweet water will be available for the ice production. If the demand of sweet water increases it is possible to dig more wells. For the electricity supply generators has to be bought.

The way of processing is going to be the same as before. The difference will be that the fresh fish will be increased from 10% to 50%. At the same time dried fish will be decreased from 90% to 50%.

4.2 Objectives

The main objectives of the project are to increase the living standard of the traditional fishermen and to supply increased quantities and even better quality of fish.

By developing the port, more people will get employment which will automatically increase their living standard. When the living standard will increase people will afford to spend more money on other things and business of other branches will develop too. Increased living standard leads to higher educational level. Increased quantity of fish will make it possible for people inland to buy fish at reasonable price.

These objectives would be achieved by the establishment of a pier and the shore facilities will be improved by an ice plant and a cold store. The salted and dried fish will be of a better quality by improving the drying area by racks. Limited fresh water resources are available nearby. If yiélds are low the use of fresh water can be reduced by making ice of sea water.

4.3 Fishing Seasons

Most of the year the coastline of PDRY is subject to monsoon conditions. Normally the southwest and northeast monsoon is prevailing from May to September and November to March respectively. The cycle of the monsoons varies slightly from year to year. Fishing is particularly good during the southwest monsoon. Normally three months between July and October yield the highest landings.

4.4 Fishing Craft

The number of fishing craft amounts to 80 huris, 5 co-operative sambuk, 15 visiting sambuk and 10 sambuk from the small boats division.

The huris, which are about 5-8 metres long, are basically dug-out canoes, though they are occasionally constructed of rough planking on ribs. Very often the huris are supplemented by a collar planking on ribs, allowing a higher free-board and better safety. The basic huris are powered by rowing or sailing, the more supplemented huris are often driven by outboard engines.

Huris driven by sail or rowing usually conduct daily fishing trips 1,6 to 2,5 kms off the coast lasting about 4-5 hours. Outboard driven huris and sambuks make fishing trips lasting 10-12 hours. The sambuks have an estimated length of 13 metres and are powered by inboard diesel engines.

According to interviews, Bi´r ´Ali is chosen as a base by the visiting sambuks and the small boats division because it is situated close to good fishing grounds and the Bi´r 'Ali bay offers some shelter in periods of bad weather.

4.5 Fishing gear

The main fishing gear employed are handlines, longlines, gillnets, castnets and beach seines.

4.6 Fish handling

No harbour facilities exist at Bi´r ´Ali. Landings of the fish take place on the beaches, which are mostly unprotected. Natural shelter is found to some extent.

Hygiene, which is the fundamental aspect of fish handling, is almost totally ignored. The traditional fishing boats do not take ice on their fishing trips. Landed fish is thrown on the beach and dirty floors, with very little water used for washing and cleaning. Discards such as fishheads and intestines are thrown around the premises of the receiving place, causing severe pollution problems.

4.7 Salting and drying of fish

In areas where there are no receiving stations and cold storages, the surplus fish that cannot be sold fresh is salted for subsequent drying. Very often the fish is gutted and split at the water´s edge, sprinkled with salt and stacked on the ground for a few days before it is spread out to dry in the sun. Some of the fish flesh receives very little salt in this process, and is rotten long before it is dry. This was very obvious at Bi´r ´Ali, where several tons of rotten dried fish were treated along the beach. The amount of salt available is far too short of the minimum required for salting the fish meant for drying.

During the drying process, the fish is spread on the beach, which explains the large amount of sand found in the finished product. A major part of the dried product is of poor quality, due to careless handling, inadequate salting, contamination with sand and insect attack caused by poor storage.

4.8 Smoked fish

Smoked fish is a traditional Yemeni product, produced at a number of fisheries cooperatives. Tuna and similar species are smoked in round pits that are dug into the ground. Fire is built at the bottom of these pits using firewood.

4.9 Marketing

The dried and salted fish is collected by trucks belonging to the Ministry of Fish Wealth (MFW) for marketing in the interior. The MFW transports fresh fish on ice in insulated truck 2-3 times weekly from Bi´r ´Ali to Aden for domestic marketing. The ice is transported in blocks from Aden to Bi´r ´Ali by the insulated trucks where the ice is manually crushed.

5. THE PROJECT

In order to utilize the abundant marine resources to a higher degree, a fishery project located at Bi῾r ῾Ali has been proposed. The project is conceived as improvements of port and shore facilities for the traditional sector.

5.1 Project objectives

The main objectives of the proposed project would be:

- to increase the living standard of the traditional fishermen;
- to supply increased quantities of fish for domestic marketing.

The objectives would be achieved by building a pier and other facilities on land i.e. ice plant, cold store, drying yard etc. The project would:

- despatch fresh fish on ice for local marketing
- serve the local traditional fishing operation
- serve as an unloading pier for visiting sambuks during the peak season.

5.2 Increased benefits from improvement of the fish products

- The utilization of ice in the handling of fish will increase the quality and reduce the spoilage
- By building the pier the landing and receiving facilities will enable an efficient and hygienic off-loading and thereby reducing the spoilage.

The major beneficiancies are the fishermen themselves as they will receive a higher price for fresh fish products than what is presently obtained for dried and salted fish products. The consumers of the marketed fresh fish will also benefit as more fish at higher quality will be marketed.

5.3 Projected fish landings

By building the pier the catch will increase with about 15%. The pier will make it easier for the fishermen to unload the catch and it will take shorter time. The spoilage will be less too. The establishment of a pier leads to that the visiting sambuks will increase.

Because of improved handling, marketing and earning possibilities, the fishermen are anticipated to go for the more valuable species rather than the inexpensive small pelagic fishes.

5.4 Ice requirements

Ice will be required for:

- fishing operations: 0.5 ton of ice per 1 ton of fish for the sambuk fishery;
- re-icing of landed fish intended for cold processing and marketing as fresh fish: 0.5 ton of ice per 1 ton of fish

The quantity of ice required has been at about 10 tons per day during the peak season.

Peak season:

$$\underbrace{0.5 \cdot 30 \; 0.35}_{\text{on board}} + \underbrace{0.5 \; (30.0.35+80.0.07)}_{\text{re icing of half of the landed fish}} \; . \; 0.5 = 9.3 \text{ ton say } 10.$$

The amount of sambuk is 30 and each sambuk gets about 0.35 ton fish. There are 80 huries and each of them gets 0.07.

5.5 Landings

The fishermen land their catches at a landing pier.The fish is put into non-iced boxes fetched by the fishermen at a box store belonging to the co-operative and pulled on small four wheel trailors to a receiving place. The pier has a 5 m wide traffic lane in the centre and a 5 m unloading ramp which leans 1:60 along 90 m ramp. The sambuks will be able to unload on the front part of the pier.

5.6 Curing

The fish for curing is divided into small pelagic shoal fish and other fish. The curing will be carried out in the same manners as today, mostly sun-drying.

The small pelagic shoal fish is transported directly after weighing to an area reserved for drying. This area will be located close to the access road to the Aden-Mukalla highway. At the drying area the fish is put on racks to prevent contamination of sand and to allow for an even drying.

6. SUMMARY ON THE INVESTMENT COSTS

		Appendix
Machinery for the ice plant	354 000 Skr	1
Ice plant	42 000	2
Cold store	95 000	3
Fish boxes	20 000	4
Trailors	10 000	4
Drying racks	10 000	5
Other equipment	15 000	5
Pier	2 500 000	6
Machines + landpreparation	100 000	
Contingencies	300 000	

7. CONCLUSION

<u>Annual income</u>

Before improvements	2 155 000 Skr	7
After -"-	2 870 000	8
Net income	715 000 Skr	9

<u>Annual cost</u>

First year	642 000 Skr
Second year	632 000 "
Third year	620 000 "

As the result shows above it is worth to invest in the proposed project to achieve the aims. In the authors opinion it is better to develop small landing places and make certain improvements rather than develop advanced ports.

COSTS FOR ICE PLANT

Equipment

- Water-cooled slice-ice unit
  Capacity 4T/24H , 2.5 mm thickness
- Water-cooled condensing unit 3000 kcal/H
  at -15°/+40° C incl. electric switchboard
- Air cooler
- Pipes , valves etc

The cost is 320.000 DKR for the capacity 4T/24H . The extra cost for 8T/24H is about 70.000 DKR

The need is about 10T/24H and the cost is $\frac{70'}{4} \cdot 6 + 320' = 425.000$ DKR

1 SKR is equal to 1,2 DKR

$\frac{425.000}{1,2} = 354.000$ SKR for the machinery

Above mentioned figures are fetched from Engineering Consult Atlas DK's calculations.

Appendix 2

The fish handled will be a) consumed fresh
b) dried

Fish for consumption will be iced, put in cold storage or loaded directly on trucks for further transports.

Area requirement for ice maker and refrigeration plant is about 20 m^2 for a 10 ton ice plant according to "Planning and engineering data". Fresh fish handling.

Costs for the square meter wall area is as below:

concrete	100:-
reinforcement	100:-
form work 2 sides	300:-
insulation	100:-
vapour barrier	30:-
crossbar	20:-
internal lining	70:-
	720:- SKR

This figures are fetched från Scandiaconsults report FAO - PROSJEKTERING A/S, calculations

Bi 27 (84-09)

Storage capacity needed

$0.07 \cdot 80 \quad = 5.6$ ton/day

$0.35 \cdot 30 \quad = 10.5$ -"-

$\quad\quad\quad\quad\quad 16.1$ ton fish/day

About 50% is stored $\Rightarrow$ storage capacity needed is $0.5 \cdot 16.1 \approx 8.0$ ton/day

Storage room dimensions are according to Engineering Consult Atlas DK

$3 \times 4 \times 2.4$ m

Cost for the ice plant will be

$2 \cdot (3 \times 4 + 3 \times 2.4 + 4 \times 2.4) \cdot 720 = \boxed{42.000}$ SKR

COST FOR THE COLD STORE

The catch will be fetched everyday during the pick period and transported to Aden. In other case the catch will be stored for about 3 or 4 days before further transportation. In case there is something wrong with the transporting vehicle or the fish which is going to be dried has to be stored before getting any place on the drying yard the necessary capacity will be 20 T.

The internal volume per T of fish stored is 5.0 m^3/t

Total volume required for the cold store is $5 \cdot 20 = 100\ m^3$

We assume that the cold store will have dimensions $6.0 \times 6.0 \times 2.5$

Surface area will be $(6 \cdot 6 + 6 \cdot 2.5 + 6 \cdot 2.5) \times 2$

$= 132\ m^2$

Cost for the cold store

$132 \cdot 720^{*}$ SKR/m^2 $=$ $\boxed{95.000 \text{ SKR}}$

* Se appendix 2

BI 27 (84-09)

COST FOR THE FISHBOXES

We assume that the amount of boxes needed will be for about 12 T catch. Each box will carry 30 kg ⇒ 400 boxes has to be purchased

Cost per unit 50 SKR ⇒ 50·400 = $\boxed{20.000 \text{ SKR}}$

COST FOR THE TRAILORS

Our guess is that about 20 trailors are needed. Estimated cost for each trailor will be 500 SKR

Total cost will be 500·20 = $\boxed{10.000 \text{ SKR}}$

Above mentioned costs are estimated by getting advice by skilled people at Scandiaconsult.

DRYING COST

How much does it cost to dry fish? There can never be one universal answer to that question. it may not even be the right question to ask. Perheps the question should be how much will the consumer pay for the finished product? The answer to that may well determine what the maximum processing cost is to be for raw material at a given price.

The fish is going to be dried natural. During the peak period it will be about 6T fish/day to dry. The land area needed is 1 m^2 for about 15 kg fish. Total landarea needed for about 5 days drying is $\frac{6000}{15} \cdot 1.5 = 2.000 m^2$

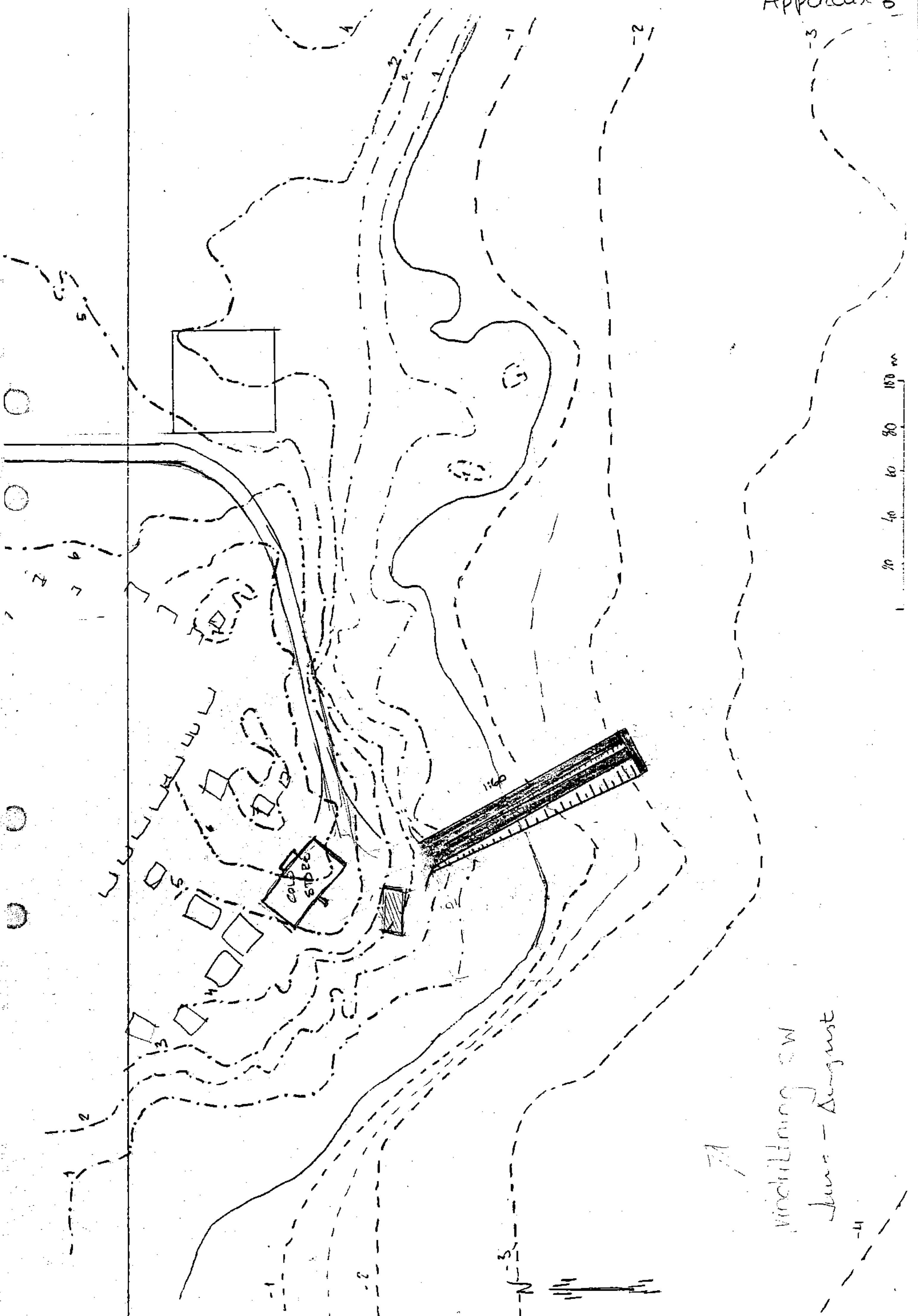
We assume that it won't cost anything to receive the land area.

Drying racks need about 1/3 space of the land. For 1 m^2 it costs 2.4 \$. The cost will be $2000/3 \times 3.2 \cdot 4.6 = \boxed{10.000 \text{ skr}}$

Costs for miscellaneous equipment is assumed to be $\boxed{15.000 \text{ skr}}$

BI 27 (84-09)

Appendix 6



STRUCTURAL CALCULATIONS.

BLOCKWORK QUAY

A. DESIGN LOADS

1. Vertical line loads 5 kN/m²
2. Loading of Bollards
   .1 line pull 100 kN
   .2 Alt. 15 kN/m
3. Earth Pressure
   .1 Active Earth Pressure
   .2 Active Earth Pressure from line load

   Angle of internal friction

   Rubble $\varphi = 35°$

   Angle of wall friction

   Rubble $\delta = 17{,}5°$

Density kN/m³		sand	Rubble
Above water	$\gamma = 18$		18
Submerged	$\gamma' = 11$		11

4. Water pressure

The permeability between the blocks and in the backfill is good. Calculate with a water pressure differance on the quay wall of half the height of the highest waves to be expected.

Heighest waves height = 1.0 m
Water pressure differance = 0.5 m
$P_w = 0.5 \cdot 10 = 5,0 \ kN/m^2$

be controlled

The stability of the quay will bee controled at two water levels.

MLLW approx. − 0.1 m
MHHW " + 1.3 m

B. Calculation

1. Ground pressure

.1 The bottom joint

For long time loads – dead loads, vertical line load and loading of water pressure difference – the resultant shall remain in the middle third of the foundation bearing area.

For short time loads – loading of Ballard – the resultant shall remain in the three middle fifths when acting simultaneously with all other unfavorable forces.

har el räknat

Description of Soil and Rock

The northern part of the investigated area (land area) consists of sand overlying rock in a 0 to more than 6 m thick layer. South of the shoreline a 5 to 20 m wide uneven "platform" of lava rock is visible at low-water level.

In the southern part of the investigated area a reef is situated only 1–3 m below low-water level. The reef consists of lava-rock covered with sand, boulders and coral. The maximum depth of sand in this area was recorded to about 3.0 m.

Between mentioned areas the harbour basin in question will be arranged. Borings in this area indicated the same ground conditions with sand overlaying rock. However, the depth of the sand varies from 0 to more than 10 m, the higher figure occuring in the middle of this area. The upper part of the sandlayer is soft and gives very little resistance when drilling.

Conclusions

The investigation indicate that soil conditions are suitable for the proposed project with respect to the following conclusions:

Breakwaters can be built by placing rockfill direct on the sea bed. A slight compression of the ground will take place when filling but will set immediately and give no long term settlement.

.2 Joints in the Block Wall

When all unfavorable forces are applied simultaneously the resultant shall remain in the four middle sixths of the foundation bearing area

2. Sliding

.1 The sliding safety shall not be less than 1.5 when all unfavorable forces are applied simultaneously including water pressure difference as well as hydralic uplift

---

Active Earth Pressure

$$K_A = \frac{\cos^2 \varphi}{\cos \delta \left[1 + \sqrt{\dfrac{\sin(\varphi + \delta) \sin \varphi}{\cos \delta}} \right]^2}$$

Rubble $\varphi = 35^\circ$ $\quad K_A = 0.25$
$\delta = 17.5^\circ$

WATER LEVEL -0.1 m

-0.1 $\quad p_A = 1.4 \cdot 1,8 \cdot 0.25 = 0.63$ $\quad t/m^2$

-1.1 $\quad p_A = 0.63 + 1,0 \cdot 1,1 \cdot 0,25 = 0.90$ $\quad$ "

$-2,2$ $\quad p_A = 0.90 + 1,1 \cdot 1,1 \cdot 0,25 = 1.21$ $\quad$ "

LIVE LOAD $0.5\ t/m^2$

$$p_L = 0.25 \cdot 0.5 = 0,12\ t/m^2$$

WATER LEVEL $+1.3$ m

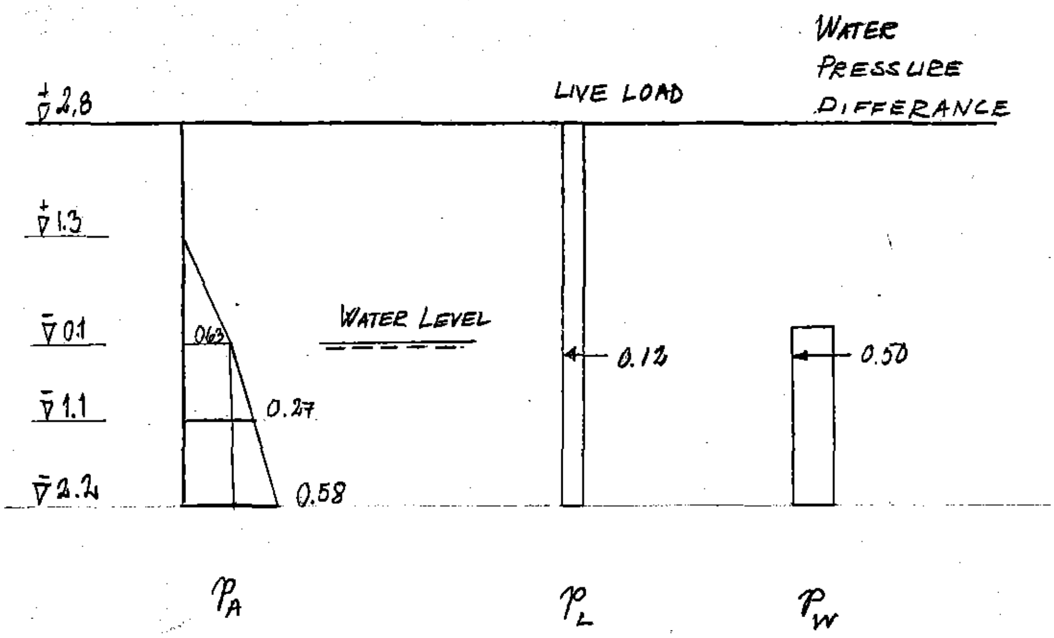
$+1.3$ $\quad p_A = 0$

-0.1 $\quad p_A = 1.4 \cdot 1,1 \cdot 0.25 = 0.38$ $\quad t/m^2$

$-1,1$ $\quad p_A = 0,38 + 1,0 \cdot 1,1 \cdot 0.25 = 0.66$ $\quad$ "

$-2,2$ $\quad p_A = 0,66 + 1,1 \cdot 1,1 \cdot 0,25 = 0.96$ $\quad$ "

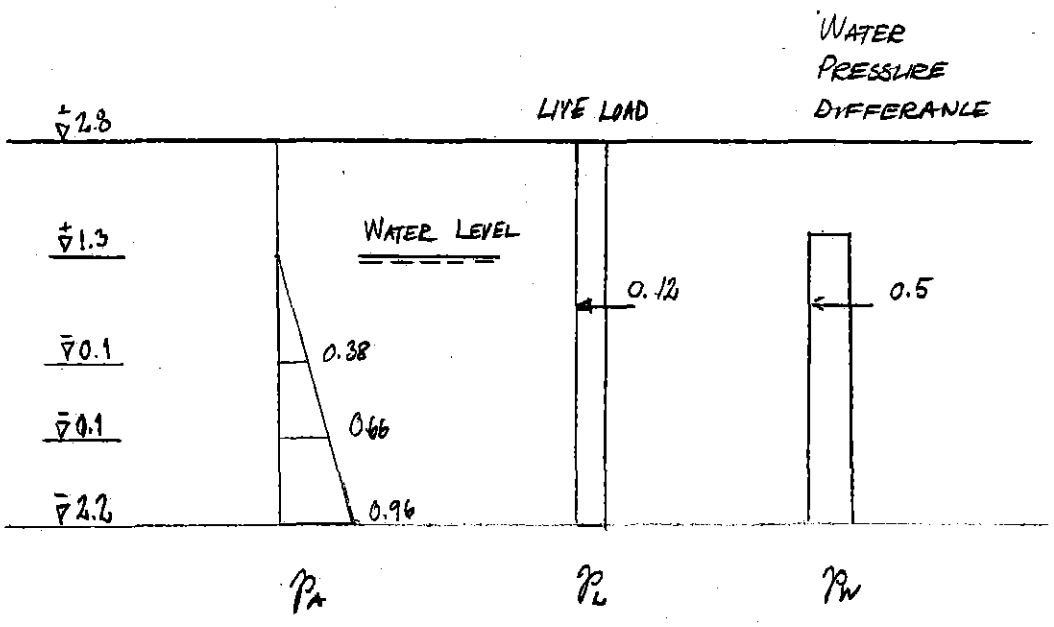
HORIZONTAL FORCES WATER LEVEL -0.1



WATER LEVEL −0.1

JOINT			H t/m	e m	M tm/m
−0.1	p_A	$0.63 \cdot 1.4 \frac{1}{2}$	0.44	0.47	0.21
	p_L	$0.12 \cdot 2.9$	0.35	1.45	0.50
			0.79		0.71
−1.1	p_A		0.44	1.47	0.65
		$0.63 \cdot 1.0$	0.63	0.5	0.32
		$0.27 \cdot 1.0 \cdot \frac{1}{2}$	0.14	$1/3$	0.05
	p_L	$0.12 \cdot 3.9$	0.47	1.95	0.91
	p_W	$0.5 \cdot 1.25$	0.62	0.62	0.38
			2.30		2.31
−2.2	p_A		0.44	2.57	1.13
		$0.63 \cdot 2.1$	1.32	1.05	1.39
		$0.58 \cdot 2.1 \frac{1}{2}$	0.61	$2.1/3$	0.43
	p_L	$0.12 \cdot 5$	0.60	2.5	1.60
	p_W	$0.5 \cdot 2.35$	1.18	1.18	1.38
			4.15		5.83

HORIZONTAL FORCES WATER LEVEL +1.3



WATER LEVEL + 1.3

JOINT			H t/m	e m	M tm/m
-0.1	p_A	$0.38 \cdot 1.4 \cdot \frac{1}{2}$	0.27	1.4/3	0.13
	p_L	$0.12 \cdot 2.9$	0.35	1.45	0.50
	p_W	$0.5 \cdot 1.65$	0.82	0.82	0.68
			1.44		1.30
-1.1	p_A	$0.66 \cdot 2.4 \frac{1}{2}$	0.79	2.4/3	0.63
	p_L	$0.12 \cdot 3.9$	0.47	1.95	0.91
	p_W	$0.5 \cdot 2.65$	1.32	1.32	1.76
			2.58		3.28
-2.2	p_A	$0.96 \cdot 3.5 \frac{1}{2}$	1.68	3.5/3	1.96
	p_L	$0.12 \cdot 5.0$	0.60	2.5	1.50
	p_W	$0.5 \cdot 3.75$	1.88	1.88	3.52
			4.16		6.98

VERTICAL DEAD LOAD OF BLOCKWORK

DENSITY OF CONCRETE

ABOVE WATER $2.3\ t/m^3$

SUBMERGE $1.3\ t/m^3$

WATER LEVEL -0.1

BLOCK TYPE 1-4 $V_{1-4} = 0.5 \cdot 3.0 \cdot 2.3 = 3.45\ t/m$

5 $V_5 = 0.4 \cdot 3.0 \cdot 2.3 + 0.1 \cdot 3.0 \cdot 1.3 =$

$= 3.15\ t/m$

6-9 $V_{6-9} = 0.5 \cdot 3.0 \cdot 1.3 = 1.95\ t/m$

WATER LEVEL +1.3

BLOCK TYPE 1-2 $V_{1-2} = \quad = 3.45\ t/m$

3-9 $V_{3-9} = \quad = 1.95\ t/m$

CAPPING $V_{11} = 0.5 \cdot 3.0 \cdot 2.3 = 3.45\ t/m$

THE RESULTANT POSITION

BLOCK WORK QUAY WATER LEVEL -0.1

JOINT -0.1	V t/m	e m	M tm/m
V_{11}	3.45	1.5	5.18
V_{1-4}	13.80	1.5	20.70
WALL FRICTION 0.79 tan 17.5	0.25	3.0	0.75
HORIZONTAL FORCES	0		-0.71
	17.50	1.48	25.92

$B/3 = 3.0/3 =$
$= 1.0$

JOINT -1.1

	V t/m	e m	M tm/m
V_{11}	3.45	1.5	5.18
V_{1-4}	13.80	1.5	20.70
V_5	3.15	1.5	4.73
V_6	1.95	1.5	2.93
	22.35		33.52
WALL FRICTION $(2.30-0.62)\tan 17.5^\circ$	0.53	3.0	1.59
HORIZONTAL FORCES	0		-2.31
HYDRAULIC UPLIFT			
$-3.0 \cdot 0.5 \cdot 0.5$	-0.75	$3.0 \cdot \frac{2}{3}$	-1.50
	22.13	1.41	31.30

$B/3 = 3.0/3 = 1.0$

JOINT -2.2

	V	e	M
$V_{11} + V_{1-6}$	22.35		33.52
V_{7-9}	5.85	1.5	8.78
	28.20		42.30
WALL FRICT. $(4.15-1.18)\,tg\,17.5$	0.94	3.0	2.81
HOR.	0		-5.83
HYDR. $-3.0 \cdot 0.5 \cdot 0.5$	-0.75	$3 \cdot \frac{2}{3}$	-1.50
	28.39	1.33	37.78

$B/3 = 3.0/3 = 1.0$

THE RESULTANT POSITION

BLOCK WORK QUAY WATER LEVEL +1.3

JOINT -0.1

	V t/m	e m	M tm/m
V_{11}	3.45	1.5	5.18
V_{1-2}	6.90	1.5	10.35
V_{3-4}	3.90	1.5	5.85
	14.25		21.38
WALL FRICTION $(1.44-0.82)\,tg\,17.5$	0.20	3.0	0.59
HOR.	0		− 1.30
HYDR. $-3.0 \cdot 0.5 \cdot 0.5$	− 0.75	$3.0\,\frac{2}{3}$	− 1.50
	13,70	1.40	19.17

$B/3 = 3.0/3 = 1.0$

JOINT -1.1

	V t/m	e m	M tm/m
$V_{11} - V_{1-4}$	14.25		21.38
V_{5-6}	3.90	1.5	5.85
	18.15		27.23
WALL FRICTION $(2.58-1.82)\,tg\,17.5$	0.40	3.0	1.19
HOR.	0		− 3.28
HYDR. $-3.0 \cdot 0.5 \cdot 0.5$	− 0.75	$3.0\,\frac{2}{3}$	− 1.50
	17.80	1.33	23.64

$B/3 = 3.0/3 = 1.0$

JOINT -2.2

	V t/m	e m	M tm/m
$V_{11} + V_{1-6}$	18.15		27.23
V_{7-9}	5.85	1.5	8.77
	24.00		36.00
WALL FR. $(4.16 - 1.88) \, tg \, 17.5$	0.72	3.0	2.16
HOR.	0		- 6.98
HYDR - $3.0 \cdot 0.5 \cdot 0.5$	- 0.75		- 1.50
	23.97	1.24	29.68

$B/3 = 3.0/3 = 1.0$

A - A

ACTIVE EARTH PRESSURE

$$K_A = \frac{\cos^2\varphi}{\cos\delta\left[1+\sqrt{\frac{\sin(\varphi+\delta)\sin\varphi}{\cos\delta}}\right]^2}$$

RUBBLE $\varphi = 35°$ $\delta = 17.5°$ $K_A = 0.25$

WATER LEVEL -0.1 m

-0.1 $p_A = 1.4 \cdot 1.8 \cdot 0{,}25 = 0.63$ t/m^2

-1.1 $p_A = 0.63 + 1.0 \cdot 1.1 \cdot 0.25 = 0.90$ t/m^2

-2.1 $p_A = 0.90 + 1.0 \cdot 1{,}1 \cdot 0{,}25 = 1.18$ t/m^2

LIVE LOAD $0.5\ t/m^2$

$p_L = 0.25 \cdot 0.5 = 0.12\ t/m^2$

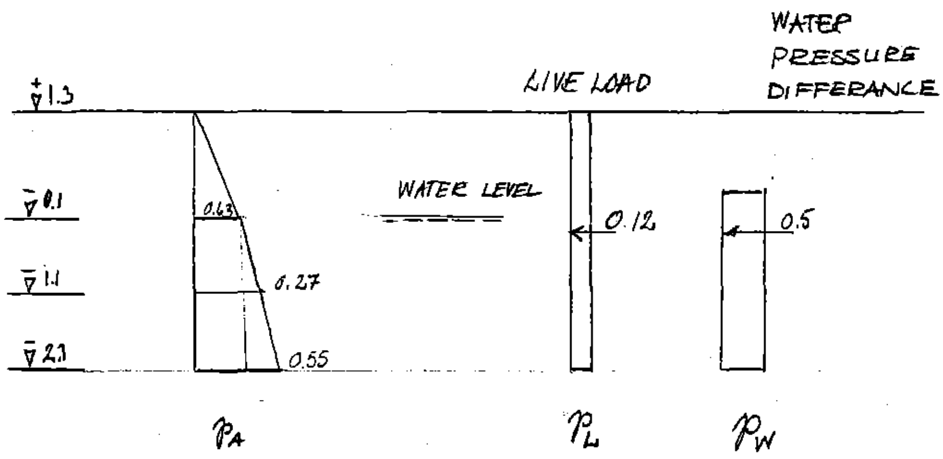
WATER LEVEL $+1{,}3$ m

-0.1 $p_A = 1.4 \cdot 1{,}1 \cdot 0{,}25 = 0.38$ t/m^2

-1.1 $p_A = 0.38 + 1{,}0 \cdot 1{,}1 \cdot 0{,}25 = 0.66$ t/m^2

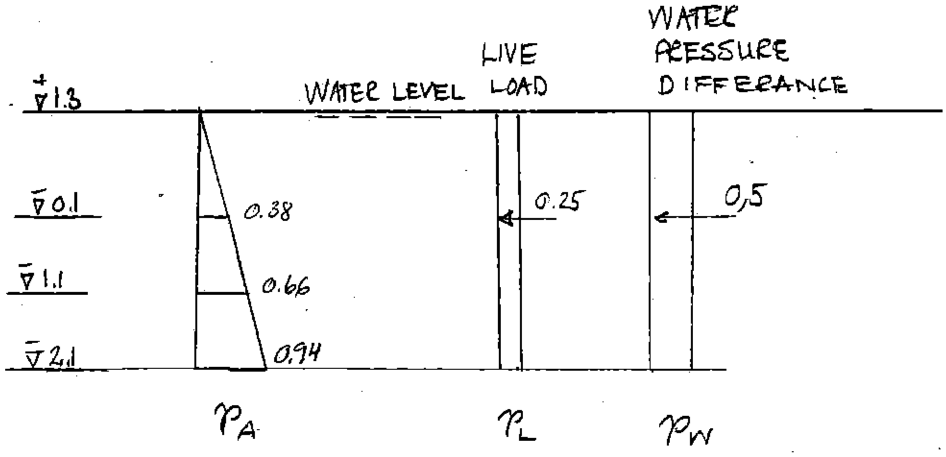
-2.1 $p_A = 0.66 + 1.0 \cdot 1{,}1 \cdot 0.25 = 0.94$ t/m^3

HORIZONTAL FORCES WATER LEVEL -0.1



JOINT		H t/m	e m	M tm/m
-0.1				
p_A	$0.63 \cdot 1.4 \cdot \frac{1}{2}$	0.44	0.47	0.21
p_L	$0.12 \cdot 1.4$	0.17	0.7	0.12
		0.61		0.33
-1.1				
		0.44	1.47	0.65
p_A	$0.63 \cdot 1.0$	0.63	0.5	0.32
	$0.27 \cdot 1.0 \cdot \frac{1}{2}$	0.14	1/3	0.05
p_L	$0.12 \cdot 2.4$	0.29	1.2	0.35
p_W	0.5 1.25	0.62	0.62	0.38
		2.12		1.75
-2.1				
		0.44	2.47	1.09
p_A	$0.63 \cdot 2.0$	1.26	1.0	1.26
	$0.55 \cdot 2.0 \cdot \frac{1}{2}$	0.55	2/3	0.37
p_L	$0.12 \cdot 3.4$	0.41	1.7	0.69
p_W	$0.5 \cdot 2.35$	1.18	1.18	1.38
		3.84		4.79

HORIZONTAL FORCE WATER LEVEL +1.3



JOINT −0.1		H t/m	e m	M tm/m
p_A	$0.38 \cdot 1.4 \cdot \frac{1}{2}$	0.25	1.4/3	0.12
p_L	$0.12 \cdot 1.4$	0.17	0.7	0.12
p_W	$0.5 \cdot 1,4$	0.70	0.7	0.49
		1.12		0.73

− 1.1				
p_A	$0.66 \cdot 2.4 \frac{1}{2}$	0.79	2.4/3	0.63
p_L	$0,12 \cdot 2.4$	0.29	1.2	0.35
p_W	$0.5 \cdot 2,4$	1.20	1.2	1.44
		2.28		2.42

− 2.1				
p_A	$0,94 \cdot 3.4 \frac{1}{2}$	1.60	3.4/3	1.81
p_L	$0.12 \cdot 3.4$	0.41	1.7	0.69
p_W	$0.5 \cdot 3.4$	1.70	1.70	2.89
		3.71		5.39

VERTICAL DEAD LOAD OF BLOCKWORK

DENSITY OF CONCRETE

ABOVE WATER	2.3	t/m^3
SUBMERGE	1.3	t/m^3

WATER LEVEL -0.1

BLOCKTYPE

1	$V_1 = 3{,}0 \cdot 0.5 \cdot 2.3 = 3.45$ t/m
2-5	$V_{2-6} = 3.0 \cdot 0{,}5 \cdot 1.3 = 1.95$ t/m
CAPPING	$V_{11} = 3.0 \cdot 0.9 \cdot 2.3 = 6.21$ t/m

WATER LEVEL +1.3

BLOCKTYPE

1-5	$V_{1-6} = 3.0 \cdot 0.5 \cdot 1{,}3 = 1.95$ t/m
CAPPING	$V_{11} = 3{,}0 \cdot 0.9 \cdot 1{,}3 = 3.51$ t/m

THE RESULTANT POSITION

BLOCK WORK QUAY WATER LEVEL −0.1

JOINT	V t/m	e m	M tm/m
−0.1			
V_{11}	6.21	1.5	9.32
V_1	3.45	1.5	5.18
WALL FRICTION 0.61 tan 17.5	0.19	3.0	0.58
HORIZONTAL FORCES	0		−0.33
	9.85	1.50	14.75

$$\boxed{B/3 = 3.0/3 = 1.0}$$

−1.1			
V_{11}	6.21	1.5	9.32
V_1	3.45	1.5	5.18
V_{2-3}	3.90	1.5	5.85
W.F (2.12−0.62) tan 17.5	0.47	3.0	1.42
HOR.	0		−1.75
HYDRAULIC UPLIFT 3.0·0.5·0.5	−0.75	$3.0 \cdot \frac{2}{3}$	−1.50
	13.28	1.39	18.52

−2.1			
V_{11}	6.21	1.5	9.32
V_1	3.45	1.5	5.18
V_{2-5}	7.80	1.5	11.70
W.F. (3.84 − 1.18) · tan 17.5	0.84	3.0	2.52
HOR	0		−4.79
HYD	−0.75	$3.0 \cdot \frac{2}{3}$	−1.50
	17.55	1.28	22.43

THE RESULTANT POSITION

BLOCK WORK QUAY WATER LEVEL +1.3

JOINT		V t/m	e m	M tm/m
−0.1				
V_{II}		3.51	1.5	5.26
V_{I}		1.95	1.5	2.92
W.F	(1.12−0.7) tan 17.5	0.13	3.0	0.40
HOR.		0		−0.73
HYD	3,0·0,5·0,5	−0,75	$3\cdot\frac{2}{3}$	−1.50
		4.84	1.31	6.35

$\boxed{B/3 = 3.0/3 = 1.0}$

JOINT		V t/m	e m	M tm/m
−1,1				
V_{II}		3.51	1.5	5.26
V_{I-3}		5,85	1,5	8.78
W.F	(2,28−1.2) tan 17.5	0.34	3.0	1.02
HOR.		0		−2.42
HYDR.	3,0·0,5·0,5	−0.75	$3\frac{2}{3}$	−1.50
		8.95	1.24	11.14
−2.1				
V_{II}		3.51	1.5	5.26
V_{I-5}		9,75	1.5	14.62
W.F.	(3.71 − 1.7) tan 17.5	0.63	3.0	1,90
HOR		0		−5.39
HYDR.	3,0·0,5·0,5	−0.75	$3\cdot\frac{2}{3}$	−1.50
		13.14	1.13	14.89

B - B

ACTIVE EARTH PRESSURE

RUBBLE $\varphi = 35°$ $\delta = 17.5°$ $K_A = 0.25$

WATER LEVEL -0.1 m

-0.1 $p_A = 2.13 \cdot 1.8 \cdot 0.25 = 0.96$ t/m^2

-1.0 $p_A = 0.96 + 0.9 \cdot 1.1 \cdot 0.25 = 1.21$ t/m^2

LIVE LOAD 0.5 t/m^2

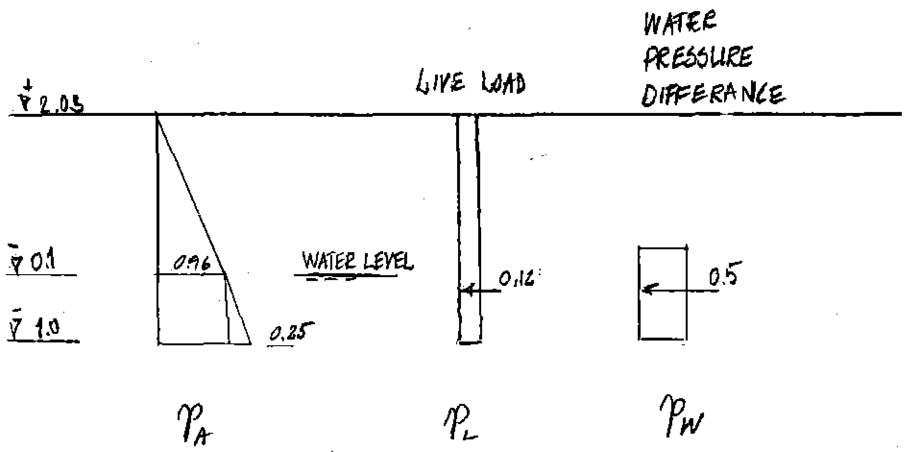
$p_L = 0.25 \cdot 0.5 = 0.12$ t/m^2

WATER LEVEL

-0.1 $p_A = 0.73 \cdot 1.8 \cdot 0.25 + 1.4 \cdot 1.1 \cdot 0.25 = 0.71$ t/m^2

-1.0 $p_A = 0.71 + 0.9 \cdot 1.1 \cdot 0.25 = 0.96$ t/m^2

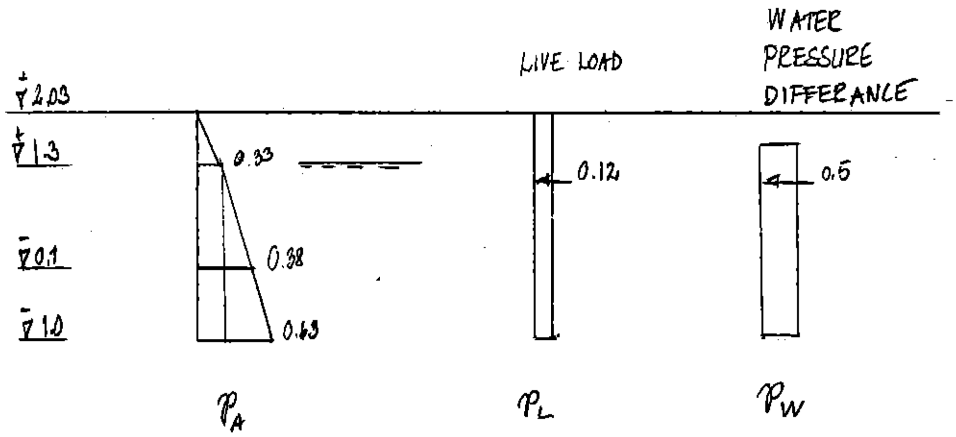
HORIZONTAL FORCES WATER LEVEL -0.1



JOINT -0.1		H t/m	e m	M tm/m
P_A	$0.96 \cdot 2.13 \cdot \frac{1}{2}$	1.02	2.13/3	0.72
P_L	$0.12 \cdot 2.13$	0.26	2.13/2	0.27
		1.28		0.99

−1.0				
		1.02	0.9+2.13/3	1.64
P_A	$0.96 \cdot 0.9$	0.86	0.45	0.39
	$0.25 \cdot 0.9 \frac{1}{2}$	0.11	0.3	0.03
P_L	$0.12 \cdot 3.03$	0.36	3.03/2	0.55
P_W	$1.15 \cdot 0.5$	0.58	0.58	0.33
		2.93		2.94

HORIZONTAL FORCES WATER LEVEL +1.3



JOINT -0.1		H t/m	e m	M tm/m
P_A	$0.33 \cdot 0.73 \cdot \frac{1}{2}$	0.12	1.4+0.73/3	0.20
	$0.33 \cdot 1.4$	0.46	0.7	0.32
	$0.38 \cdot 1.4 \frac{1}{2}$	0.27	0.7	0.19
P_L	$0.12 \cdot 2.13$	0.26	2.13/2	0.28
P_W	$0.5 \cdot 1.65$	0.83	0.83	0.68
		1.94		1.67

JOINT −1.0		H t/m	c m	M tm/m
		0.12	2.3 + 0.73/3	0.31
p_A	0.33 · 2.3	0.76	2.3/2	0.87
	0.63 · 2.3 · ½	0.72	2.3/2	0.83
p_L	0.12 · 3.03	0.36	3.03/2	0.55
p_W	0.5 · 2.55	1.28	1.28	1.63
		3.24		4.19

VERTICAL DEAD LOAD OF BLOCKWORK

DENSITY OF CONCRETE

ABOVE WATER 2.3 t/m^3

SUBMERGE 1.3 t/m^3

WATER LEVEL −0.1

BLOCK TYPE

1 − 3 $V_{1-3} = 2{,}5 \cdot 0.5 \cdot 2{,}3 = 2{,}88$ t/m

4 $V_4 = 2{,}5 \cdot 0.1 \cdot 2{,}3 + 2{,}5 \cdot 0.4 \cdot 1{,}3 = 1.88$ t/m

5 $V_5 = 2.5 \cdot 0.5 \cdot 1.3 = 1.62$ t/m

CAPPING $V_{11} = 2{,}5 \cdot 0.53 \cdot 2{,}3 = 3{,}05$ t/m

WATER LEVEL + 1.3

BLOCK TYPE

1 $V_1 = 2.5 \cdot 0{,}2 \cdot 2{,}3 + 2.5 \cdot 0{,}3 \cdot 1{,}3 = 2{,}12$ t/m

2 − 5 $V_{2-5} = 2.5 \cdot 0.5 \cdot 1.3 = 1.62$ t/m

CAPPING $V_{11} = 2.5 \cdot 0.53 \cdot 2{,}3 = 3.05$ t/m

THE RESULTANT POSITION

BLOCK WORK QUAY WATER LEVEL -0.1

JOINT -0.1	V t/m	e m	M tm/m
V_{11}	3.05	1.25	3.81
V_{1-3}	8.64	1.25	10.80
WALL FRICTION 1.28 tan 17.5	0.40	2.50	1.01
HORIZONTAL FORCES	0		-0.99
	12.09	1.21	14.63

$\boxed{B/3 = 2.5/3 = 0.83}$

-1.0			
V_{11}	3.05	1.25	3.81
V_{1-3}	8.64	1.25	10.80
V_4	1.88	1.25	2.35
V_5	1.62	1.25	2.02
W.F (2.93-0.58) tan 17.5	0.74	2.50	1.85
HORIZONTAL FORCES	0		-2.94
HYDRAULIC UPLIFT 2.5·0.5·0.5	-0.62	2.5 $\frac{2}{3}$	-1.04
	15.31	1.10	16.85

WATER LEVEL +1.3

-0.1			
V_{11}	3.05	1.25	3.81
V_1	2.12	1.25	2.65
V_{2-3}	3.24	1.25	4.05
W.F. (1.94-0.83) tan 17.5	0.35	2.50	0.87
H.F	0		-1.67
H.U. 2.5·0.5·0.5	-0.62	2.5 $\frac{2}{3}$	-1.04
	8.14	1.07	8.67

JOINT -1.0	V t/m	e m	M tm/m
V_{11}	3.05	1,25	3.81
V_1	2.12	1.25	2.65
V_{2-5}	6,48	1.25	8.10
W.F (3.24-1.28) tan 17.5	0.62	2.5	1.54
HOR.F	0		-4.19
HYDR. $2.5\ 0.5^2$	-0.62	$2.5 \cdot \frac{2}{3}$	-1.04
	11.65	0.93	10.87

C-C

ACTIVE EARTH PRESSURE

RUBBLE $K_A = 0.25$

WATER LEVEL -0.1

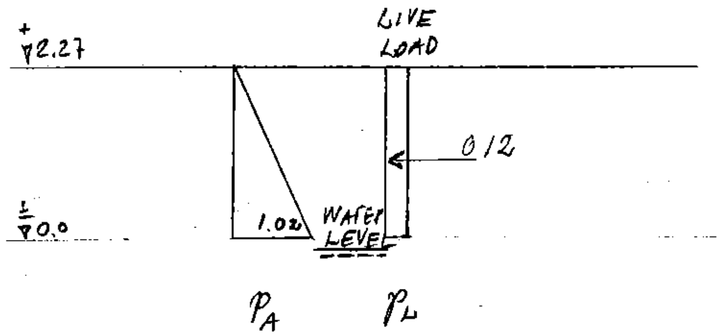
$\pm 0.0 \quad p_A = 2.27 \cdot 1.8 \cdot 0.25 = 1.02 \quad t/m^2$

WATER LEVEL +1.3

$+1.3 \quad p_A = 0.97 \cdot 1.8 \cdot 0.25 = 0.44 \quad t/m^2$

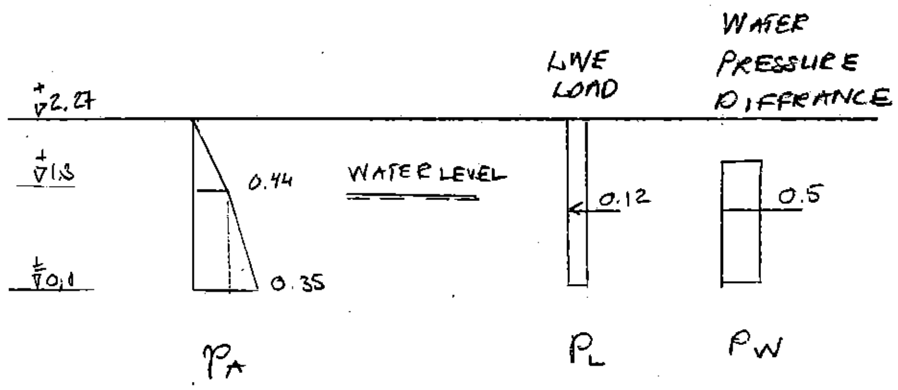
$\pm 0.0 \quad p_A = 0.44 + 1.3 \cdot 1.1 \cdot 0.25 = 0.79 \quad t/m^2$

HORIZONTAL FORCES WATER LEVEL -0.1



JOINT		H t/m	e m	M tm/m
±0				
p_A	$1.02 \cdot 2.27 \frac{1}{2}$	1.16	$2.27/3$	0.88
p_L	$0.12 \cdot 2.27$	0.27	$2.27/2$	0.31
		1.43		1.19

HORIZONTAL FORCES WATER LEVEL +1.3



JOINT ±0.0		H t/m	e m	M tm/m
P_A	$0.44 \cdot 0.97 \frac{1}{2}$	0.21	$1.3 + \frac{0.97}{3}$	0.35
	$0.44 \cdot 1.3$	0.57	1.3/2	0.37
	$0.35 \cdot 1.3 \cdot \frac{1}{2}$	0.23	1.3/3	0.10
P_L	$0.12 \cdot 2.27$	0.27	2.27/2	0.31
P_W	$0.5 \cdot 1.55$	0.78	0.78	0.60
		2.06		1.73

VERTICAL DEAD LOAD OF BLOCKWORK

WATER LEVEL − 0.1

BLOCK TYPE

1 − 3 $V_{1-3} = 0.5 \cdot 2.0 \cdot 2.3 = 2.30$ t/m

CAPPING $V_{11} = 0.77 \cdot 2.0 \cdot 2.3 = 3.54$ t/m

WATER LEVEL + 1.3

BLOCK TYPE

1 $V_1 = 0.2 \cdot 2.0 \cdot 2.3 + 0.3 \cdot 2.0 \cdot 1.3 =$

$= 1.70$ t/m

2 − 3 $V_{2-3} = 0.5 \cdot 2.0 \cdot 1.3 = 1.3$ t/m

CAPPING $V_{11} = 0.77 \cdot 2.0 \cdot 2.3 = 3.54$ t/m

THE RESULTANT POSITION

BLOCK WORK QUAY WATER LEVEL −0.1

JOINT	V t/m	e m	M t/m
± 0.00			
V_{11}	3.54	1,0	3.54
V_{1-3}	6,90	1.0	6.90
W.F 1.48 tan 17.5	0.45	2.0	0.90
HOR. F	0		−1.19
	10.89	0.93	10.15

$\boxed{B/3 = 2.0/3 = 0.67}$

WATER LEVEL +1.3

± 0.0			
V_{11}	3.54	1.0	3.54
V_1	1.70	1.0	1.70
V_{2-3}	2,60	1,0	2.60
WF (2.06 − 0.78) tan 17.5	0.40	2.0	0.81
HOR. F.	0		−1.73
HYDR. 2.0 · 0.5 · 0.5	−0.50	$2 \cdot \frac{2}{3}$	−0.67
	8,74	0.71	6.25

D - D

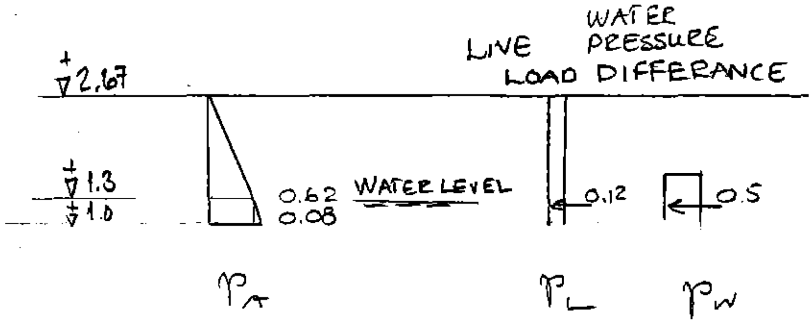
ACTIVE EARTH PRESSURE

RUBBLE $K_A = 0.25$

WATER LEVEL + 13

$+1.0 \quad p_A = 1.37 \cdot 1.8 \cdot 0.25 + 0.3 \cdot 1.1 \cdot 0.25 = 0.70 \, t/m^2$

HORIZONTAL FORCES WATER LEVEL +1.3



JOINT +1.0		H t/m	e m	H tm/m
p_A	$0.62 \cdot 1.37 \cdot \frac{1}{2}$	0.42	$1.37/3 + 0.3$	0.32
	$0.62 \cdot 0.3$	0.19	0.15	0.03
	$0.08 \cdot 0.3 \frac{1}{2}$	0.01	0.1	0
p_L	$0.12 \cdot 1.67$	0.20	0.84	0.17
p_W	$0.5 \cdot 0.55$	0.28	0.28	0.08
		1.10		0.60

VERTICAL DEAD LOAD OF BLOCKWORK

WATER LEVEL +1.3

BLOCKTYPE

1 $\quad V_1 = 0.5 \cdot 1.0 \cdot 2.3 = 1.15 \, t/m$

2 $\quad V_2 = 0.2 \cdot 1.0 \cdot 2.3 + 0.3 \cdot 1.0 \cdot 1.3 =$
$= 0.85 \, t/m$

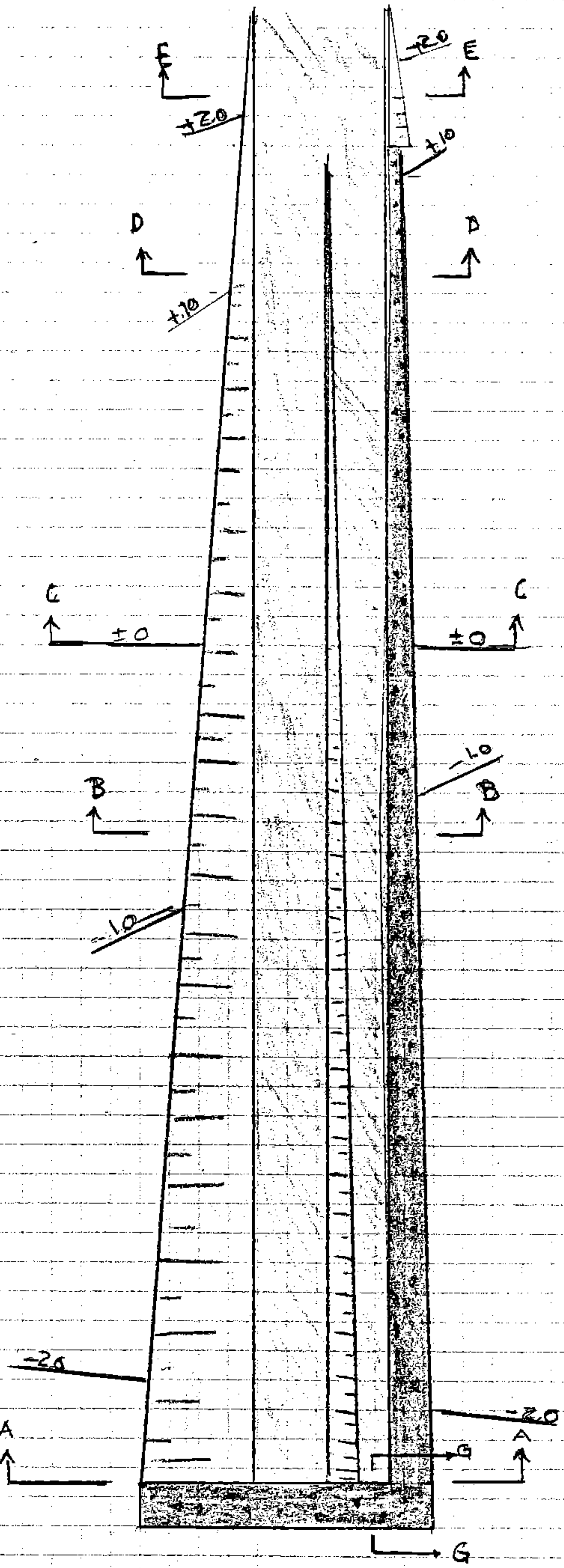
CAPPING $\quad V_{11} = 0.67 \cdot 1.0 \cdot 2.3 = 1.54 \, t/m$

THE RESULTANT POSITION

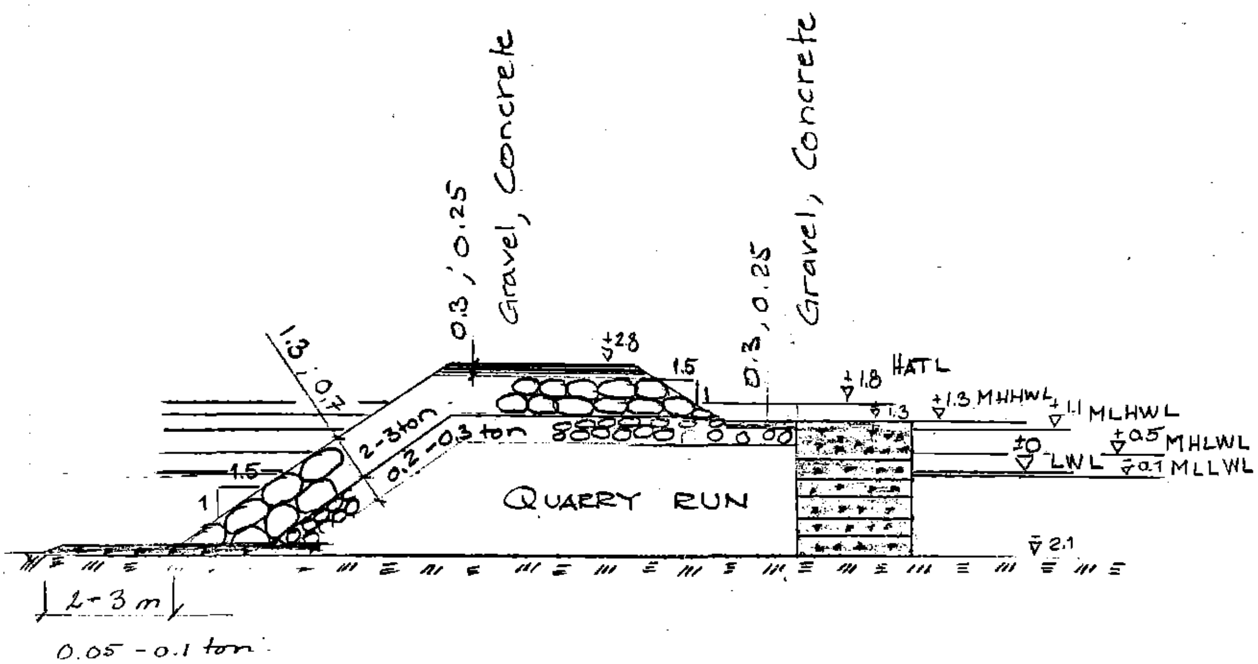
BLOCKWORK QUAY WATER LEVEL +1.3

JOINT +1,0	V t/m	e m	M tm/m
V_{11}	1.54	0.5	0.77
V_1	1.15	0.5	0.57
V_2	0.85	0.5	0.42
W.F (1.10 - 0.28) tm 17.5	0.26	1.0	0.26
HOR. F	0		- 0.60
HYDR. 1.0 0.5 · 0.5	- 0.25	$1.0 \cdot \frac{2}{3}$	- 0.17
	3.55	0.35	1.25

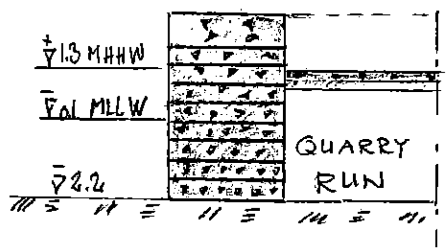
$$\boxed{B/3.0 = 1.0/3 = 0.33}$$

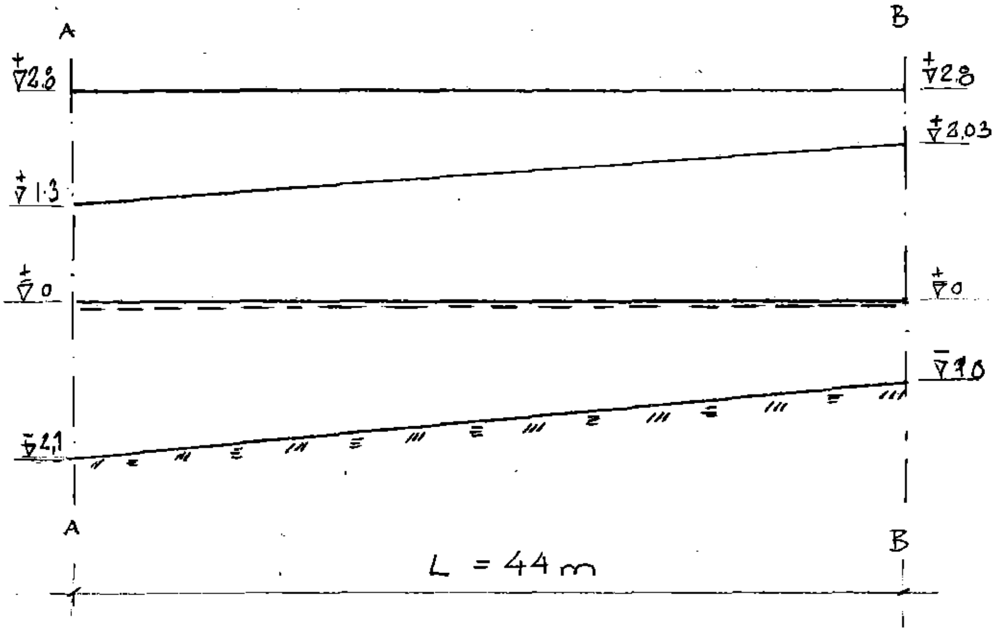

+20
E
E
+20
+10
D
D
+10
C
±0
C
±0
-10
B
B
-10
-20
-20
A
A
G
G

A - A

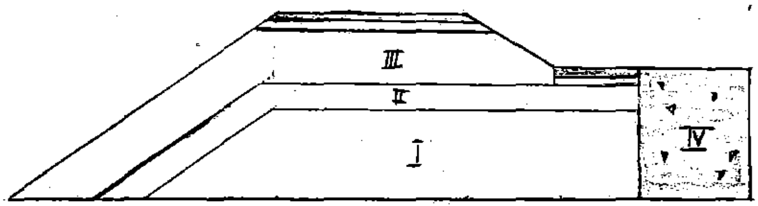

0.3 ; 0.25
Gravel, Concrete
0.3 , 0.25
Gravel, Concrete
1.3 , 0.7
+2.8
1.5
1
+1.8 HATL
+1.3 MHHWL
+1.1 MLHWL
+1.3
±0 LWL
+0.5 MHLWL
+0.1 MLLWL
2-3 ton
0.2 - 0.3 ton
1.5
1
QUARRY RUN
-2.1
2-3 m
0.05 - 0.1 ton

G-G


+1.3 MHHW
+0.1 MLLW
-2.2
QUARRY RUN



A - A



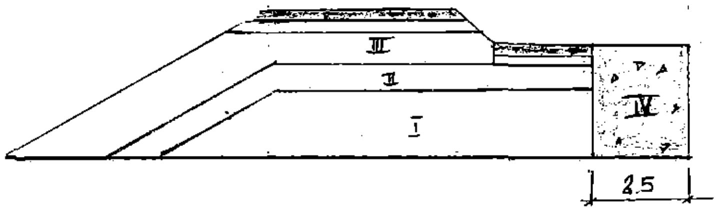
$$A_{I} = 9{,}6 \cdot 2{,}4 + 4.0 \cdot 2{,}4 \cdot \frac{1}{2} = 27.84 m^2$$

$$A_{II} = 9{,}6 \cdot 0{,}7 + 4.8 \cdot 0{,}7 = 10{,}08 m^2$$

$$A_{III} = 2.0 \cdot 1{,}3 \cdot \frac{1}{2} + 5.8 \cdot 1{,}3 + 7{,}3 \cdot 1.3 = 18.33$$

$$A_{IV} = 3{,}0 \cdot 3{,}4 = 10{,}20 m^2$$

B - B



$A_{I} = 8.4 \cdot 1.8 + 3.0 \cdot 1.8 \frac{1}{2} = 17.82 \ m^2$

$A_{II} = 8.4 \cdot 0.7 + 4.2 \cdot 0.7 = 8.82 \ m^2$

$A_{III} = 6.0 \cdot 0.8 + 5.9 \cdot 1.3 = 12.47 \ m^2$

$A_{IV} = 3.03 \cdot 2.5 = 7.58 \ m^2$

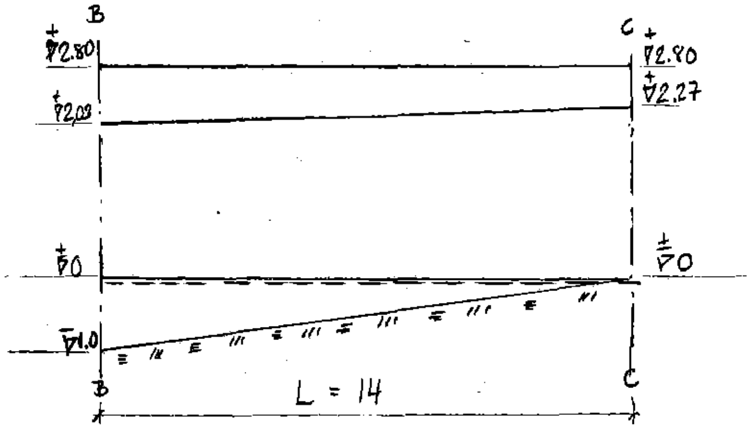
Volumes

$$V_{I} = \frac{27.84 + 17.82}{2} \cdot 44 = 1004.52 \ m^3$$

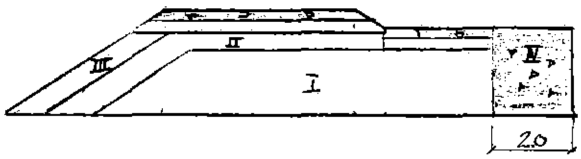
$$V_{II} = \frac{10.08 + 8.82}{2} \cdot 44 = 415.80 \ m^3$$

$$V_{III} = \frac{18.33 + 12.47}{2} \cdot 44 = 677.60 \ m^3$$

$$V_{IV} = \frac{10.20 + 7.58}{2} \cdot 44 = 391.16 \ m^3$$



C - C



$$A_{I} = 8.0 \cdot 1.7 + 2.4 \cdot 1.7 \cdot \tfrac{1}{2} = 15.64 \ m^3$$

$$A_{II} = 5.0 \cdot 0.4 + 3.4 \cdot 0.7 = 4.38 \ m^3$$

$$A_{III} = 4.0 \cdot 0.6 = 2.40 \ m^3$$

$$A_{IV} = 2.0 \cdot 2.03 = 4.06 \ m^3$$

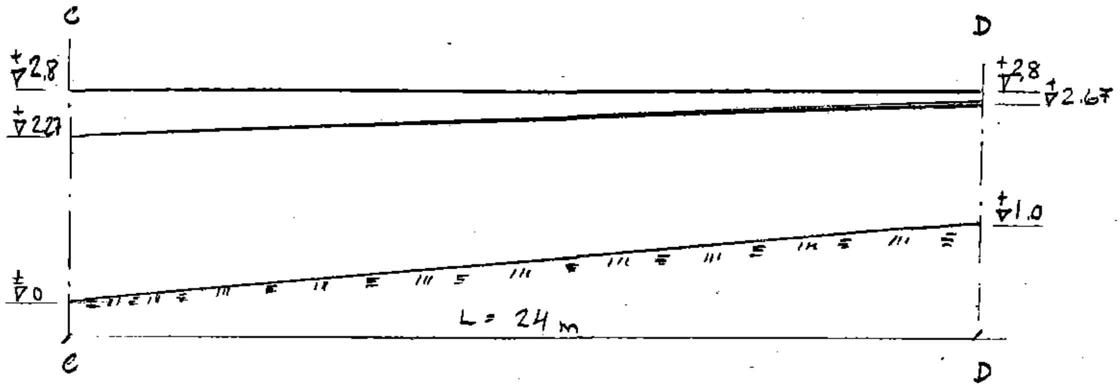
VOLUMES

$$V_{I} = \frac{17.82 + 15.64}{2} \cdot 14 = 234.22 \ m^3$$

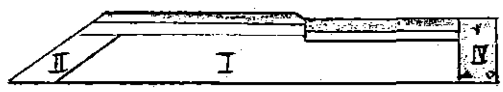
$$V_{II} = \frac{8.82 + 4.38}{2} \cdot 14 = 92.40 \ m^3$$

$$V_{III} = \frac{12.47 + 2.40}{2} \cdot 14 = 104.09 \ m^3$$

$$V_{IV} = \frac{7.58 + 4.06}{2} \cdot 14 = 81.48 \ m^3$$



D - D



$A_I = 2.12 \cdot 4.0 + 2.25 \cdot 5.0 + 1.6 \cdot 2.25 \cdot \frac{1}{2} = 21.53\ m^2$

$A_{II} = 2.0 \cdot 0.7 = 1.40\ m^2$

$A_{IV} = 1.67 \cdot 1.0 = 1.67\ m^2$

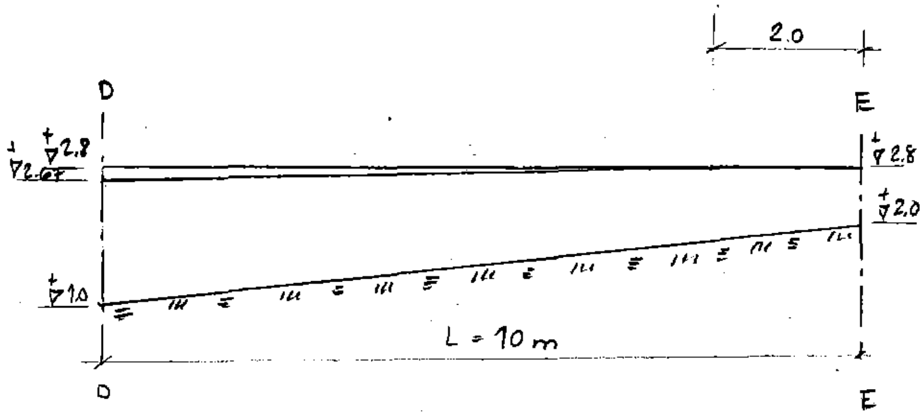
VOLUMES

$$V_I = \frac{15.64 + 21.53}{2} \cdot 24 = 446.04\ m^3$$

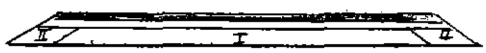
$$V_{II} = \frac{4.38 + 1.40}{2} \cdot 24 = 69.36\ m^3$$

$$V_{III} = \frac{2.40}{2} \cdot 24 = 28.80\ m^3$$

$$V_{IV} = \frac{4.06 + 1.67}{2} \cdot 2.4 = 68.76\ m^3$$



E - E



$$A_I = 9{,}6 \cdot 0{,}25 = 2.40 \ m^2$$

$$A_{II} = 0.25 \cdot 0{,}7 + 0{,}25 \cdot 0{,}7 = 0.35 \ m^2$$

VOLUMES

$$V_I = \frac{21.53 + 2.40}{2} \cdot 10 = 119.65 \ m^3$$

$$V_{II} = \frac{1.40 + 0.35/2}{2} \cdot 10 + \frac{0{,}35/2}{2} \cdot 2{,}0 = 8{,}05 \, m^3$$

$$V_{IV} = \frac{1{,}67}{2} \cdot 8{,}0 = 6.68 \ m^3$$

VOLUMES

$$V_I = \frac{2.40}{2} \cdot 2.5 = 3.0 \ m^3$$

$$V_{II} = \frac{0.35}{2} \cdot 2.5 = 0.44 \ m^3$$

TOTAL VOLUMES

$$V_I = 1004.52 + 234.22 + 446.04 + 119.65 + 3.0 = \underline{\underline{1807.43}}$$

$$V_{II} = 415.80 + 92.40 + 69.36 + 8.05 + 0.44 = 586.05 \ m^3$$

$$V_{III} = 677.60 + 104.09 + 28.80 = 811.30 \ m^3$$

$$V_{IV} = 3.91.16 + 81.48 + 68.76 + 6.68 = 548.08 \ m^3$$

VOLUME T-JETTY

$$V_{IV} = 20 \cdot 3 \cdot 5 = 300 \ m^3$$

REINFORCEMENT

$$V_V = (0.5 \cdot 3 \cdot 20 +$$

QUANTITY

DESCRIPTION	UNIT	QUANITY	COST PER UNIT Skr	AMOUNT IN Skr
PIER.				
QUARRY RUN	m^3	1810	120	217 200
BOULDERS 0.05-0.1t	m^3	460	160	73 600
— " — 0.2-0.4t	m^3	590	200	118 000
— " — 2.-3t	m^3	820	320	262 400
CONCRETE	m^3	650 200	700 600	455 000 120 000
REINFORCEMENT	tons	10	7400	74 000
BITT 10t	no	5	6 000	30 000
— " — 2t	no	0.8·90	2 000	144 000
SURFACING OF ROAD ON PIER	m^2	800	200	160 000
CONCRETE PLATE	m^3	200	600	120 000
REINFORCEMENT	tons	10	7 400	74 000
FORMWORK	m^2	220	200	44 000
— " —	m^2	660	200	132 000
				2030 000
CONTINGENCIES.		20%		405 000
				2,5 milj kr.

Appendix 7

Annual incomes from the catch before improvement

Before improvement 10% of catch was sold fresh while 90% was cured.

Incomes will be:

Fresh fish 90.000/5 + 60.000/5 = 18.000 + 12.000 = 30.000

Dried fish $99.000 \cdot \frac{4}{5} + 99.000 = 178.200$ SYD

1 SYD is 3 US \$ and 1 US \$ is equal to 4.6 SKR according to 1975 years value.

Total income is $(30.000 + 178.200) \times 3 \times 4.6$

$= 2.873.160$ SKR

From the above prices 25% is deducted for the use of engines and fishing implements belonging to the co-operative

$0.75 \times 2.873.160 = \boxed{2.155.000 \text{ SKR}}$

Appendix 8.1

INCOMES FROM THE FISH AFTER IMPROVEMENT

Fresh fish

About 30 sambuks will be fishing for about 3 months, 15 sambuks for 3 months and 5 sambuks for 3 months.

Each month has 25 days and each sambuk gets about 0.35T fish/day

Price for the fresh fish is 0.14 SYD/kg during November-May and 0.105 SYD/kg during June-Oktober.

As 50% of the catch is sold fresh it will be 0.5 · 0.35 = 175 kg/day

Income from the sambuks will be:

$30 \cdot 3 \cdot 25 \cdot 175 \cdot 0.14 + 15 \cdot 3 \cdot 25 \cdot 175 \cdot 0.14 +$
$5 \cdot 3 \cdot 25 \cdot 175 \cdot 0.105 = 90.000$ SYD

BI 27 (84-09)

Appendix 8.2

The huris are 80 in amount

During November to May the huris will be out fishing 3.5 months and the price for the fish will be 0.14 SYD/kg

During June to October the huris will be out fishing 3.5 months and the price for the fish will be 0.105 SYD/kg

The catch will be $0.5 \cdot 0.07 = 0.035$ ton/day
$= 35$ kg/day

Income from the huries will be:

$80 \cdot 3.5 \cdot 25 \cdot 35 \cdot 0.14 + 80 \cdot 3.5 \cdot 25 \cdot 35 \cdot 0.105 = \underline{60.000}$ SYD

BI 27 (84-09)

Dried Fish

Price for the dried fish is 0.270 SYD/kg
By drying the fish the weight will decrease to one third.
Of the total catch 2.200 ton/year 50% is dried
Income from the dried fish will be :
$0.5 \cdot 2200.000 \cdot 0.27 \cdot 1/3 = \underline{99.000 \text{ SYD}}$

Total income is 90.000 + 60.000 + 99.000 =
249.000 SYD

1 SYD is 3 US \$ and 1 US \$ is 4.6 SKR ⇒
$249.000 \cdot 3 \cdot 4.6 = 3.326.000$ SKR

From the above prices 25% is deducted for the use of enginees and fishing implements belonging to the co-operative
$0.75 \cdot 3.326.000$ SKR = 2.495.000 SKR

By developing the landing place a number of aspects will be improved and that leads to that the catch will increase about 15%.
Annual incomes from the catch will be
$1.15 \cdot 2.495.000 = \boxed{2.870.000 \text{ SKR/year}}$

BI 27 (84-09)

Annual net income after the improvement

Income after the improvement - Income before
2.870.000 - 2.155.000 = 715.000 SKR

Investment costs financed with the foreign and local loan.
We assume that the local loan has an interest of 5% and the foreign loan an interest of 10%.
Depreciation for the whole project will be 30 years. All the amounts in the calculations are based on todays rate and are in Swedish currancy.

Appendix 10

Costs	Depreciation time	Foreign finance	Local finance	Σ
Machinery for the ice plant	15 years	354'	–	354
Ice plant	20 -"-	30'	12'	42
Cold store	20 -"-	57'	38'	95
Fish boxes	5 -"-	20'	–	20
Trailors	5 -"-	10'	–	10
Drying racks	2 -"-	3'	7'	10
Other equipment	2 -"-	5'	10'	15
Pier	30 -"-	1.250'	1.250'	2.50
Machines + land-preparations		50'	50'	100'
		1.78 million	1.37 million	3.2

We assume that contingencies is 10 % of the total investment cost

Annual writing off will be

$$\frac{354'}{15} + \frac{42'}{20} + \frac{95'}{20} + \frac{20'}{5} + \frac{10'}{5} + \frac{10'}{2} + \frac{15'}{2} + \frac{2.500'}{30} =$$

$= \underline{132' \text{ SKR}}$

Annual cost for the labour is 120'
Annual cost for the fuel is 115'
Annual interest

As contingencies is 10% of the total investment cost the total cost will be 1.1 × 3.2 million = 3.5 million SKR

Foreign loan will be 1.1 × 1.78 = 2.0 million SKR with 10% interest
Local loan will be 1.1 × 1.37 = 1.5 million SKR with 5% interest
Interest for the first year will be
0.1 × 2.0 + 0.05 × 1.5 = 275.000 SKR
Interest for the second year will be based on the total amount minus first years writing off.

3.500.000 − 132.000 = 3.368.000

$$\left(0.1 \times \frac{2.0}{3.5} + 0.05 \cdot \frac{1.5}{3.5}\right) \times 3.368.000 = 265.000 \text{ SKR}$$

BI 27 (84-09)

Interest for the third year will be based on the total amount minus two years writing

$3\,500.000 - 2 \times 132.000 = 3.236.000$ SKR

$\left(0.1 \times \frac{2.0}{3.5} + 0.05 \times \frac{1.5}{3.5}\right) 3.236.000 = \underline{254.000}$ SKR

FUEL COST

Approximate electricity consumption for flake ice production in the tropical climate zone is 70- 85 kWh/t according to "Fresh fish handling"

Ice production is about 10t/day ⇒

$85 \times 10 = 850$ kWh/day

1 kWh = 860 kcal

850 kWh = $850 \times 860 = 731.000$ kcal

10250 kcal/kg fuel ⇒

$\frac{731.000}{10250}$ = 71 kg fuel

The density for the fuel is 0.835 kg/l

71 kg/0.835 kg/l = 85.0 l fuel/day is needed for the ice plant

Ice plant is on duty about 7 month/year

Each month has 25 days

Fuel cost is about 2.45 SKR/l according to shell refinary

$7 \times 25 \times 85 \times 2.45$ = 36.000 SKR

Appendix 12

FUEL CONSUMPTION FOR THE FISHING CRAFT

Huries are driven by 5 hp outboard engines. Amount of outboard driven huris are estimated to 40 and their fishing trips lasting 10-12 hours.

$1\ hp = 0.178107\ kcal/s \Rightarrow$

$5 \cdot 40 \cdot 2 \cdot 3600 \cdot 0.178107 = 256.474\ kcal$

10250 kcal/kg fuel

$\frac{256474}{10250} = 25$ kg fuel

$25/0.835 = 30\ l/day$

7 months/year

$7 \cdot 25 \cdot 30 \cdot 2.45 = \underline{12863}$ kr

Sambuks are powered by inboard diesel engines of about 40 hps.

$40 \cdot 30 \cdot 4 \cdot 3600 \cdot 0.178107 = 3077689\ kcal$

10250 kcal/kg fuel

$\frac{3077689}{10250} = 300$ kg

$300/0.835 = 360\ l/day$

$\Sigma = 30 + 360 = 400\ l$ fuel/day

Price 2.45 kr/l according to shell refinary

3 months/year $3 \cdot 25 \cdot 360 \cdot 2.45 = \underline{66000}$

Total cost $\approx$ 36.000 + 12.863 + 66.000 $\approx$ 115.000

BI 27 (84-09)

LABOUR

Based on 200 kgs processing capacity per operator and hour, the number of operators during peak season is calculated to be :

$\frac{16}{0.2 \cdot 4} = 20$

It is assumed that they will work for four hours to clean and get the fish.

This number is calculated for the peak period.

If more people are needed there will be no problem as the labour capacity is sufficient

We assume that each person costs about 1000 SKR/month $\Rightarrow$ 20 × 1000 = 20.000 SKR

At an average this people will work about 6 months/year

6 × 20.000 = 120.000 SKR

Appendix 14

Annual cost

Year	1	2	3
Interest	275'	265'	254'
Writing off	132'	132'	132'
Labour	120'	120'	120'
Fuel	115'	115'	115'
	642'	632'	620'

BIBLIOGRAPHY

1) Food and Agriculture Organization of the United Nation (FAO). Fisheries policy study mission. No TA 3296, 1975.

2) FAO; WECAF REPORTS No. 19; Extension training of artisanal fishermen and other fisheries personnel in the WCCAF region; 1978

3) FAO; Fisheries Technical Paper no. 123; Fishery harbour planning, 1973

4) FAO; Fisheries Technical Paper no. 136; Small harbours and landing places on difficult coasts; 1974

5) FAO; Fisheries Technical Paper no. 142; The production of fish meal and oil; 1975

6) FAO; Fisheries Technical Paper no. 157; Across-beach operations in the small-scale fishery, 1976

7) FAO; Technical report 21; Pre-investment survey of fishing harbours; India. 1972

8) Ulf Wijkström; Note on planning for exploitation and utilization of fishery resources; 1978

9) Report No. PAK; Ap-34; Appraisal of the second marine fisheries development project in Pakistan; 1980

10) Scandiaconsult and Agro-fisheries; T.A No 397, PAK; Balluchistan fisheries development project; Final report.

11) FAO; Fisheries Technical Paper No. 160; The production of dried fish. 1976

12) Final report from Scandiaconsult; Preparation of Bi´r ´Ali fishery harbour and shore facilities; 1978

13) Report no. 1 from Scandiaconsult; Preliminary site investigations and layout report

14) FAO; Planning and engineering data; Fresh fish handling; 1981

15) United Nations Industrial Development Organization, Manual for the preparation of Industrial Feasibility Studies. 1978

16) Robert M. Krone; Systems analysis and policy sciences (Theory and Practice); 1980

17) David S. Clifton, Jr; David E. Fyffe; Project Feasibility Analysis; 1977.

18) C.West Churchman; System analysis, 1968.