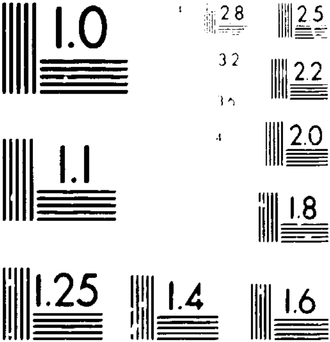
UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org



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SHIPYARD STRUCTURES FOR BUILDING AND REPAIRING SHIPS AND BOATS*

prepared by

T. Mulyoharsono**

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** Naval architect. Indonesia.

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I. Introduction

To handle their sea and river transportation in developing countries, there is a general need for small ships.
By the term "Small Ships" is meant ships with load capacities of under 500 DWT, which are made of steel, wood, GRP, or other materials.
For a good "upkeep" of such transportation fleet, it is necessary that suitable maintenance and repair facilities are available.
A major equipment for a maintenance and repair facility is a drydock. Generally, this drydocking equipment is one of the main decisive factors for the capacity of the size as well as the number of the ships able to be maintained/repaired by the yard annually.
This paper will therefore analyse several dry docking equipment with capacities to dock ships of 500 DWT and less or with measurements of approximately : L x B x T = 50m x 8m x 3m, whereby the lifting capacity of the equipment is ± 350 t.

II. Main Factors

There are several factors which are assumed to be pre-requisites indesigning yard structures of that size for developing countries :

1. The shipyard structure has to be suitable for the level of technological progress and technical knowhow of the local people. With other words, it has to be simple, robust but - suitable and, as far as posible, the local techicians should be able to build and maintain it.

2. Matching the local conditions, the necessary investment for the structure to be built should be as cheap as possible

without reducing the work safety.

3. Maintenance and repair cost should be as cheap and as low as possible.
4. Work speed of the equipment should be sufficiently reasonable but should not be the main decisive factor.
5. If necessary it should be open for development by using more sophisticated techniques/technology, but without causing to waste too much of the earlier investment.
6. Due to the technical condition of the ships, they usually do not sail in periods of bad weather and in those periods they do their annual maintenance whereby the greater part of the maintenance work is carried out by the crew.
7. A relatively sufficient waterfront for floating repair should be available in the yard's area.

Besides the above main factors there may be local factors which have to be considered. It goes without saying that one should keep in mind the economic feasibility which has to be thoroughly evaluated.
With the exception of the economic feasibility, this paper will make use of the seven main factors for analysisng the structures of a slipway and shiplift.
These two types of structures will be analysed in this paper because they are the most suitable ones for small ships.

III. Slipways and Shiplifts.

It is known that a slipway is usually a construction with a series of rails supported by wood, stone or concrete with a certain inclination (1:15-1:30) extending into the water until it reaches sufficient depth for docking of ships. On the rails there are carriages for hauling/lowering the ships with the help of a winch.
There are two kinds of slipways. The first one is the longitudinal slipway and the second one is the transverse slipway.

3.1. Wooden longitudinal slipway

At the simplest level of technology, the pair of rails - installed on the slipway is made of wood and the cradle is also constructed of wood without wheels.
To ease the hauling/lowering of the ship positioned on the cradle, the surface between the wooden rails and the sled (the lower part) of the cradle is made slippery by greas - ing it.
In operation, this slipway needs a winch and often also a small tugboat to pull a ship.
This type of slipway is illustrated in picture 1.
Analysis of the main factors is a follows :

1. This kind of longitudinal slipway is of very simple - construction; it can be made anywhere in the developing countries which generally have several types of timber to be used for this kind of structure. Also, there is no need for high technical skill.

2. For the wooden cradle and rails the investment needed - relatively small.
   For soft soil the costs for the civil works will be much higher as compared to the costs for the cradle.

3. Maintenance and repair is easy but has to be carried out quite often. The capacity of this slipway is very limit ed due to reasons of structural problems and costs,which may no longer be viable with regard to the income.

4. As compared to other stuctures, the hauling/lowering - speed of this structure is very low.

5. Development using more advanced technology is difficult to implement without making new, relatively quite big investment,whereby the greater part of the earlier in- vestment can no longer be utilized.

6. A slipway can accommodate only one ship. Adding side - tracks poses a very big problem.

Therefore, if there is a need to dock several ships simultaneously, more slipways have to be built.

7. By adding more slipways the waterfront which could be utilized for floating repairs, will be reduced.

3.2. Longitudinal slipway using cradle on wheels

A further development of the slipway is the installation of rails with a cradle on wheels. The ship can be hauled in an inclined or horizontal position (see picture 2 & 3).

Analysis :

1. The inclined cradle structure is simple to build. It does not need high technical skills, but it need accuracy and close supervision in building it, so that it will operate well.
2. The investment needed for the rails and the carriage is relatively small but the civil engineering works will cost much, especially if the condition of the soil is not good. For the inclined carriage, calculations have to be made for the max. load at the pivot point, this max. load force may reach ± 30% of the ship's weight.
3. Maintenance is easy, but has to be done often and regularly. Carriage repair is also easy. Maintenance of the underwater civil works is a difficult and rather expensive job.
4. Hauling/lowering speed is much higher as compared to the wooden slipway.
5. There are limited possibilities for further development using more advanced technology; one is to add side tracks.
6. It is very difficult to install side tracks for an inclined cradle. It is much easier for a horizontal one. As can be seen in picture number 3, side tracks development can be carried out without wasting any of the ear-

lier investment. With appropriate adjustments this can be carried out easily.

7. As is the case with the wooden slipway, the inclined - carriage needs one slipway to accommodate one ship. If many ships are to be docked simultaneously, it would necessarily affect the waterfront.
   In the case of a horizontal carriage, this would not pose any problems if side tracks are added.

3.3. Transverse/side slipways

The difference of this system with the longitudinal slip - way is that drydocking is carried out transversely (see picture 4). The series of carriages have to be hauled simultaneously.
This is usually done by connecting the power source to several drums which are in turn interconnected by one shaft.
The inclination of this slipway is about 1:8 - 1:16.
At this angle the rails or the hauling length is not as long as in the case of the inclined longitudinal slipway.

Analysis :

1. The structure of the transverse/side slipway is more - complicated than the inclined longitudinal slipway.
2. Excluding the civil works, the investment for the rails, carriages and hauling system is more than that for the longitudinal slipway.
3. Maintenance & repair costs are approximately equal to those for the longitudinal slipway with level position of the ships.
4. Workspeed is equal to that of other slipways at 1-2 M/min.
5. Further development consists only of adding side tracks.
6. Adding of the side tracks can be done at a later date, without getting to much in the way of work carried out on ships being docked.

7. The required length of the waterfront for a side slip - way is approximately 10% longer than the length of the ship to be docked and this is generally more than the - waterfront length needed for a longitudinal slipway.

3.4. Shiplift

In recent years, various types of shiplifts have been de - signed, developed and operated. The difference of the various types is only in the power system, which is either mechanical, hidraulical or electrical.

A shiplift is actually an elevator with a platform that can be raised or lowered vertically from or into the water. The ship to be drydocked or to be lowered into the water is positioned on this platform horizontal.

It is quite common that a carriage with wheels is put on rails on this platform. The ship is then positioned on this carriage, which is needed for transferring the ship from the lift on to the shore.

Drydocking is carried out at even keel. The lifting/raising system may use steel cable with cable drums, chain and sheave, or other systems which are adjusted to the local conditions.

Four (4) lifting points are needed as a minimum. The operation principle of a shiplift is depicted in picture no.5, 5A, 5B.

Analysis :

1. A shiplift may use a technologically advanced or simple lifting system so that it can be easily adjusted to the local technological progress. Picture no. 5 is an illustration of this.
   At present a hydraulic lift system as in picture no. 5b is being built at Banjarmasin - Indonesia.
   Each lifting point uses two hydraulic jacks which are checked in place by a threaded shaft and nut, just as in the common case of a floodgate. This system is ----

adjusted to local conditions. Manual hydraulic jacks may be used to reduce costs.

2. The investment needed is relatively small if the lift - ing points are limited to four, particularly if appro - priate technology is used.
3. The maintenance costs are lower than those for a slip - way due to the fact that only a small part of the sys - tem is permanently placed in the water, which is also - made of concrete (piling).
   If repaires are needed, they usually cover parts which- are above water level.
4. The lifting speed of a shiplift is slower than that of a side slipway if the hydraulic jack system is used.
5. Without breaking down or changing the structure too much, a shiplift can be developed in accordance to the avail- able funds, but it has to be kept in mind that the ships to be drydocked are of equal measurements and size,which means that the original size it was intended for, can not be increased, so only the number of ships to be docked and the ease of work can be increased.
6. As is the case for the side slipway, the docking capaci- ty of a shiplift can be increased by adding rails and side tracks.
7. The length of the needed waterfront is at least equal to that of a longitudinal slipway. If the shiplift is installed offshore, access piers for floating repairs can be built as additions to the waterfront.

Some Comparisons

From the foregoing analysis we can make comparisons by drawing up a table (see table 1).
For evaluation purposes we attach scores from 0 up and includ - ing 5 for the various points.

The highest positive score is 5 which is also the most benefi - cial. This table does not yet sufficiently show the optimum of a structure in a certain area due to the many factors which have still to be considered, among others, possibilities for develop ing the capacity, the skill of the local people/technicians , macro as well as micro economic factors, and other local fac - tors which may have great influence.

However, aside from all those considerations, the evaluation or scores may be used as a basis for further studies.

V. Conclusion

From the foregoing descriptions and comparisons we may conclude that shipyard structures for shipbuilding and repairing of small ships, particularly in developing countries, need further inten sive studies.
As a minimum, these studies shall cover the following points - with the following sequence :

1. The present conditions of and needs for ships with estimates for the future.
2. The present level of technology used in the areas concerned, the available equipment, material and work force.
3. The local conditions, among others soil, current, waves, etc.

The study will be the basis for selecting the most suitable - structure and its alternatives. These alternatives may relate to the types of structure, but may also relate to one structure capable of future development for certain levels of technology.

A further necessity is the economic feasibility of the struc - ture and its alternatives.

Table 1 (table of comparisons) reflects an indication of the tendency to select the shiplift as a structure for building & repairing ships, with all its locally adjusted powersystem, whe- re as the wooden slipway, due the relatively small investment - needed, will stand a chance for ships of limited size.

Note : As an illustration the following figures are taken from the Palembang slipway and Banjarmasin shiplift projects currently in progress.

No. Item	Approx. Cost in US$ Palembang 2 Slipways @ 400 GT	Approx. Cost in US$ Banjarmasin 4 Berths @ 500 GT
1. Civil Works	440.000,-	625.000,-
2. Mechanical Works	200.000,-	650.000,-
Total	640.000,-	1.275.000,-

Table 1. Comparisons of several structures based on main factors

No.	Type of Structure / Compared Items	Wooden Slipway (Max. Cap ± 50 Ton)	Longitudinal Slipway: Inclined Shipposition	Longitudinal Slipway: Horizontal Shipposition	Transverse Slipway	Shiplift
1.	Construction :					
	a. Simple	5	4	3	2	4
	b. Appropriateness	3	4	5	5	5
2.	Investment :					
	a. Facilities for one ship	5	4	3	3	3
	b. Facilities for several ships	0	1	3	4	4
	c. Civil works for one ship	5	1	1	2	4
	d. Civil works for several ships	0	0	3	3	3
3.	Maintenance & Repair of Structure :					
	a. Easy	5	4	4	4	4
	b. Cheap	5	4	4	4	4
	c. Relatively not often	1	3	3	3	3
	d. Civil Works	2	2	2	2	5
4.	Hauling & Lowering Speed :	1	5	5	5	4
5.	Up grading possibility :					
	a. Technology	0	0	0	0	3
	b. Ease of Work	0	0	0	0	3
6.	System development without reducing length of waterfront :					
	a. Number of ships drydocked	0	0	3	5	5
	b. For new building	0	0	3	5	5
7.	Length of waterfront for floating repairs/outfitting :	4	4	4	3	5
		36	36	46	50	64

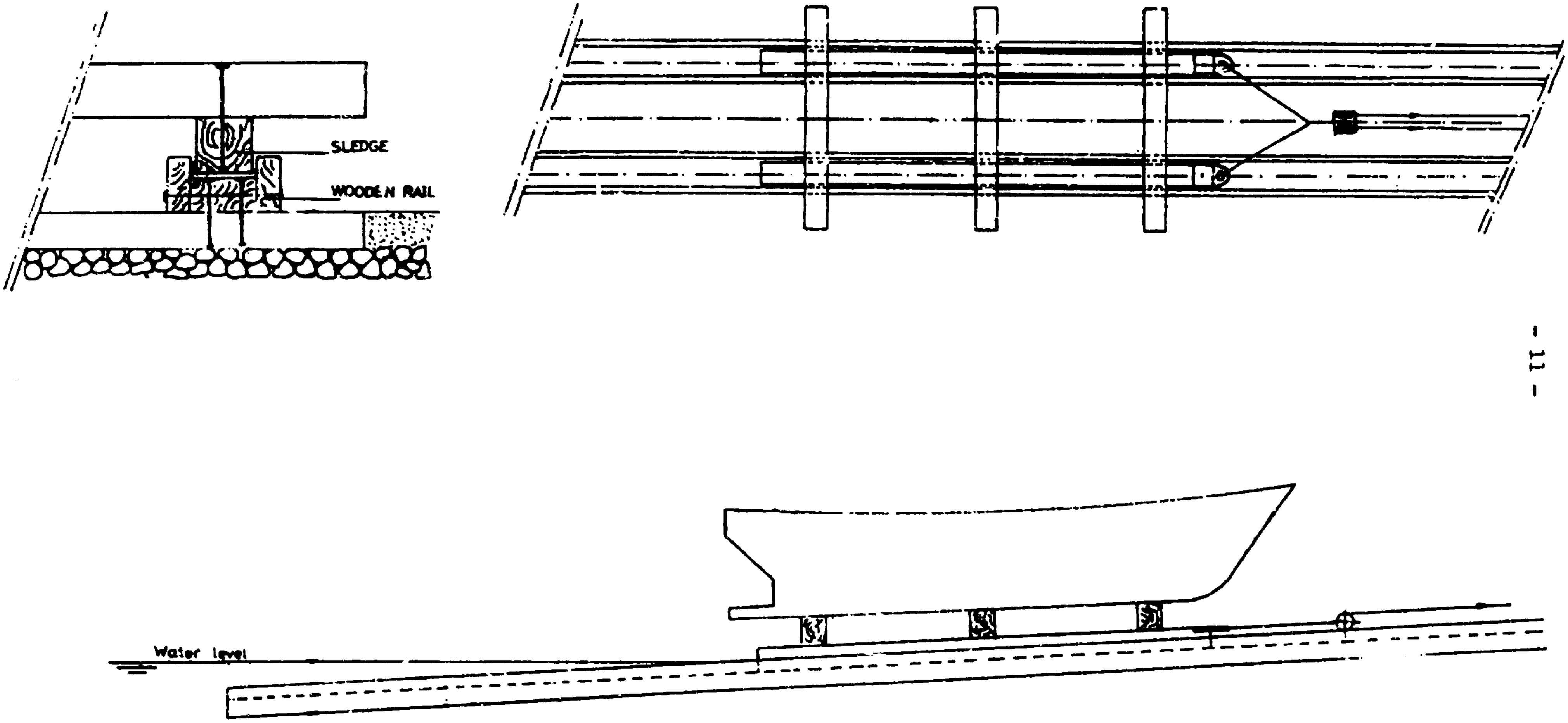
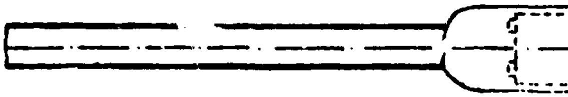
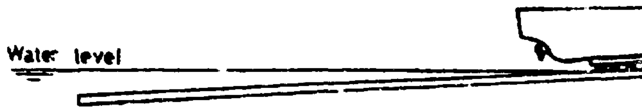


FIG. 1 WOODEN SLIPWAY




Water level

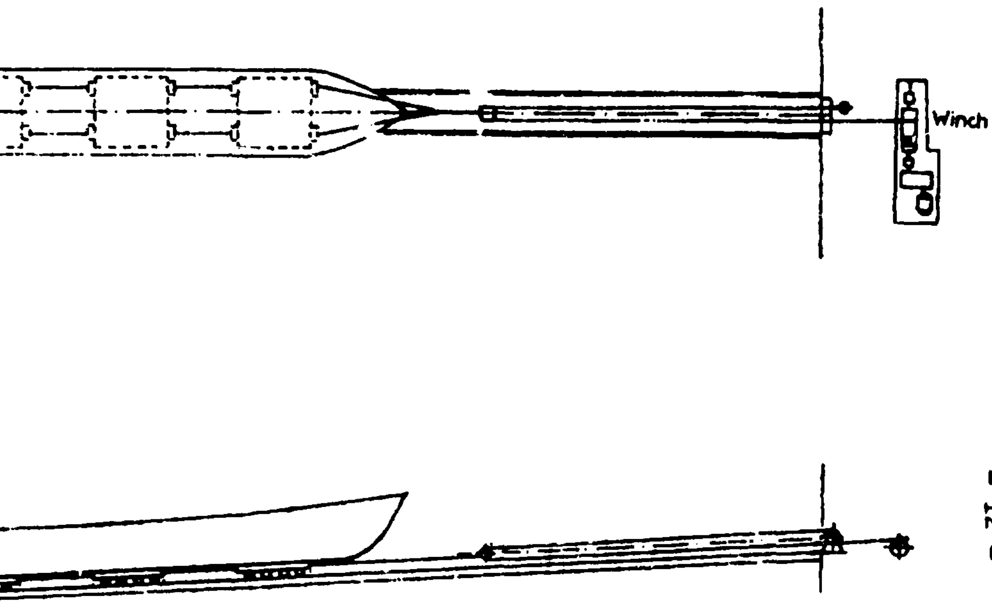


FIG. 2 INCLINED LONGITUDINAL SLIPWAY

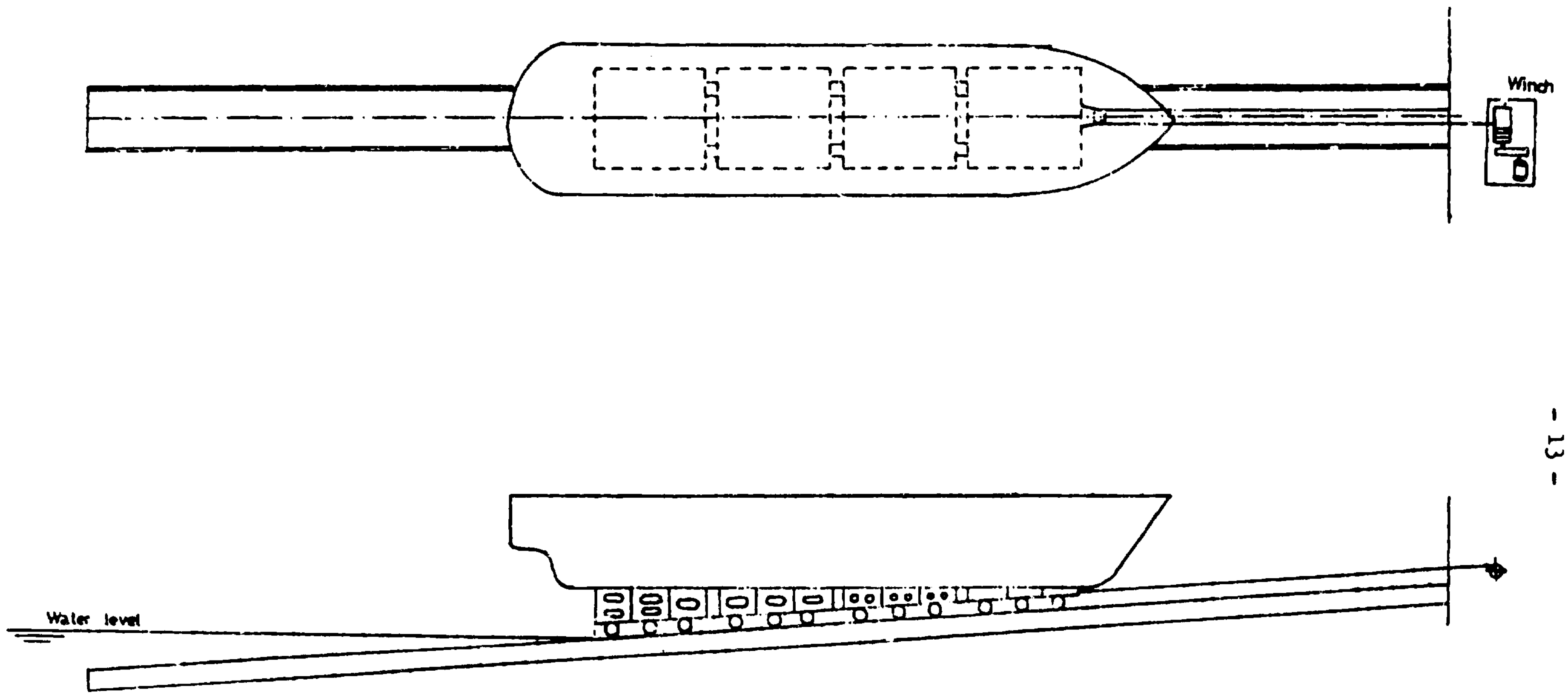


FIG. 3 HORIZONTAL LONGITUDINAL SLIPWAY

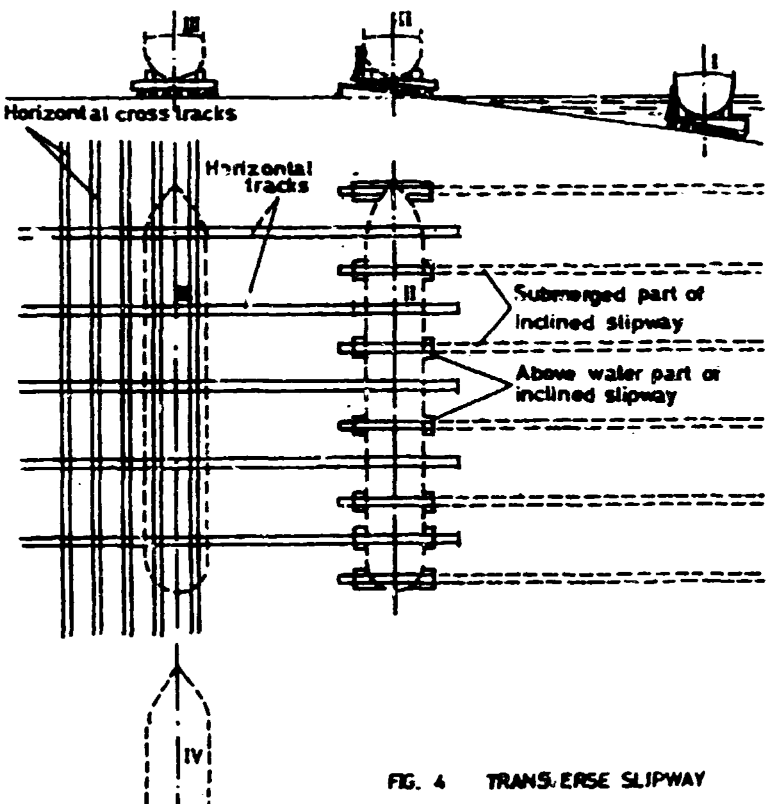


FIG. 4 TRANSVERSE SLIPWAY WITH SIDE TRACKS

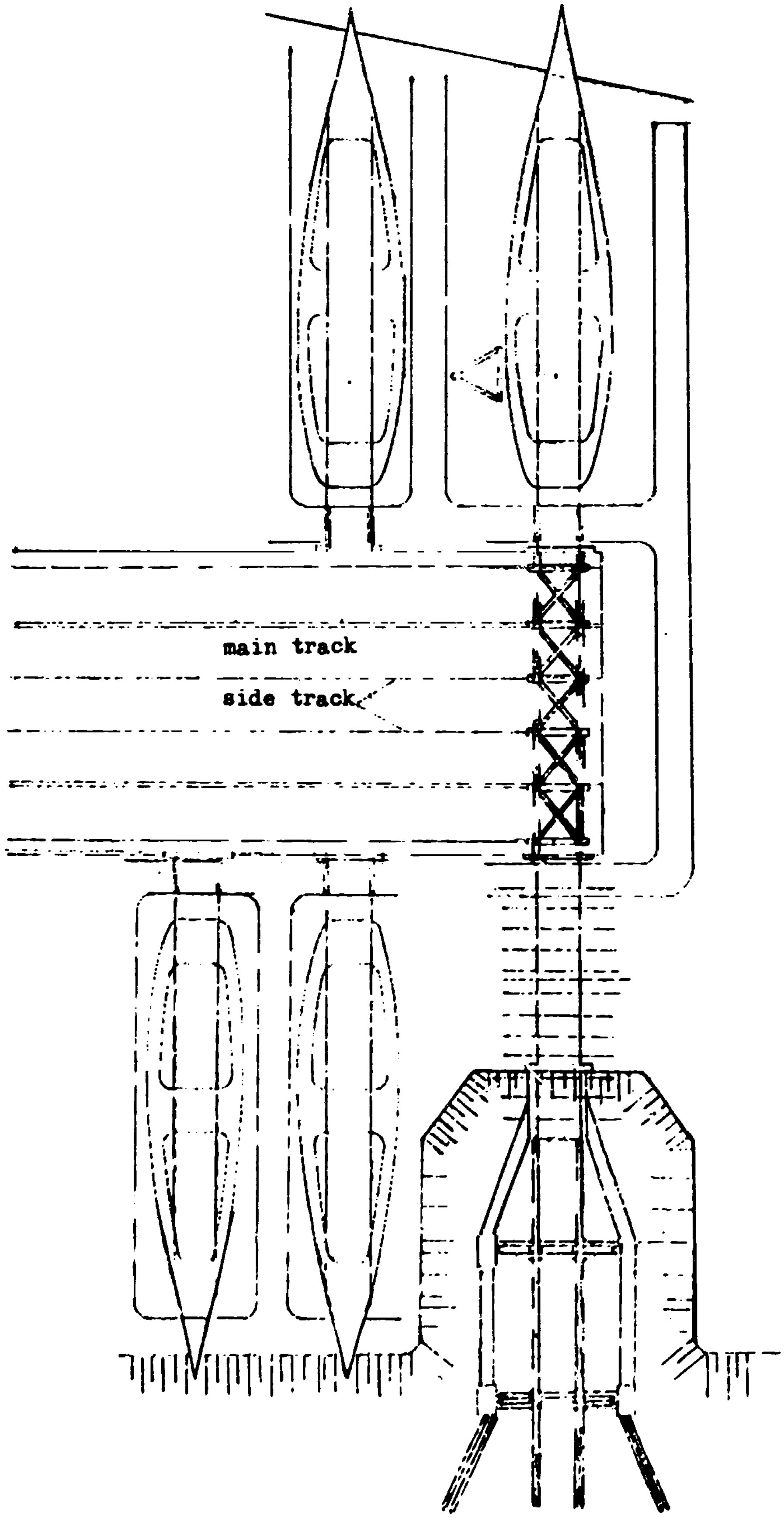


Fig.5 Lay out of Banjarmasin Shiplift

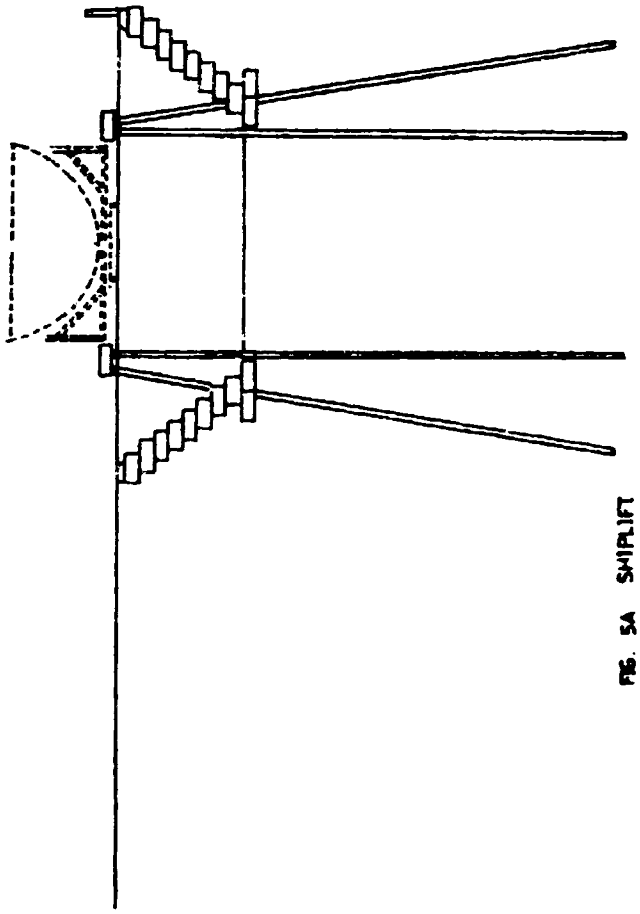


FIG. 5A SHIPLIFT

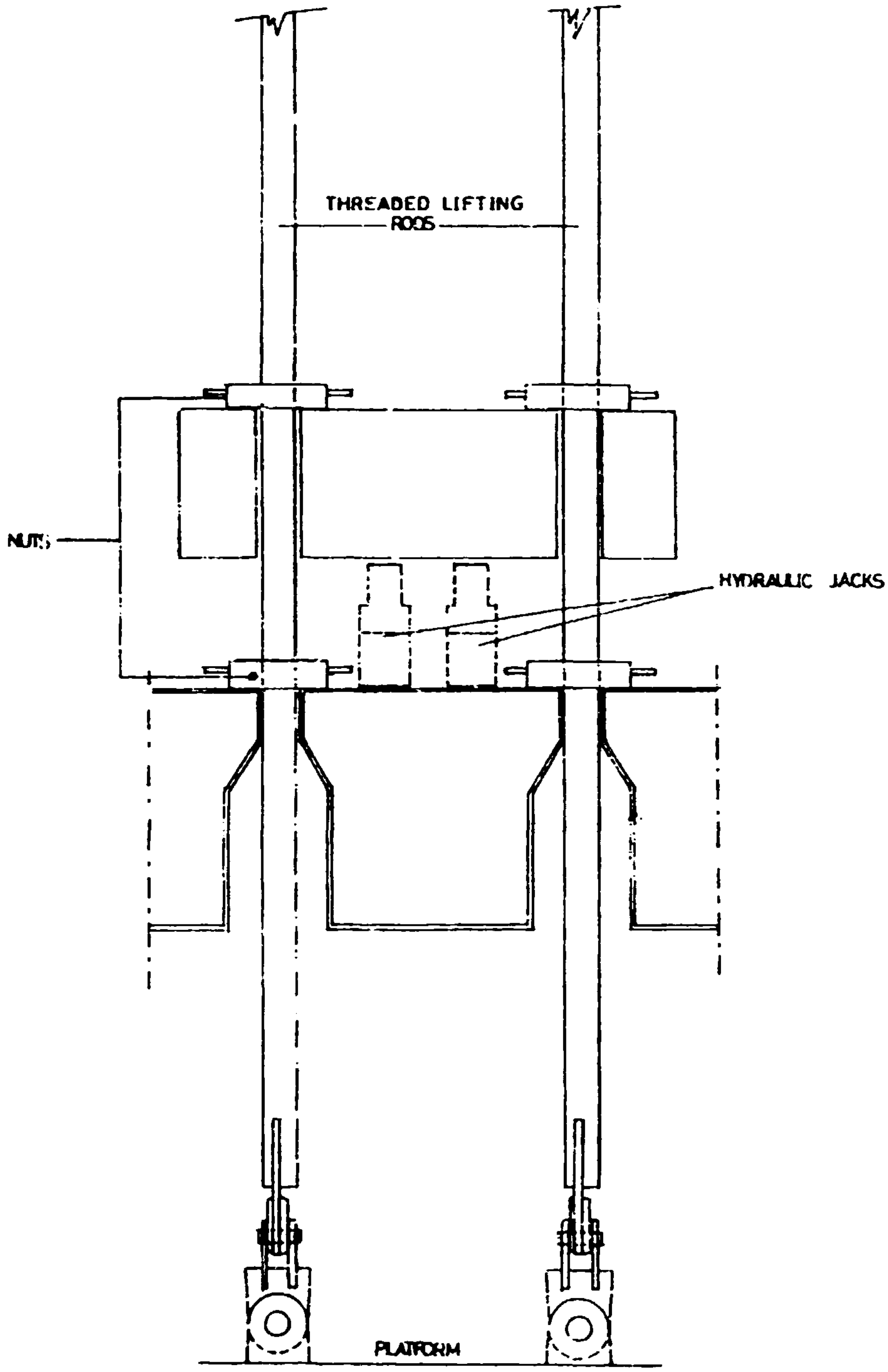


FIG. 58 LIFTING SYSTEM
WITH RODS AND JACKS