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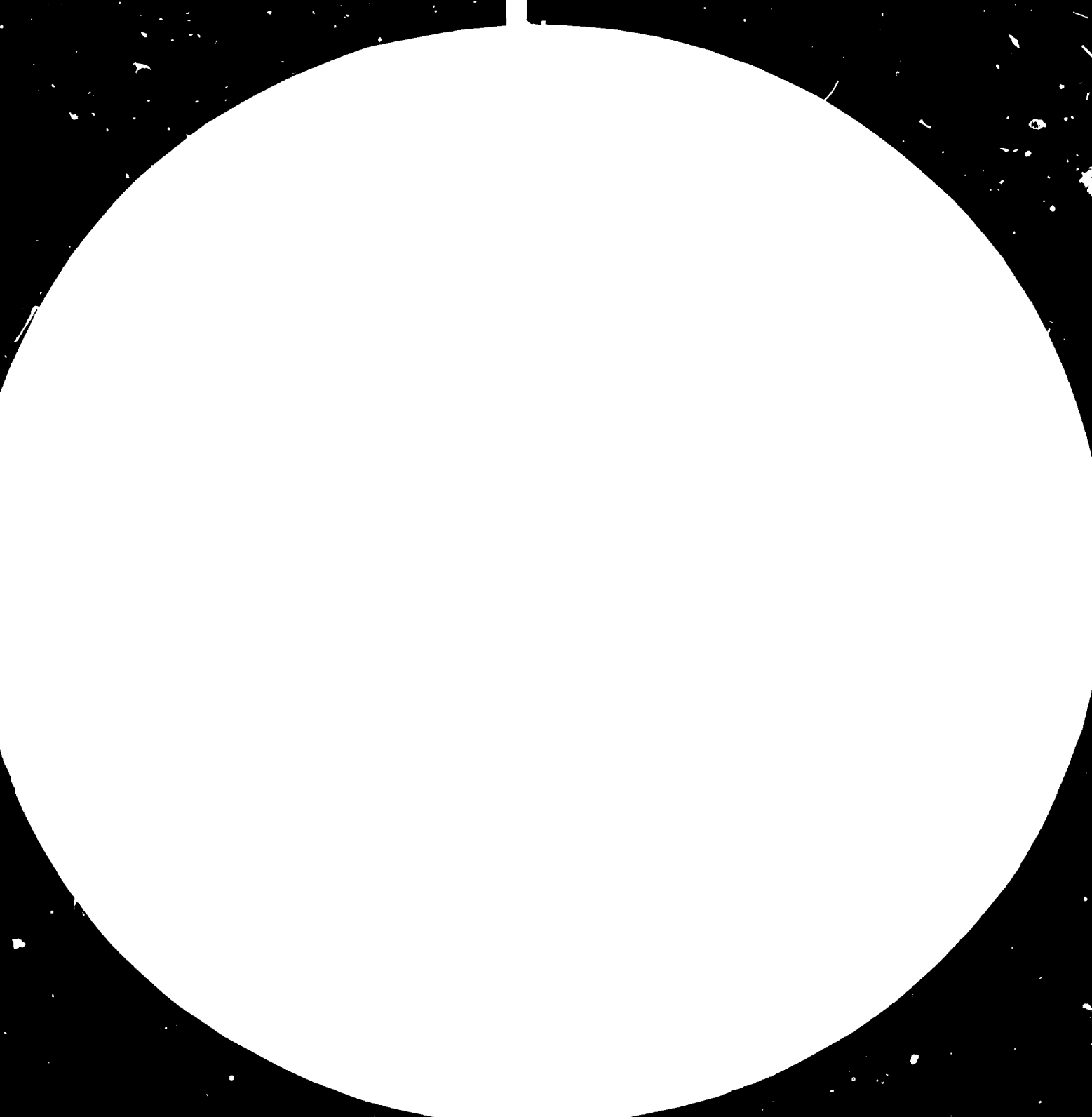

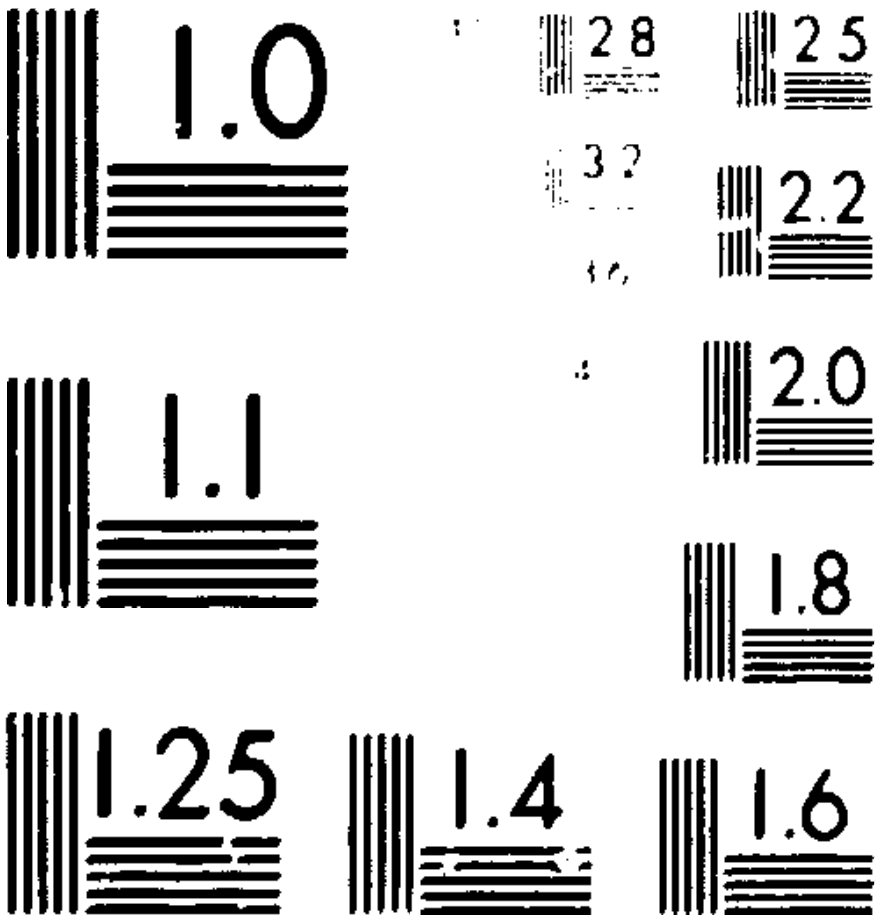

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DEVELOPMENT OF THE RECONSTRUCTION WORKS AT THE SHIPYARD "VELJKO VLAHOVIC" BIJELA, MONTENEGRO

SI/YUG/79/804

YUGOSLAVIA

Technical report: Present state of reconstruction *

Prepared for the Government of Yugoslavia
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of B. K. Mazurkiewicz, expert in shiprepair

United Nations Industrial Development Organization

Vienna

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ABSTRACT

This report concerns the project SI/YUG/79/804 "Reconstruction of the Shipyard "Veljko Vlahović" Bijela, Montenegro" and is the result of the mission SI/YUG/79/804/11-02/31.9.D performed during the period from 5th to 13th August 1981. The purpose of the mission was the evaluation of the present state of reconstruction of the shipyard, damaged during the earthquakes occured in April and May 1979, as well as the analysis of design and construction works which should allow first of all to reach the original productive capacity.

The report deals specifically with following three problems being the objectives of the mission:

1. Existing, permanent and temporary, shiprepair and steel construction facilities and the possible increase of their production capacity.

2. Reconstruction and development programme and the possible changes allowing the future extension.

3. Present state of construction of shiprepair and steel constructions facilities and the possible changes allowing the decrease of costs and shortening of the building period.

Following main conclusions and recommendations have been drawn:

1. It is necessary to increase the contractors activity on the site to hand over as soon as possible all main transportation means i.e. transportation roads and access platform to the floating dock.

2. Necessary financial support should be quarrantied to speed the construction works and purchasing of different equipment and tools.

3. It is recommended to increase the efective length of

mooring berths to assure the predicted increase of amount of ship-repair works.

4. It is recommended to shorten the docking time for repaired vessels through the introduction of a very efficiency equipment for cleaning and painting of hulls of ships being drydocked.

5. To increase the efficiency of the reconstructed shipyard it is proposed to make changes in the general lay-out among others through shifting the repair shops nearer to the floating docks.

6. The steel constructions fabrication yard should be the subject of future investigations to perform a profitable production programme for the facilities already existing and planned in the future.

7. It is recommended to perform adequate analyses, investigations and calculations to change the structural solution of the foundation slabs of the floors for repair, workshops R_1 and R_2.

8. It is recommended to introduce as soon as possible operational planning and operational execution of all reconstruction and development works.

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INTRODUCTION

The shipyard "Veljko Vlahović" in Bijela, Montenegro, was founded in 1927 with the main activities in the repair and construction of small wooden and steel vessels. After the Second World War the shipyard expanded its production facilities and production programme which included two main profiles: ship-repairing of considerably large vessels and manufacturing of steel structures, pipelines and other equipment for the chemical and petrochemical industry.

As a result of earthquakes on 15 April and 15 May 1979 the shipyard nearly lost all workshops, including machine tool equipment, tools and parts of vessels which were under repair. Other facilities were also damaged or completely destroyed, including 250 m of quay wall equipped with a jib crane of 10 ton capacity, and 120 m of quay wall without a crane. The total damage, including the damage of main store of raw materials and spare parts as well as head office with possessed documentation, is estimated at US $ 120 million.

Immediately after the earthquakes an action was taken to reconctruct the shipyard and to reach at least the original production capacity. The rehabilitation programme is organized by the Federation whilst the financial support is quarrantied by Republics involved in the programme. Also a UNIDO SIS assistance programme has been introduced, comprizing among other short-term consultations in the field of preparation and execution of the reconstruction programme. The mission being subject of this report is one of the performed consultations and concerns mainly the final stage of planing and the continuation of the reconstruction works.

In the report all references are made to general plan

(Situationt plar Brodogradilista - idejno resenje) dated 01.1981 and performed by R.O. za Projektovanje "PREDNAPREGNUTI BETON" Beograd. This plan is included in the project Nr. 0779 as drawing .1. Due to local restriction this plan could not be attached to the present report.

I. SHIPYARD FACILITIES AND PRODUCTION CAPACITY BEFORE EARTHQUAKE

The shipyard before the 1979's earthquakes has had the following shiprepair facilities:

1. Floating dock of 33 000 t lifting capacity equiped with two 12 t jib cranes.

2. Floating dock of 10 000 t lifting capacity equiped with two 7 t jib cranes.

3. Quay walls: 200 m (west side) equiped with one 10 t jib crane and 120 m (south side) without cranes.

4. Pier of 600 m mooring length equiped with one 25 t jib crane.

5. Repair workshops equiped with necessary machines and having the total area about 4000 sqm including:

a) Mechanical shop - 700 sqm

b) Equipment repair shop - 900 sqm (pumps, séparators etc)

c) Engine shop - 600 sqm

d) Electrical shop - 600 sqm

e) Piping shop - 400 sqm

The relation between the total mooring length and the total length of the floating docks was for this stage 850 : 363 = 2.34.

The steel structures fabrication took place in a steel fabrication hall of the total area of 2500 sqm equiped with two overhead travelling cranes of 20 and 5 t lifting capacity. This hall was connected through an assembly area equiped with one jib crane 25 t capacity with a place ended by launching berths.

The total amount of ships repaired in the year 1978 and the amount of used working hours were as follows:

Type of repair	Amount of vessels	Amount of labour hours	%
Repair in the harbours	8	16 000	2.3
Repair in the yard	57	570 000	80.7
Class repair	6	120 000	17.0
Collisions	-	-	-
Rebuilding	-	-	-
Total	69	706 000	100

The amount of employees 820, including workers and technical personnel as well as administration.

The steel structures fabrication shop has delivered in 1978 about 8000 t steel construction and was employing 100 workers and 40 personnel (also administration).

From the above amount of steel construction 1500 t was used for shiprepair (rebuilding of ships) and 4000 t for new floating units e.g. pontoons. The rest, it is about 2500 t was used for pipelines, piles etc.

For further considerations it is assumed that the amount of workers reaches about 60% of the whole amount of personnel i.e. round 492 persons. It should be mentioned that the data concerning the period before earthquake are not available due to the loss of all inventary documentation. However, the rough estimation gives for 1978 a yearly number of hours for one worker of about 1434 hours.

II. SHIPYARD FACILITIES AND PRODUCTION CAPACITY AT THE PRESENT STAGE OF RECONSTRUCTION

At the time of the mission the repair works are proceeding on the basis of following facilities:

1. Floating dock of 30 000 t with two 12 t jib cranes.
2. Floating dock of 10 000 t with two 7 t jib cranes.
3. Pier of 600 m mooring length with one 25 t jib crane.
4. Repair workshops in provisionally erected sheds with total area 3100 sqm including:
   a) Mechanical shop 375 sqm
   b) Electrical shop 375 sqm
   c) Equipment repair shop 375 sqm
   d) Engine shop 375 sqm
   e) Piping and lock-smith shop 1600 sqm

The relation between the total mooring length and the total length of the floating docks is recently 600 : 363 = 1.65.

In comparison to the situation before the earthquake following two main machines are still not available, namely the large swing lathe and the boring mill.

In addition it should be mentioned that a certain amount of machines is already ordered with considerably long delivery periods, whilst these machines which are in operation are temporary placed in the workshops what causes settlements, bendings etc.

This creates great difficulties in execution of certain repair works which in such case may be done only in cooperation with a other repair shipyard. Neverthless the following amount of ships have been repaired during the first half of the year 1981.

Type of repair	Amount of vessels	Amount labour hours	%
Repair in the harbours	6	18 000	4.1
Repair in the yard	18	270 000	61.6
Class repair	5	150 000	34.3
Collisions	-	-	-
Rebuilding	-	-	-
Total	29	438 000	100

The amount of workers 449, amount of other employees 305 including administration. Total number of employees 754.

The steel fabrication shop after repair is also recently in fully operation. The deliveries of steel structures in the first half of the year 1981 amounted to 2000 t whilst the amount of recently employed workers is 100 persons and personnel 40 persons. The amount of steel structures used for sh repair is approximately 500 t, i.e. 25%. However, at the day of mission the slipway allowing launching of floating vessels is still out of use due to damage during the earthquake. This forces to change the production programme.

The comparison of the yearly production capacity in ship-repair before earthquake and at the time of the mission in the terms of labour hours show an increase of 24% (before ~ 706 000 recently ~ 876 000 hours).

This is a considerably increase when taking additionally in consideration the condition in which the repair work is performed. First of all a very big hinderance create transportation problems, namely, from the workshops to the floating docks

(recently through pontoons and auxiliary vessels), inside the shipyard and to the repair and outfitting pier. It shall be mentioned that on the site the civil engineering works are in full progress what causes a considerably hinderance in evaluation of a clear ship-repair technology. This, however, does not mean that efforts should not be made to increase the recent shiprepair capacity of course in connection with the total reconstruction programme. Following suggestion can be made in this field:

1. Increase the contractors activity to finish as soon as possible the civil engineering works connected with protection of the slope along the main yard road.

2. Change the time schedule of the construction of the access platform to the floating docks so that it should be handed over to the shipyard in possible shortest time.

3. Change the planning and time schedule of preparation of the area and substrata for main transportation roads in the shipyard. The existing situation does not quarantee a smooth transportation and materials flow between different workshops and working places. A temporary pavement may be here also recommended.

4. Increase the activity in purchasing and soonest installation of following equipment necessary for the increase of repair capacity in the reconstruction conditions:

a) Movable units for ship-hull cleaning and painting placed in the floating dock during docking of the repaired vessel.

b) Compressor station which could serve all the shiprepair and steel construction workshops and working places and substitute the existing temporary one seriously damaged during earthquake.

Taking, however, into consideration the fact that the increase of shiprepair capacity is fully dependend on the amount

of work done in the reconstruction range, one shall state that the improvement of shiprepair technology and facilities is the function of the time of delivery of different civil engineering structures and buildings as well as deliveries and installation of necessary equipment. Thus one general suggestion or propersal may be presented, namely, that the involved parties should make efforts to change the planning in such a way that the necessary financial support will be available to shorten as much as logically possible the periods of civil engineering works, periods of order and delivery of equipment and periods of its installation. This may mean also to involve additional contractors e.g. for road construction. The present situation indicates that the shipyard will not reach the foreseen stage of reconstruction in the planned time.

Concerning the steel fabrication shop one can state that recently there are no hinderances which could lower the production capacity in relation to this which was before earthquake. When analyzing the working possibilities, however, one can also rise question concerning transportation means. Thus also here a fast reconstruction of roads should be suggested. In addition it seems reasonable to recommend the purchase of a transportation platform of e.g. 100 ton lifting capacity (e.g. Scheuerle type) which may be used for transportation not only of steel structures from the assembly area to outside transportation means, but also for transportation of sections, engines etc. belonging to vessels under rebuilding.

A general remark has to be made in connection with steel fabrication shop, namely, that all heavy equipment as presses etc. have a very low using factor. Thus it may be suggested to investigate to increase the production capacity trough the use of

these equipment during two or three shifts and thus prepare work for larger amount of workers during the basic shift. This may concern mainly the execution of structures on assembly areas on which only welding processes are limiting the efficiency of the steel structures fabrication works. In any case it is recommended to analyse the existing production programme for steel structures mainly due to the fact that recently the dimensions and weight limits of final structures are not exactly defined.

III. RECONSTRUCTION AND DEVELOPMENT PROGRAMME

The reconstruction and development programme for the ship-repair and steel structures fabrication activities had been prepared on the basis of following assumptions:

1. Existence of two floating docks 10 000 and 30 000 t capacity limiting totaly the docking capacity of the yard.

2. Existence of energy station 35/10 kV limiting the situation of electrical energy delivery plant.

On the basis of previous local experiences and statistical consideration a total amount of working hours per annum has been introduced as the limit value for employment and production capacity. This amount is estimated to be 1 200 000 hours. Assuming considerably high amount of hours for one worker per year of about 1800 hours it gives the possibility to employ about 670 workers. Additionally it is stated that from the 1 200 000 hours 1 020 600 will be used in shiprepair and 179 400 in steel works for ships. It is rougly 15% of the whole capacity. One shall here mention that the shipyard has recently an assembly hall for steel structures of the area 2500 sqm in which the steel construction works for ship repair may be witho. a problem done.

As stated before, taking into consideration the local experiences and the market requirements mainly based on the analysis of the harbours in Bar and Ploče and shipping companies in Dubrownik, Bar and Kotor, the following distribution of repair in the final stage of reconstruction is plamed and assumed as the basic data for all other reconstruction activities.

The assumed amount of vessels and labour hours may be of course a subject of wide discussion particularly that in some repair shipyards about 20% shiprepair activity concerns the repair due to collisions. However, one may assume that the above data

Vessels dwt	1 Repair in the harbour			2 Repair in the yard			3 Class repair			4 Collisions			5 Rebuilding		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
to 1000	7	200	1400	16	1000	16000	2	4500	9000	-	-	-	-	-	-
000-10200	11	400	4400	47	3500	164500	5	25000	125000	-	-	-	1	25000	-
000-100000	9	800	7200	65	5500	357500	8	40000	320000	2	25000	50000	2	60000	120000
Total	29	-	13000	128	-	538000	15	-	454000	2	-	50000	3	-	145000

	Amount of vessels	Amount of labour hours	%
1	27	13000	1,1
2	128	538000	44,8
3	15	454000	37,8
4	2	50000	4,2
5	3	145000	12,1
Total	175	1200000	100,0

a - amount of vessels
b - amount of hours
c - total amount of hours

are the result of local statistical investigations and thus accept them for further considerations.

Taking however into consideration the existing recently labour hours consumption per one vessel one can easily state that the presented above figures are considerably low. This could mean that the ships being under repair are more damaged than before. However, this means also that the amount of labour works for reaching the planned amount of vessels may be considerably raised. This means also that one should take into consideration the need of additional repair berths with a possible increase of capacity of the two existing floating docks.

The above statements and the planned relation between the total mooring length and total length of floating docks (~ 2.2) allow to draw following very important conclusions:

1. To assure the necessary increase of labour hours on ships being repaired the reconstruction of the yard should be made in such a way that in the future additional berthing places for repaired ships may be found. These places can be obtained by:

a) Construction of the North quay wall (10 on general plan) as a outfitting quay. The introduced structure of this quay allow the increase not only of the depth but also of the surchange which for shiprepairyards may be of the range 1.5 to 2.0 t/m^2. Necessary fenders, bollards and crane tracks may be foreseen in the reconstruction period.

b) Finalize as soon as possible the idea to use the mooring dolphins of the floating docks as mooring dolphins of repaired ships. However, it should be checked if it would not be necessary to place two additional mooring dolphins for mooring ropes of the stern and bow of considerably large ship. This would allow to moore all sizes of vessels. It has to be here stated that the

planned berthing length to the total length of the floating docks due to erection of the new pier will be 808 : 363 = 2.22, it is less than before the earthquake.

Due to the fact that the floating docks are the limiting facilities of the shiprepair capacity it is recommended to check if it is not possible to place on the floating dock walls additional jib cranes with considerably large outridge. This would allow first of all to speed the cleaning and painting works of the hull and thus shorten the docking time as well as repair the ships which are moored along the mooring dolphins of the floating docks. In the present situation it will be very difficult to keep the planned average 4 days period for one dry docking.

The increase of the efficiency of the reconstructed shipyard may require following changes in the lay-out of the shipyard:

a) Shifting of the administration head office (7 on general plan) and the sanitary and lavatory house (5 on general plan) in the area laying along the fence connected to gate Nr 1 (1 on general plane). Additionally all the above functions may be easily combined in one building particularly that a final design of these buildings is not available.

b) Shifting in the area 5,7,9 (on the general plan) shiprepair facilities which thus will be much nearer the floating docks and other repair facilities. This concerns the painter's shop (63 on general plan), rigging and sailmakers' shop (36 on general plan) and carpenters' and joiners' shop (58,59,60,61 on general plan).

c) Shifting the transportation facilities (53 on general plan) in the area used by carpenters and joiners shop (58,59,60, 61 on general plan) using a separate gate for connection with outside. Here also should be the parking area for shipyard trans-

portation means.

d) Connection of the scrab area (62 on general plan) with the outside gate mentioned in point c.

Independently it is recommended to redesign the building which recently is foreseen as nuclear shelter and cantine for workers. It is very near the repair area and thus taking a very important and valuable space. Taking into consideration the real distances in the shipyard which are considerably small it may be suggested that the nuclear shelter could be placed under the repair building (14 on general plan) whilst the cantine can be easily combined in the main building mentioned under point a. The same concerns the fire brigade which could be placed on the West side of the main building having gates also available from outside in the case when it is needed for a fire in the surrounding villages. The thus obtained area may be used for location of other facilities which now may be have small space e.g. a new proposition to this given in point b is thus possible.

Analysing the location of the energetic sources one can have doubts that they are so far from the repair shops. Taking, however, into consideration the main assumption of the reconstruction design, namely, the unchangeable location of the electrical power station, one can accept the proposed solution as reasonable.

Concerning the two main repair shops R_1 and R_2 following remarks can be made:

1. The size of the different shops shows only in some cases big differences between the area which they have before the earthquake and the area now designed. The comparison is as follows:

mechanical shops - 700 sqm before and 940 sqm now

equipment repair shop - 900 sqm before and 840 sqm now
engine shop - 600 sqm before and 1340 sqm now
electrical shop - 600 sqm before and 1170 sqm now
piping shop - 400 sqm before and 780 sqm now
locksmith shop - 1600 sqm before and 1170 sqm now
maintenance shop - 150 sqm before and 480 sqm now

This means that the main workshops have now an area which is about 1700 sqm larger than the area before the earthquake. The increase is about 36% what seems to be in coincidence with the amount of labour hours in the two periods (~ 44%). Thus, one should accept the proposed solution taking however, into consideration the fact, that the areas of different workshops are estimated only on the basis of experiences of the shipyard staff without detailed calculations based on detailed repair programme obtained from the market analysis and taking into consideration cost/benefit calculations not only for the whole programme but also for its parts and stages.

One additional question may be, however, pointed namely the question of engine repair shop (machine shop) equiped with heavy machines as large swing lathe, boring mill and heavy overhead crane. The planned distribution of repair shows only two collision repairs during year. Other repairs which may require heavy machines may be included in the group of ships for class repair. Assuming about 10% of the planned amount of these ships to be repaired using the heavy machines one may obtain 4 ships which could need these tools. However, the data given in point II and III does not show that the shipyard has repaired in the last time any ships damaged due to collision. Thus doubts may arise if the engine repair shop (machine shop) must have really such big area and if it has to be equiped with the foreseen heavy machines

particularly that it is connected with high investment and operating costs. In addition it should be stressed that the shipyard has a good practice in cooperation with other shipyards what could also mean that this part of work may be done in these shipyards. However, taking again into consideration the general programme of reconstruction and development of the shipyard and the fact that some repair shipyards in the world use 20% of their production capacity for repairs of ships damaged in collisions, one may accept to construct the buildings of the foreseen area, but to shift the purchasing of the heavy equipment to the time when it would be necessary i.e. after considerable change of the repair programme. From the other hand this area may be recognised as the extension area for the future increase of shiprepair activities in the shipyard.

The second main problem concerns the steel construction facilities. These facilities before the earthquake were limited to an assembly hall of the area of about 2500 sqm, however, without storage for plates and profiles and without cleaning and grouting facilities. As mentioned before the deliveries of steel structures in 1978 have reached 8000 t from which 1500 t was used for shiprepair and 4000 t for new floating units. The recently presented programme for the steel construction yard is based on delivery of 15 000 t steel structures per year of which 3000 t have to be used in shiprepair. There is, however, no specialisation foreseen what would mean a production of general steel structures. However, the possibilities of construction of floating units as barges and pontoons should be also foreseen. This requires above all the reconstruction of the launching facilities i.e. launching berths what should be made as soon as possible.

Concerning the number of workers involved in the future in steel fabrication an amount of 15 000 • 60/1800 = 500 workers is foreseen. The shiprepair, however, needs more working hours for one tonne of steel structures. Therefore an addition of 40 hours per tonne is planned what gives additionally 67 workers. However, this work is anticipated to be performed by cooperation with other shiprepair yards.

An analysis of the whole steel constructions fabrication yard together with connected assembly areas shows that totaly about 83 250 sqm of production area may be engaged for this production in comparison to about 55 390 sqm in shiprepair. This allows in the future to study a separate production programme e.g. offshore units. However, for to day it is recommended to safe the whole possesed area, clean and level it in such a way that it can be in the future immediately used when necessary.

Concerning the existing production line comprising the steel fabrication hall (46 on general plan), the assembly area of about 19 000 sqm (44 on general plan) which is ended by a launching berth, one should recommended to install here an additional jib crane placed on the crane track of the existing one. Also the construction of the plate and profile storage plants (49 and 48 on géneral plan), the cleaning and grouting plant (51 on general plan) as well the extension of the production hall (47 on general plan) is fully recommended.

Doubts maybe raised if the storage areas for plates and profiles are not to large (4150 and 1875 sqm respectively). One can state that it is too large for the hitherto foreseen 15 000 ton steel construction production. But, taking into consideration the fact that in the future the steel production may rise significantly through the involment of the area (52 on general

plan) measuring about 30 000 sqm, and that the costs does not rise significantly with the slight increase of the span of the magnetic overhead crane, the presented solution may be recognised as reasonable at time being.

Generally speaking it is necessary to start as soon as possible to investigate the market conditions to have the possibility to prepare a final profitable production programme for the steel constructions fabrication yard taking of course into consideration the available production areas which are much larger than these foreseen for the shiprepair yard. This programme should be in any case supported by a cost-benefit calculation showing above all positive results for the company. The problem of elongation of ships may be here investigated.

In the above mentioned investigations the problem of the gantry crane should be analysed. One can here state that a gantry crane may be a profitable mean when it is fully used and necessary for the production works. Such a situation may take place in the case of production of long series of units comprising either blocks or sections of the weight corr esponding to the lifting capacity of gantry crane or final products with considerably short ereetion periods also of the same weight. In other cases jib cranes with various lifting capacities are more economical. This means that the planed erection of gantry crane should be also a subject of future investigations in connection with the performance of the total production programme for the whole steel constructions fabrication yard and also partly of the shiprepair yard when taking into consideration the repair workshop e.g. for ship covers of Mc Gregory type.

All the presented considerations indicate that the whole reconstruction and development programme i.e. concerning the ship-

repair yard as well as the steel constructions fabrication yard should be the subject of permanent investigations which should allow to make necessary corrections not only of the amount of construction works but also of the whole production programme. Particularly a continuous study of the existing market is recommended for a continuously delivery of data which could have the influence on changes which in the reconstruction period are still possible and necessary. Basing on own experience may not always deliver a optimal solution.

IV. CIVIL - ENGINEERING WORKS

Civil-engineering works are performed on the basis of detail designs made by the design office R.O. za Projektovanje " "PREDNAPREGNUTI BETON" in Beograd. The whole design is based on the report on earthquake in the area of Bijela performed by Republički Seizmološki Zavod - Titograd under the title "Seizmicke i seizmotektonske karakteristike Lokacije Brodogradilista "Veljko Vlahović" - Bijela, Titograd 1979. According to this report the maximum earthquake which can occur in the area in consideration can not be higher than 9^{o} MCS. This means, however, that all buildings and civil engineering structures have to be designed for the intensity of 10^{o} in MCS.

A general analysis of the designed structures shows that these conditions have been fully introduced particularly by choosing the majority of structures on steel end bearing piles reaching with the tips a rock layer which is reported on the depth of about 40 m under the mean sea level. The use of piles should quarantee the stability of these structures for the existing soil conditions which are generally characterised by a sand layer underlayed by a clayey weak layer and compacted gravel layer. Due to the earthquake a possibility of liquefaction of the upper sandy layer and sliding of the underlayed weak soils layer have to be taken into consideration. The analysis of the movements of soils and structures during the last earthquakes shows that such phenomena took place causing a horizontal movement of the existing concrete blocks quay wall and sinking of the soil and building laying on the area along this quay. This analysis however shows also that it is a complex problem and that the existence of piles may cause a significant hinderance to evaluate such a state mainly due to lowering the settlements

value and due to the creation of a kind of barier disturbing a free sliding of the upper layers on the weak nearly frictionless clayey layer.

In the design the West quay wall is substituted by a protected slope with a necessary statical stability. In the case of earthquake the stability of this slope is however much higher than the stability of a vertical wall made of not joined concrete blocks what means that a horizontal movement of the liquefacted sand may have also considerable hinderances. This may mean that the slope protection is a kind of stability factor and may be as such one taken into consideration.

The above consideration may be the basis for a review of the design of the floor of the two repair workshops R_1 and R_2. According to the existing design these two floors have to be made as heavy reniforced concrete slabs resting on piles, read foundations not sensitive to earthquakes. This solution is of course very good but also very expensive and not profitable when analysing the whole investment costs. Thus, to lower the costs, a recommendation is made to investigate additionally the soil (liquefaction potential) and to redesign the floor constructing it as a set of reinforced concrete slabs placed directly on compacted fill with the floor level on the level of foundation for columns of the steel construction of the workshop halls. One should leave of course between these foundation and floor slabs necessary expansion joints. This solution has the necessary horizontal stability in the case of horizontal movement of the substrata. The problem remains still with the vertical displacements. However, it is proposed to perform here adequate settlement calculations taking into consideration the thickness of the compacted fill, the thickness of the sand layer under liquefaction and the ex-

istence of vertical and inclined steel end bearing piles which may act here as a composite piles using the phenomenon of negative skin friction. It is of course questionable if a liquefacted sand has the properties of a friction material, but in the case of a complex horizontal and vertical movement not only of the liquefacted sand but also of the fill and underlayerd clayey layer such assumption may be made and recognised as possible.

Taking into consideration all the above facts it is recommended to perform the adequate calculations taking into account the real stratygraphy of the soil underlaying the R_1 and R_2 workshops floors. If the calculated settlement in the case of the maximum intensity of the earthquake will be not larger than the difference between the highest water level in the soil and the level of the floors so it will be reasonoble to use a revised solution of the foundation slabs of the floors of R_1 and R_2 workshops.

The next problem concern the time schedule of civil engineering works. Following delivery times have been foreseen:

South Pier (66 on general plan)	31.03.1982
Access platform to floating docks (75 on general plan)	31.03.1982
Crane (33 on general plan)	31.12.1982
Crane repair (34 on general plan)	31.12.1982
Central storage (11 on general plan)	30.09.1981

It is reported that these structures will be delivered on time. Problems arrise, however, with the repair workshops R_1 and R_2 with delivery time in 31.12.1981, which are delayed due to foundation problems. Taking into consideration the fact that the assembly of the steel structures will take about 5 to 6 months with the execution of the foundations it is recommended to start as soon as possible with the revision of the foundations design as

suggested above.

In connection with the civil-engineering works a more complex problem have to be mentioned, namely, the problem of existence of a operative time schedule or delivery programme. In the case of reconstruction and development of two more or less independent factories as shiprepair yard and steel constructions fabrication yard it is necessary to have a operational planning and reporting showing daily increase of works and daily discrepances between the planned and realised time schedule. This operational coordination of civil engineering works, purchases, deliveres, settings in operation should be made by a coordination team reporting to the shipyard and governemental authorities all delays, needs of financial or general supports etc. In addition this operational planning, coordination and supervision should first of all allow to put into operation in proper time all new workshops, assembly areas etc. without a considerably production hinderance. One shall here state that without such a body and its proper work the total reconstruction and development programme can not be properly realised thus causing not only delays but also grouping of different works in the same time. Therefore it is recommended to introduce as soon as possible this operational performance of the whole reconstruction and development programme.

The next problem concerns the levels of the different areas in the shiprepairyard. In the design it is foreseen that between the piers and surrounding areas a difference in height about 1.1 m will exist. It is a considerably hinderance in transportation particularly of heavy platforms. One should of course take into consideration the fact of additional loading of the soil sensitive to earthquake and the costs of delivery of additional fill. Neverthless the problem will still exist. Therefore to obey

some of the unconvenienties it is proposed to finish the new South pier in such a way that the surface of the area near the pier will meet the coping structure of the pier under construction. This requires an adequate construction of the undersea slope (e.g. steeper inclination and heavier protection) but in any case it is recommended for execution due to many profits which such a solution contains.

At the end of the analysis of the civil-engineering works it shall be stressed that the works are made of a good quality with following of all rules concerning the necessary measurements, investigations etc.

V. CONCLUSIONS AND RECOMMENDATIONS

The report deals specifically with following three problems being the objectives of the mission, namely:

1. Existing, permanent and temporary shiprepair and steel construction facilities and the possible increase of their production capacity.

2. Reconstruction and development programme and the possible changes allowing the future extension.

3. Present state of construction of shiprepair and steel constructions facilities and the possible changes allowing the decrease of costs and shortening of e building period.

In this report adequate analises have been performed allowing to present answers to all above mentioned questions and to draw some more general conclusions and recommendations. However, it is found unnecessary to repeat all these conclusions and recommendations particularly that it is necessary to know the background of all these statements. Therefore it is proposed to go through the total report and make on its basis own analyses and statements if necessary or discuss these which are presented. Neverthless following main conclusions and recommendations may be mentioned, namely:

1. It is necessary to increase the contractors activity on the site to hand over as soon as possible all main transportation means i.e. transportation roads and access platform to the floating docks. These may cause a considerably increase of the recent production capacity of the shiprepair yard.

2. Necessary financial support should be quarrantied to speed the construction works and purchasing of different equipment and tools. This should allow to reach the final capacity in shortest possible time.

3. It is recommended to increase the effective length of mooring berths to assure the predicted increase of amount of ship repair works and the necessary relation between the total mooring length and the total length of the floating docks.

4. It is recommended to shorten the docking time for repaired vessels trough an introduction of a very efficiency equipment for cleaning and painting of hulls of ships being drydocked.

5. To increase the efficiency of the reconstructed shipyard it is proposed to make changes in the general layout among others trough shifting the repair shops nearer to the floating docks and outfitting piers.

6. The steel constructions fabrication yard should be the subject of future investigations to perform a profitable production programme for the facilities already existing and planned in the future.

7. It is recommended to perform adequate analysis and calculations to change the structural solution of the foundation slabs of the floors for repair workshops R_1 and R_2. This should allow to meat the foreseen delivery programme and lower significantly the investment costs.

8. It is recommended to intoduce as soon as possible operational planning and execution of all reconstruction and develcpment works.

As mentioned before the whole material of this reports contains proposition of changes, analyses etc. Thus is should be read totaly to obtain the indication of all proposed conclusions and recommendations.