REPORT ON THE FEASIBILITY STUDY OF THE CONSTRUCTION OF A FACTORY OF PRECAST CONCRETE MEMBERS IN INDONESIA

DECEMBER 1971

OVERSEAS TECHNICAL COOPERATION AGENCY
GOVERNMENT OF JAPAN

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SECTION 1 INTRODUCTION

Chapter 1 Purpose of Survey

Developments have been taking place in various fields in Indonesia since the New Five-Year Development Plan was put into effect three years ago to organize the intra-structures. The Indonesian Government has a considerable number of development projects for the construction of roads, railways, irrigation systems, electric facilities and houses. The realization of those projects will bring about a great demand for structural members and products.

At present Indonesia does not have any factory which manufactures precast concrete members. The structural members or products are formed or produced at the construction sites in Indonesia. It is a well-known fact, however, in advanced countries that the use of prefabricated precast concrete members and products produces favorable effects such as reduction of the construction period, improvement of quality control and reduction of construction costs.

P.N. Hutama Karya, state enterprise which belongs to the Department of Public Works and Power, wishes to construct a factory for the manufacture of precast prestressed concrete members. Recently it has been decided that the Board of Directors of the State Construction Enterprises belonging to the Department of Public Works and Power should study the plan of construction of such a factory and its feasibility.

Indonesia has not yet been given any technical assistance for the manufacture of precast prestressed concrete members by foreign countries, and she is therefore not in a position to lay out the plan of construction of the factory and judge its feasibility. This survey team conducted a survey, by request from the Indonesian Government, as experts of the Colombo Plan to help the Board of Directors of the State Construction Enterprise study the plan of construction of a factory for the manufacture of prestressed and precast concrete members and its feasibility.

The members of the survey team and survey itinerary

The present survey team consisted of the following three people.

Yasuji Tahara	(President of Nippon Structure and Bridge Research Co., Ltd.)
Tetsuo Kunihiro	(Manager of the Bridge Research Laboratory, Institute of Public Works, Ministry of Construction)
Akio Fukuoka	(Engineer of Civil Engineering Department, Sumitomo Construction Co., Ltd.)

The itinerary and details of the survey are as follows:

Month	Day	Day of the Week	Place Visited	Survey	Place of Stay	Remarks
July	7	Wed		Tokyo - Djakarta	Djakarta	Tahara, Kunihiro, Fukuoka
	8	Thu	Dept. of Public Works and Power Hutama Karya Japanese Embassy	Arrangement of survey itinerary	"	"
	9	Fri	Dept. of Public Works and Power	Arrangement of survey itinerary and method	"	"
	10	Sat	Visit to the City	Visit to steam power station at Tandjung Priuk	"	Kunihiro, Fukuoka
	11	Sun		Holiday	"	
	12	Mon	Visit to the City	Visit to bridges and construction sites in Djakarta	"	"
	13	Tue	Hutama Karya	Survey	"	"
	14	Wed	"	"	"	"
	15	Thu	"	"	"	"
	16	Fri	"	"	"	"
	17	Sat	"	"	"	"
	18	Sun	Bandung	Visit to bridge construction site at Tjisokan	"	"
	19	Mon	Hotel	Discussion of survey results	"	Tahara, Kunihiro, Fukuoka
	20	Tue	Hutama Karya	Survey	"	Kunihiro, Fukuoka
	21	Wed	"	"	"	"
	22	Thu	"	"	"	"
	23	Fri	"	"	"	"
	24	Sat	Djakarta - Purwokerto	Visit to Central Java	Purwokerto	"
	25	San	Purwokerto - Surakarta	"	Surakarta	"
	26	Mon	Surakarta and vicinity	"	"	"
	27	Tue	Surakarta - Djakarta	"	Djakarta	"
	28	Wed	Hutama Karya	Survey	"	"
	29	Thu	Hotel	Discussions of survey results	Djakarta	Tahara, Kunihiro, Fukuoka

	30	Fri	Ministry of Public Works and Power	Intermediate report of survey results to the Indonesian authorities	Djakarta	Tahara, Kunihiro, Fukuoka
	31	Sat	Hutama Karya	Survey	"	Kunihiro, Fukuoka
Aug.	1	Sun		Holiday	"	
	2	Mon	Djakarta - Denpasar	Visit to const-ruction sites in Bali Island	Denpasar	"
	3	Tue	Bali Island	"	"	"
	4	Wed	"	"	"	"
	5	Thu	"	"	"	"
	6	Fri	Denpasar - Djakarta	"	Djakarta	"
	7	Sat	Hutama Karya Japanese Embassy	Report of survey results to Hutama Karya and Japanese Embassy	"	"
	8	Sun	Djakarta - Tokyo (Kunihiro)		"	Fukuoka
	9	Mon	Hutama Karya	Survey and discussion	"	"
	10	Tue	Hutama Karya and Japanese Embassy	"	"	"
	11	Wed	"	"	"	"
	12	Thu	"	"	"	"
	13	Fri	Hutama Karya	"	"	"
	14	Sat	Tangerang	Visit to pipe factory	"	"
	15	Sun		Holiday		
	16	Mon	Hutama Karya and Japanese Embassy	Survey and Discussion	"	"
	17	Tue		Independence Day, Holiday	"	"
	18	Wed	Djakarta - Padang	Visit to const-ruction site of projected Sumatra Throughway	Padang	"
	19	Thu	Padang - Shimatidu	"	Shimatidu	"
	20	Fri	Shimatidu - Bangko	"	Bangko	"
	21	Sat	Bangko	"	Train	"
	22	Sun	Lubuklinggau - Palembang - Djakarta	Visit to Southern Sumatra	Djakarta	"
	23	Mon	Hutama Karya and Japanese Embassy	Report of survey results	"	"

	24	Tue	Djakarta - Makassar	Visit to Tonasa Cement Factory	Makassar	Fukuoka
	25	Wed	Makassar	Visit to water supply facilities and irrigation site of Makassar City	"	"
	26	Thu	Makassar - Djakarta	Visit to construction sites in Makassar City	Djakarta	"
	27	Fri	Hutama Karya and Japanese Embassy	Report	"	"
	28	Sat	Hutama Karya	Survey	"	"
	29	Sun		Holiday	"	"
	30	Mon	Development Bank	Collection of information from Mr. Fujita, advisor to the Development Bank	"	"
	31	Tue	Dept. of Public Works and Power	Collection of information from Mr. Sudjono,Manager of the Irrigation Sec. and Mr. Sarsono, Manager of the Road Section	"	"
Sept.	1	Wed	Dept. of Public Works and Power	Collection of information from Mr. Tenksan,Manger of the Technical Section	"	"
	2	Thu	Hutama Karya	Survey	"	"
	3	Fri	"	"	"	"
	4	Sat	"	"	"	"
	5	Sun		Holiday		
	6	Mon	Hutama Karya	Survey	"	"
	7	Tue	Dept. of Public Works and Power	Meeting for reporting survey results to the Indonesian Government	"	Iwamoto, Nakaoka, (Japanese Embassy) Fukuoka
	8	Wed	Left Indonesia for Japan			

SECTION 2 PRESENT CONDITION AND OUTLOOK FOR THE FUTURE

Chapter 1 Types of Precast Concrete Members to be Manufactured and Their Demand

2-1-1 Types of Precast Concrete Members to be Manufactured

The requirements for the precast concrete members which may be manufactured in Indonesia are as follows:

(1) They are in great local demand.
(2) The manufacturing cost may be reduced by precasting.
(3) The quality may be improved.

From this point of view the survey team considered the types of precast concrete members which might be manufactured in Indonesia. In the long run, however, the survey team came to the conclusion that it would be more effective to consider all types of precast concrete members including "precast prestressed concrete members" the survey of which the Indonesian Government requested the survey team to make. The precast concrete members to be manufactured there are pretensioned prestressed concrete beams for use in the construction of bridges and buildings, concrete piles, concrete pipes and concrete sleepers which may be manufactured by the manufacturing facilities and equipment for pretensioned prestressed concrete. A time will come soon, however, when the manufacture of the following precast concrete members should be considered; concrete poles for electric power transmission and communication facilities, concrete sheet piles for irrigation, concrete blocks for pavement of roads, precast concrete sheets for use in the construction of houses, etc.

2-1-2 Present Condition and Future of Concrete Bridge Members

The restoration, repair and construction of bridges are indispensable to the organization of infrastructures, and, indeed, the Indonesian Government emphasizes their importance in its New Five-Year Development Plan.

The recent construction of bridges took place mainly in Java, Sumatra and Bali Island, as shown in Table 1. The bridges constructed there are mostly reinforced concrete bridges and prestressed concrete bridges, the bridges of steel construction occupying only 25%.

All the prestressed concrete bridges were erected by the post-tension method. All those bridges were constructed by the Freyssinet method and B.B.R.V. method, and a bridge with a center span of 120 m (Rantau Beragin) is under construction in Sumatra, using the Freivorbau method.

Table 1
Past Construction of Bridges by State (*1969/1970)

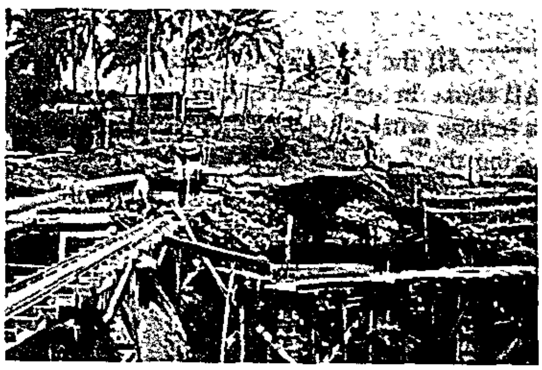
No.	Province	Surface Area (m^2)	No.	Province	Surface Area (m^2)
1	Atjeh	-	14	East Kalimantan	-
2	North Sumatra	907.5	15	West Kalimantan	-
3	West Sumatra	907.0	16	Central Kalimantan	-
4	Riauw	5,321.0	17	South Sulawesi	-
5	Dambi	-	18	South West Sulawesi	315
6	South Sumatra	1,240.0	19	North Sulawesi	486
7	Bengkulu	420.0	20	Central Sulawesi	-
8	Lampung	-	21	Bali	2,873.3
9	West Java	2,770.0	22	N.T.B.	304
10	Central Java	662.0	23	N.T.T.	-
11	D.I. Jogjakarta	-	24	Maluku	-
12	East Java	1,999.0	25	West Irian	-
13	South Kalimantan	-			
				Total	18,204.8 (m^2)

(Source: D.P.U.P. (Department of Public Works and Power)

* The period from April 1969 to March 1970.

Reinforced concrete bridges	Approx. 37.5 %
P.S. concrete bridges	Approx. 37.5 %
Bridges of steel construction	Approx. 25 %
Bridges of wooden construction	0 %

For the majority of reinforced concrete bridges with a span of 14 - 15 m visited by the survey team, the bridge girders were made on the road near the sites and slab concrete was placed, as shown in Photos 1 and 2. It may therefore be considered a fact that Indonesian engineers have mastered the techniques of erecting precast concrete bridge girders.



In view of the fact that the Indonesian Government makes clear its intention in the New Five-Year Development Plan to meet the demand for cement with domestic supplies and encourages the construction of concrete bridges as a guiding policy, the utilization of pretensioned prestressed concrete girders in the construction of bridges with a short span will be promoted to a great extent for their economic and qualitative advantages and ease of construction. Transportation of those products to the construction sites will be one of the problems in Indonesia. Table 2 shows Bridges Erected by Main Projects for Fiscal 1969, and Table 3 Plan of Expansion, Restoration and Construction of Bridges by New Five-Year Development Plan.

Table 2
Bridges Erected by Main Projects (1969/1970)

No.	Project	Surface Area (m^2)	No.	Project	Surface Area (m^2)
1	Djakarta-Samarang	2,973.0		(Kitamenann-Motoain)	385.2
2	Djakarta-Palembang			(Maumere-Larantuka)	756.1
	(Lampung)	388.0		(Ende-Badjawa)	458.0
	(South Sumatra)	354.4		(Badjawa-Buteng)	673.2
3	Nusa Tenggara Timur				
	(Kupang-Kafamenann)	736.0			
				Total	6,723.9 (m^2)

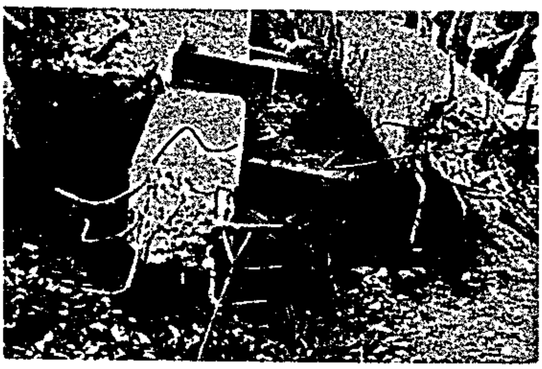
Source: D.P.U.P.

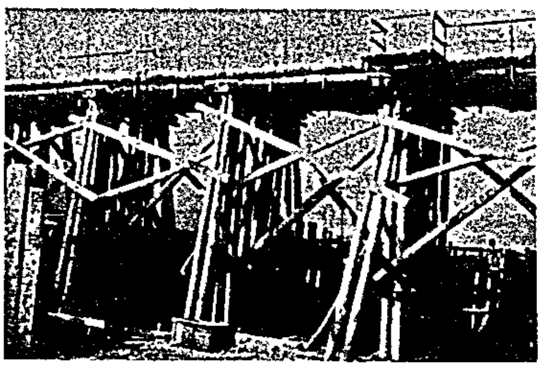
Table 3
Plan of Expansion, Restoration and Construction of Bridges by the New Five-Year Development Plan

	1969/70	1969/70-1973/74
Expansion	4,000 m	16,000 m
Restoration	6,000 m	64,000 m
Construction	?	?

2-1-3 Present Condition and Future of Foundation Concrete Piles

The piles used in the foundations of structures are mostly precast reinforced concrete square piles which are made on the construction site and wooden piles made from conconut trees. (See Photo 3.)





Judging from the Total Construction Works Performed for the past several years by the State Enterprises of Construction (Table 3) and Results and Forecast of Yearly Construction Works of the nationwide construction enterprises (Fig. 1), the foundation piles have shown a steady increase, and the structures which use a large quantity of those foundation piles are naturally expected to show the same tendency to increase. It will become more difficult to make concrete piles on the construction sites, as the land cost rises in cities in particular. According to a comparative estimate prepared by the survey team at this moment, it is expected that the centrifugal reinforced concrete piles manufactured by a special factory in the urban area will become more economical than the reinforced concrete piles made on the construction sites.

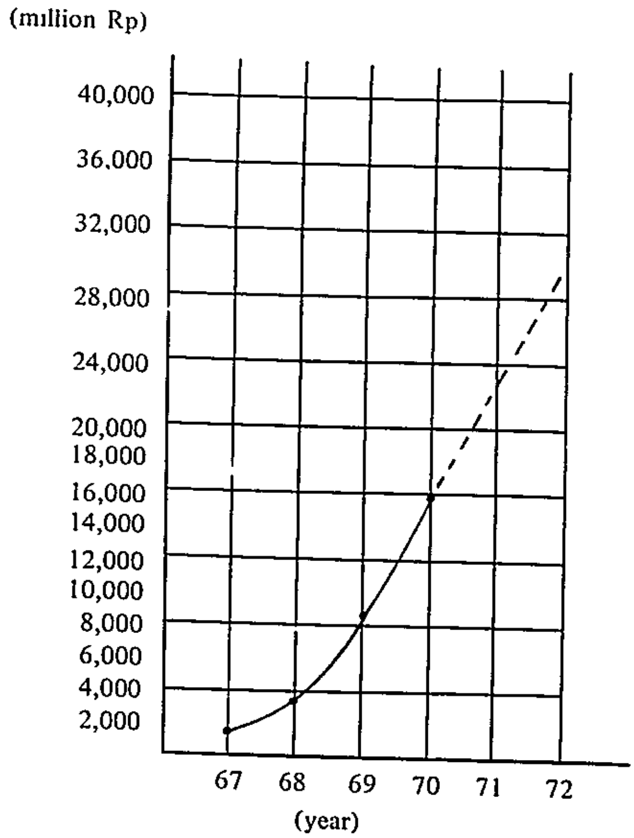
Table 3

Total Construction Works Performed
by the State Enterprises of Construction (P. N.)
for the Past Several Years

	Amount of Works (million Rp)	Comparison with Year before (%)
1967	1,459.50	-
1968	3,284.10	225
1969	8,805.70	268
1970	15,933.70	178

Figure 1

Results and Forecast of Yearly Construction Works
of the Nation-Wide Construction Enterprises



2-1-4 Present Condition and Future of Concrete Pipes

The Indonesian Government gives priority to the improvement of water supply facilities over that of sewage facilities in the Five-Year Development Plan and made public the budget for the plan of improvement of water supply and sewage facilities as shown in Table 4.

Table 4
Budget for Improvement of Water Supply and Sewage Systems by the New Five-Year Development Plan (million Rp)

	1969/70	1969/70-1973/74
Expansion Plan of Water Supply System	1,066	8,869
Improvement Plan of Sewage System	50	436

Most of the concrete pipes used in the sewage system are made of precast concrete, and small-scale enterprises manufacture plain concrete pipes by a typical instantaneous removal of forms. (Photo 4.) The manufacturing cost of those plain concrete pipes is rather low, and their demand and supply are balanced at the present moment.

However, a larger quantity of concrete pipes will be required from now on, as efforts continue to improve the sewage systems in cities (especially rain drainage during the rainy season) and promote the modernization. The concrete pipes will have to withstand larger loads on account of an increase in road loads, and as a result those small-scale manufacturers will not be able to meet the requirements, both quantitative and qualitative. Concrete pipes of higher strength and produductivity will be in need. However, those currently-available concrete pipes should be used in large quantities for economy in the fields (e.g. residential area) where high strength is not required.

Table 5 lists the ex-factory prices of plain concrete pipes manufactured and sold by factories in Dangeran districts.

Table 5

Market Prices of Plain Concrete Pipes

(Ex-factory Prices in Tangeran districts)

Inner Diameter (mm)	Wall Thickness (mm)	Selling Price (Rp)	Inner Diameter (mm)	Wall Thickness (mm)	Selling Price (Rp)
100	30	200	500	60	1,000
125	30	225	600	70	1,400
150	30	275	800	80	2,600
200	30	385	1,000	100	3,500
300	50	660			
400	50	900			

2-1-5 Present Condition and Future of Building Concrete Members

The construction of hotels, office buildings and factories has shown a marked tendency to increase in recent years in Indonesia as in other countries, as its economy grew. At present, some structural members made of prestressed concrete are used in buildings. In carrying out the New Five-Year Development Plan, the construction of houses is an imminent problem. As a matter of fact, 300,000 housing units are needed a year in the urban area, while about 40,000 housing units are supplied a year. As the research of prefabrication of houses has been conducted by the Housing Section, prefabricated concrete apartments of several stories will appear in Indonesia in the future. However, the application of prestressed concrete members in the construction of structures will first take the form of pretensioned prestressed concrete plates for use as floor and roof plates of general buildings and curtain walls.

2-1-6 Present Condition and Future of Concrete Sleepers

The Indonesian National Railways operate about 6,990 route kilometers of lines, 5,037 km of which is operated in Java Island

The majority of Sleepers used on these lines are made of hard wood such as teak and iron wood and iron. The maintenance of these railway lines is not perfect, and the Indonesian Government announced the following proposition as the future restoration plan in 1970. The main point of the plan consists in the rehabilitation of the existing railway lines for the five years' period from 1971 to 1975 and making it possible to attain a maximum speed of 80 kg/h on these lines. The budget earmarked by the Government for implementation of this plan is as shown in Table 6.

Table 6

Plan of Restoration of the Indonesian National Railways

(1,000 dollars)

	1971	1972	1973	1974	1975	Total
Restoration of Railways(tracks and bridges)	6,203	8,622	7,957	8,241	7,979	39,002

The estimated costs of restoration by railway lines are as shown in Table 7.

Table 7

Estimated Costs of Restoration of Railways (Tracks and Bridges)

	Item	Area	Quantity	Requirement ($)
Restoration of Railways	1. Djakarta-Merak	Western Java	152 km	3,220
	2. Tjirebon-Semarang	Central Java	183	5,392
	3. Semarang-Surabaja	Eastern Central Java	113	2,801
	4. Tjirebon-Kroja-Madiun	Central Java	390	11,488
	5. Pandjang-Tangit Tebak	Sumatra	188	5,546
	6. Muaraenim-Lubuklinggau	"	12	354
	7. Belawan-Medan	"	200	5,899
Total of Railway Lines Restored			1,238	34,700
Bridges		Entire Island	7,111 ton	3,557
Plan for Manufacture of Concrete Sleepers				450
Miscellaneous				295
Total				39,002

Source: Survey Team of O.E.C.F.

Report of Mr. Harada
"Survey Report on the Indonesian National Railways"

Judging from this plan, it is expected that the Indonesian National Railways will be in need of substantial sleepers.

2-1-7 Note

As discussed in Paragraph 2-1-1, the survey team selected pretensioned prestressed concrete girders, piles, pipes and sleepers as the precast concrete members which should be used in Indonesia for the time being. However, when the improvement of electric power transmission and communication facilities, irrigation facilities and houses which are the fundamental factors for the improvement of infrastructures is taken into consideration, the precasting of various structural concrete members should be realized for reducing the construction period and costs and securing the required quality.

2-2-1 Present and Future Condition of Transportation in Indonesia

One of the problems of efficient utilization of precast concrete products may be the selection of an economical means of transportation.

To transport those products, either means of transportation by land, by rail or by sea is generally selected depending the distance and location. When these means of transportation in Indonesia are taken into consideration, there seem to remain various problems to be solved. The present condition and outlook of those problems will now be discussed.

(1) Transportation by Land

The fundamental condition of transportation of precast concrete members is that the roads should be improved to such an extent as to withstand their weight. In Indonesia, however, the roads which can withstand the maximum load of 7 tons or more are only 0.2% of all the roads, and 76% of them can only withstand a load of 1 - 2 tons.

Table 8

Classification of Roads By Class (km)

Class	Maximum Automobile Load	National Highway	State Road	Prefectural Road	Total	%
I	7.0 ton	65	54	-	118	0.2
II	5.0	1,241	1,241	-	2,455	3.0
III	3.5	3,201	8,466	-	11,667	14.5
III - A	2.75	1,964	3,416	-	5,380	6.7
IV	2.0	2,015	6,430	-	8,445	10.6
V	1.5	1,614	520	49,800	51,934	65.0
Total	21.75	10,100	20,100	49,800	80,000	100.0

Source: Statistical Pocket Book of Indonesia (1964-67)

As for the number of trucks available, it is reported that about 100,000 trucks were available in 1966 in the entire islands of Indonesia. Table 8 shows the classification of the roads by class. In the local areas covered by the present survey, there were a number of extremely dangerous bridges. Coconut trees were used, for example, as reinforcement, when heavy cargos crossed those bridges. On the other hand, a number of trucks carrying heavy cargos were seen in the roads in Djakarta. The Department of Public Works and Power announced the "Instructions Concerning Design Loads of Bridges Constructed along Highways" in December 1970, making clear its policy for heavy-load vehicles and its intention of implementing the plans of restoration, improvement and construction of roads.

The current truck freight per ton which was said to be the standard freight is as shown in Table 9. However, it seems lower than actually is.

Table 9

Truck and Trailer Freights by Distance (Rp/ton)

Distance (km)	Cost (Rp/ton)
50	200
100	400
150	600
200	800
250	1,000
300	1,200

Source: Hutama Kasya

(2) Transportation by Rail

The total mileage of operating railways of Indonesia is the highest in Southeast Asia. However, the rehabilitation slowed down due to World War II and Independence War, reducing the transportation capacity of Indonesia. As mentioned in Paragraph 2-1-6 "Present Condition and Future of Concrete Sleepers", the Indonesian Government announced a plan of intensification of the transportation systems in connection with the Five-Year Restoration Plan of National Railways in an attempt to improve the transportation capacity for traffic of domestic natural resources.

The costs of railway transportation of bridge girders are shown in Table 10.

Table 10

Costs of Railway Transportation of Bridge Girders

Length of Bridge Girder (m)	Types of Freight Cars			Cost of Loading (Rp/Ton)	Cost of Unloading (Rp/Ton)
	Loading Capacity	Car Width	Car Length		
5	12 (t)	2 (m)	6 (m)	750-	750
6	12 - 15	2	6	"	"
7	30	2	12	"	"
8	30	2	12	"	"
9	30	2	12	"	"
10	30	2	12	"	"
11	30	2	12	"	"
12	30	2	12	"	"

Distance (km)	Rp/Freight car Tonnage
50	2.10/km/t
100	2.10/km/t
200	2.10/km/t

Source: Hutama Karya

(3) Transportation by Sea

The ocean transportation of secondary concrete products can be said to be efficient, only when they are used in the places near the ports and harbors well equipped. Although those ports of Tandjung Priuk, Padang and Makassar visited by the survey team appeared well equipped, the ocean freight was rather high ---- 2.80 rupias per ton/kg (excluding landing fees) as of June 1968. It appears that the ocean transportation of precast concrete products over a long distance except for particular places is not economical at the present stage of transportation development.

Chapter 3 Survey of Materials

2-3-1 Cement

According to the New Five-Year Development Plan, the production of cement in Indonesia is to tripple in 1974 as compared with 1968, as shown in Table 11. This means that the Indonesian Government aims to meet the national demand with domestic supplies.

Table 11

Yearly Production

Year	Production (tons)	Year	Production (tons)
1968/69	515,000	71/72	850,000
69/70	600,000	72/73	1,250,000
70/71	675,000	73/74	1,650,000

Source: New Five-Year Development Plan

Judging from the production of the existing three factories, however, half the demand of cement is met by imports from abroad. Since control is maintained of the quality of cement by a testing method specially modified on the basis of A.S.T.M., it cannot be compared with the quality of cement manufactured in other countries with reference to JIS, A.S.T.M. and B.S. etc., Although cement produced in Indonesia can be used as Portland Cement in the manufacture of precast concrete products, it seems' necessary to study the addition of concrete admixtures, if it is used in the manufacture of pretensioned prestressed concrete products which require short-time strength.

Table 12 shows the monthly production of the existing three cement factories and imports in 1971.

Table 12

Monthly Production of Cement of the Existing Three Factories and Imports in 1971

	Tonasa(tons)	Gresik(tons)	Padang(tons)	Total	Imports(tons)
Jan. 1970	7,369	30,768	10,798	48,935	29,800
Feb	6,702	20,771	10,140	37,613	24,000
Mar.	4,555	27,498	12,144	44,197	26,400
Apr.	7,120	26,266	14,172	47,558	39,600
May	9,229	29,696	9,235	48,160	37,200
Jun.	6,405	22,076	15,010	43,491	56,600
Jul.	7,283	19,881	15,020	42,184	34,600
Aug.	11,450	27,585	16,840	55,875	44,200
Sep.	7,808	24,164	15,370	47,342	61,800
Oct.	10,155	24,862	14,157	49,174	56,600
Nov.	7,808	30,356	7,800	45,964	50,700
Dec.	7,852	31,418	12,264	51,534	73,200
Total	93,736	315,341	152,950	562,027	534,700

2-3-2 Aggregates

The aggregates for use in precast concrete products must have a maximum diameter of about 20 mm. The survey team found on Java Island that there were not many rivers which produced gravel and that even those which produced it could not be relied upon for large quantities. The gravel which is produced in the principal producing areas on Java Island such as Bogol , Djakarta appear to be fit for use. As there are a number of mountains of andesite, aggregates can also be obtained by stone-crushing.

2-3-3 Steel Materials

All steel materials for use in the manufacture of reinforced concrete and prestressed concrete are all imported that is Indonesia depends mainly on Japan and Taiwan for steel for reinforced concrete and Japan and Switzerland for steel for prestressed concrete.

2-3-4 Price of Construction Materials

Table 13 shows the price fluctuations of the main construction materials sold in Djakarta for the past several years and prices of particular materials by area.

Table 13

Fluctuations in Prices of Construction Materials Sold in Djakarta for the Past Several Years (Rp)

Material	Unit	1966	1967	1968	1969	1970
Portland Cement	bag/50kg	150	240	625	665	725
Sand	m^3	425	425	800	1,050	1,300
Gravel	m^3	140	425	800	1,300	1,450
Cruched Stone(20-30mm)	m^3	200	600	1,500	1,700	2,300
Crushed Stone(50-70mm)	m^3	170	450	1,200	1,500	1,800
Steel for Reinforced Concrete	kg	11	15	40	46	65
Steel for Prestressed Concrete	kg	20	30	75	125	150
Angle Steel	kg	12.5	16	42.5	55	80
Channel Steel	kg	12.5	16	50	55	85
Peg	kg	20	60	65	80	120
Steel Pipe	m	1,000	875	1,300	1,400	1,500
Teak	m^3	6,000	15,000	36,000	60,000	70,000
Asphalt	kg	4	6	17.5	16	30

Source: Hutama Karya

Chapter 4 Survey of Labor Condition

2-4-1 Labor Condition and Wages

Indonesia has a population of about 120 million, 60% of which live in Java Island. The capital Djakarta has a population of 4.2 million people. It is the largest city in Southeast Asia. The population is concentrated in the industrial and commercial areas. The labor supply can be considered sufficient, since the demand for precast concrete products is concentrated in those industrial and commercial areas. However, the differences in wages are wide between the urban areas and the rural areas, and they are extremely wide between the skilled and ordinary workers. Table 14 shows the wages by area and job, and Table 15 the increase in wages for the past several years. The working hours are generally between 8 o'clock and 16 o'clock, and overtime is highly paid. Those who work till 18 o'clock are paid 1.1/2 times as much as the regular pay, and those who work till 22 o'clock 2 times as much as the regular pay.

Since the workers are serious by nature, they will be able to learn highly advanced techniques, if properly educated and trained.

Table 14

Recent Average Wages by Area (Rp/day)

	Djakarta	Denpasar	Padang	Sidjundjung	Makassar
Ordinary worker	300 - 400			375	120 - 200
Skilled worker	400 - 500			500	300
Foreman	600 - 700			500	300 - 400
Operator	700 - 800			700	500 - 700

Source: Hutama Karya

Table 15

Recent Changes in Labor Wages in Djakarta

(Rp/day)

	1966	1967	1968	1969	1970	1971
Ordinary Worker	12.50	70	135	200	200	400
Skilled Worker	22.50	90	225	300	350	500
Foreman	32.50	125	275	350	400	700

Source: Hutama Karya

Table 16

Population Census by Island

	Men	Women	Total
Java and Madura	30,801,151	32,191,905	62,993,056
Sumatra	7,942,834	7,796,529	15,739,363
Kalimantan	2,966,248	2,035,227	4,101,475
Sulavesi	3,489,797	3,589,552	7,079,349
Bali and Nusatenggara	2,761,396	2,796,260	5,557,659
Maluku	402,500	387,034	789,534
West Irian	375,154	383,242	758,396
Total	47,839,080	49,179,749	97,018,829

Source: General Bureau of Statistics.

2-4-2 Labor Law

Although a number of labor laws and regulations have been promulgated, they are not necessarily coordinated with respect to their interpretation and application.

The related labor laws and regulations are as follows:

(1) The Labor Standards Law (Ketentuan Pokok, Mengenai Tenaga Kerdja - 1969)
(2) The Labor Law (Pernjataan berlakunja Undang Kerdja Tahun 1948)
(3) The Labor Accident Law (Pernjataan berlakunja Undang Keljelakaan Tahun 1947)
(4) The Labor Dispute Mediation Law (Penjelesaian Perselisikan Perburukan 17-9-1951)
(5) Ordinances Supplementing the Labor Law (Peraturan Pernjataan berlakunja Peraturan Permintah Tabun 1948)
(6) Labor Accident Compensation Regulations [Pernjataan berlakunja Peraturan Ketjelakaan 1947 dadi Republik Indonesia Untuk Seluruk Indonesia (m.b. 8-1-1951)]
(7) The Industrial Labor Law (Arbeidsregeling-Nijverhidsbedrijven 1-8-1948)
(8) The Enterprise Declaration Obligation Law [Undang Tentang Kewadjiban Melaporkan Peruahaan (m.b. 25-12-1953)]

SECTION 3 FACTORY OF PRECAST CONCRETE MEMBERS CONCEIVED IN THE FEASIBILITY STUDY

Chapter 1 Method of the Feasibility Study

The products which might be manufactured in the precast concrete market were broadly divided into three groups, that is, precast concrete products, prestressed concrete products and concrete piles and pipes in order to forecast their respective demand. An appropriate production scale should be determined on the basis of accurate forecast of demand, but the forecast itself is extremely difficult in Indonesia, as mentioned before. Accordingly, a minimum-scale factory model which common sense would admit in consideration of the present condition of Indonesia was first conceived as a precast concrete factory of this sort (Proposition A). The costs of the products of this factory model were then calculated to compare them with those of products which were produced on the construction sites by the method generally accepted in this country. Since it is extremely difficult to forecast the future demand, a minimum-scale factory model which common sense would admit was conceived as a factory which would meet an increased demand (Proposition B). The costs of products of this factory were also calculated. In addition to the comparison of those costs, the indirect advantages of precast products such as reduction of construction period, improvement of product quality, saving of space at the construction sites, etc. were taken into consideration from a general point of view to come to a conclusion with regard to the feasibility of construction of a precast concrete factory.

Chapter 2 Model Factory Conceived

3-2-1 Outlines of Model Factory Conceived

In this survey two model factories, Propositions A and B, were conceived. Proposition A is a minimum-scale factory with the most fundamental facilities and equipment, that is, a factory which requires the least cost of construction but probably operates profitably. Proposition A thus reflects the consideration of the condition of this country where there is not a great demand for the products and labor is cheap. On the other hand, Proposition B is a minimum-scale factory which common sense would admit, if it were constructed in Japan. It is therefore more efficiently equipped than the factory of Proposition A. A factory of this scale should naturally be considered, when the demand for concrete piles and pipes increases to a greater extent and labor wages rise.

3-2-2 Layout

The factory layouts of Propositions A and B are shown in Figs. 2 and 3.

Proposition A

(1) Factory of Pretensioned Prestressed Concrete Members

The pretensioning capacity of the tension beds planned is

150 tons x 2 lines, 250 tons x 2 lines and effective length of 62.5 m.

The factory building is of the most fundamental type, an extension of only 20 m being considered.

(2) Factory of Concrete Piles (not centrifugal type)

This is a factory of the most fundamental type which is intended for use in the mass production of reinforced square concrete piles which are currently produced on the construction sites.

(3) Factory of Concrete Pipes (not centirfugal type)

This is a factory of the most fundamental type which is intended for use in the mass production of reinforced concrete pipes without the use of the centrifugal force.

Proposition B

(1) Factory of Pretensioned Prestressed Concrete Members

This is a factory of the ordinary type which has the same capacity as Factory (1) in Proposition A. The building covers the entire length of tension bed.

(2) Factory of Concrete Piles (centrifugal type)

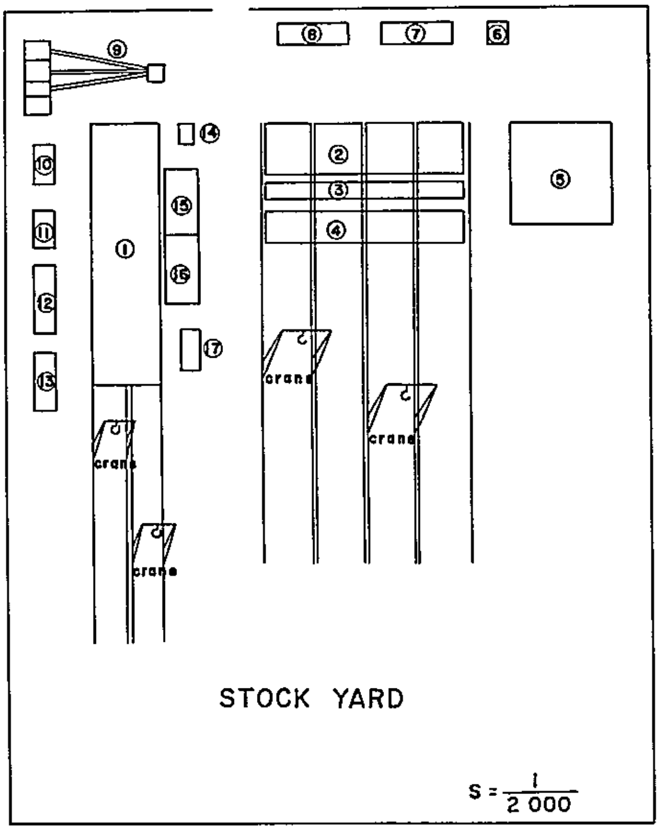
This is a factory of the ordinary type which is intended for use in the mass production of centrifugal reinforced concrete piles.

(3) Factory of Concrete Pipes (centrifugal type)

This is a factory of the ordinary type which is intended for use in the mass production of centrifugal reinforced concrete pipes.

PLAN OF PRECAST CONCRETE FACTORY

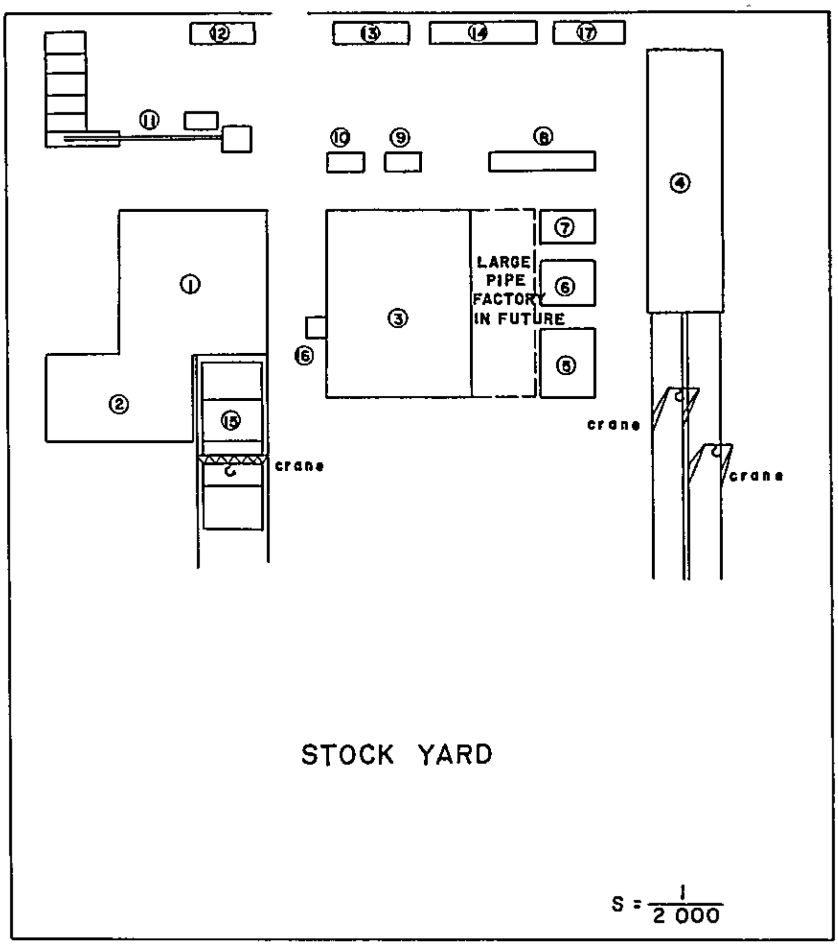
(PLAN-A)



NO	INDEX
1	PRETENSION ELEMENTS FACTRY
2	CONCRETE PILE FACTORY (NOT CENTRIFUGAL TYPE)
3	CRANE TRAVERSER
4	WATER POOL
5	CONCRETE PIPE FACTORY (NOT CENTRIFUGAL TYPE)
6	WATER TANK
7	WAREHOUSE
8	OFFICE
9	BATCHING PLANT
10	WOOD WORKS (FOR WOOD FORM)
11	FORM REPAIRING HOUSE
12	LABOUR HOUSE
13	LABORATORY
14	TRANSFORMER
15	STEEL WAREHOUSE
16	STEEL CAGE FACTORY FOR PIPE
17	BOILER HOUSE

PLAN OF PRECAST CONCRETE FACTORY

(PLAN-B)



NO	INDEX
1	CONCRETE PILE FACTORY (CENTRIFUGAL TYPE)
2	STEEL CAGE FACTORY FOR PILE
3	CONCRETE PIPE FACTORY (CENTRIFUGAL TYPE)
4	PRETENSION ELEMENTS FACTORY
5	STEEL CAGE FACTORY FOR PIPE
6	IRON WORKS (FOR REPAIRING)
7	WOOD WORKS (FOR WOOD FORM)
8	LABOUR HOUSE
9	WATER TANK TRANSFORMER
10	BOILER HOUSE
11	BATCHING PLANT
12	LABORATORY
13	OFFICE
14	WAREHOUSE
15	WATER POOL FOR PILE
16	COMPRESSOR HOUSE
17	REINFORCEMENT WAREHOUSE

3-2-3 Manufacturing Capacity

The manufacturing capacity conceived in Propositions A and B is as follows:

Proposition A

Table 17

Pretensioned Concrete Members   ℓ = 11.0 m   w = 2.0 t (Bridge Girder)

Weight		Quantity		Total Length		Bridge Area	
tons/mth.	tons/yr.	pcs/mth.	pcs/yr.	m/mth.	m/yr.	m^2/mth.	m^2/yr.
230	2,760	115	1,380	1,260	16,600	420	5,550

Table 18

Concrete Piles (not centrifugal type)

ℓ = 10.0 m   w = 2.2 t

300 mm x 300 mm   Solid Type

Weight		Quantity		Total Length	
tons/mth.	tons/yr.	pcs/mth.	pcs/yr.	m/mth.	m/yr.
700	8,400	300	3,600	3,000	36,000

Table 19

Concrete Pipes (not centrifugal type)

ℓ = 1.0 m   ϕ = 500 mm

w = 0.2 t

Weight		Quantity		Total Length	
tons/mth.	tons/yr.	pcs/mth.	pcs/yr.	m/mth.	m/yr.
250	3,000	1,250	15,000	1,250	15,000

Proposition B

Table 20

Pretensioned Concrete Members   ℓ = 11.0 m   w = 20 t (Bridge Girder)

Weight		Quantity		Total Length		Bridge Area	
tons/mth.	tons/yr.	pcs/mth.	pcs/yr.	m/mth.	m/yr.	m^2/mth.	m^2/yr.
230	2,760	115	1,360	1,260	16,600	420	5,550

Table 21

Concrete Piles (centrifugal tubular type)

ϕ 350   ℓ = 10.0 m   w = 1.5 t

Weight		Quantity		Total Length	
tons/mth.	tons/yr.	pcs/mth.	pcs/yr.	m/mth.	m/yr.
3,000	36,000	2,000	24,000	20,000	240,000

Table 22

Concrete Pipes (centrifugal tubular type)

Pipes of small diameter ϕ 200   ℓ = 2.0 m   w = 0.1 t

Pipes of medium diameter ϕ 550   ℓ = 2.43 m   w = 0.6t

	Weight		Quantity		Total Length	
	tons/mth.	tons/yr.	pcs/mth.	pcs/yr.	m/mth.	m/yr.
Pipes of small diameter	800	9,600	7,900	95,000	15,800	190,000
pipes of medium diameter	1,100	13,200	1,900	22,900	4,600	52,000
Total	1,900	22,800	9,800	117,900	20,400	242,000

3-2-4 Construction Cost

The construction costs of Propositions A and B will now be mentioned. They are shown in both domestic and foreign currencies, and the costs in the foreign currency include 10-% import duty.

Table 23

Construction Cost by Proposition A

(1,000 Rp)

	D. C.	F. C.
Factory of pretensioned concrete members	20,000	28,500
Import duty		2,850
Factory of concrete piles (not centrifugal type)	8,000	12,000
Import duty		1,200
Factory of concrete pipes (not centrifugal type)	4,000	19,000
Import duty		1,900
General facilities and equipment	27,000	48,000
Import duty		4,800
Molds	42,000	
Land (including land cost and land making expenses)	80,000	
Total	181,000	118,250
Grand Total	299,250,000 Rp	

Table 23 shows the construction cost by Proposition A, and Table 24 its breakdown. Table 25 shows the construction cost by Proposition B, and Table 26 its breakdown.

Table 24

Breakdown of Construction Cost

Proposition A

(Import duty excluded)

(1,000 Rp)

		D. C.	F. C.
Factory of pretensioned concrete members	Facilities and equipment	6,000	28,500
	Building	14,000	-
	Sub-total	20,000	28,500
Factory of concrete piles(not centrifugal type)	Facilities and equipment	4,000	-
	Building	4,000	12,000
	Sub-total	8,000	12,000
Factory of concrete pipes(not centrifugal type)	Facilities and equipment	-	19,000
	Building	4,000	-
	Sub-total	4,000	19,000
General faciliteis and equipment	Batcher plant	3,000	22,000
	Boiler	3,000	7,000
	Electric supply	-	12,000
	Other equipment	21,000	7,000
	Sub-total	27,000	48,000
Molds	Pretensioned concrete members	12,000	
	Concrete piles	24,000	
	Concrete pipes	6,000	
	Sub-total	42,000	
Land (cost and land making)	40,000 m^2	80,000	
	Grand Total	181,000	107,500

Table 25

Construction Cost by Proposition B

(1,000 Rp)

	D. C.	F. C.
Factory of pretensioned concrete members	41,000	28,500
Import duty	-	2,850
Factory of concrete piles (not centrifugal type)	97,600	70,050
Import duty	-	7,050
Factory of concrete pipes (not centrifugal type)	63,500	37,500
Import duty	-	3,750
General faciliteis and equipment	25,000	79,000
Import duty	-	7,900
Molds	16,000	110,000
Import duty	-	11,000
Land (including land cost and land making expenses)	120,000	-
Total	363,100	358,050
Grand Total	721,150	

Table 26

Breakdown of Construction Cost

(Import duty excluded)

(1,000 Rp)

Proposition B

		D. C.	F. C.
Factory of pretensioned concrete members	Facilities and equipment	6,000	28,500
	Building	35,000	-
	Sub-total	41,000	28,500
Factory of concrete piles(not centrifugal type)	Facilities and equipment	5,600	70,500
	Building	92,000	-
	Sub-total	97,600	70,500
Factory of concrete pipes(not centrifugal type)	Facilities and equipment	2,000	37,500
	Building	61,500	-
	Sub-total	63,500	37,500
General facilities and equipment	Batcher plant	6,000	30,000
	Boiler	3,000	7,000
	Laboratory	1,500	7,000
	Electric supply		20,000
	Other equipment	14,500	15,000
	Sub-total	25,000	79,000
Molds	Pretensioned concrete members	16,000	
	Concrete piles		60,000
	Concrete pipes		50,000
	Sub-total	16,000	110,000
Land(cost and land making)	60,000 m^2	120,000	
	Total	363,100	325,500
	Grand Total	688,600	

3-2-5 Estimated Manufacturing Cost

The manufacturing costs of Propositions A and B were calculated on the assumption that the following financing accommodations are available.

(a) The compoundinterest rate shall be 12%.

(b) The payment of borrowings shall be deferred for three years, and they shall be repaid in fixed installments in ten years, provided they bear interest from the first year of borrowing.

Tables 27 and 28 show the estimated manufacturing costs of Propositions A and B in the 4th year and 6th year. The fluctuations in labor expenses and costs of materials are counted out. (Depreciation declines.)

Table 27

Estimated Manufacturing Cost after 3 Years and 5 Years

Proposition A

Unit Rp/ton

		Pretensioned oncrete Members	Concrete Piles (not centri-fugal)	Concrete Pipes (not centri-fugal)
Materials	Concrete	5,000	4,000	4,000
	Reinforcement	500	1,600	1,300
	P.C. Steel	1,300	-	-
	Others	1,000	1,000	1,000
	Sub-total	7,800	6,600	6,300
Labor cost		1,700	800	1,700
Expenses		1,500	1,500	1,500
	Sub-total	3,200	2,300	3,200
Depreciation in the 4th year		7,500	3,700	4,800
Depreciation in the 6th year		6,700	3,300	4,000
Estimated Manufacturing Cost in the 4th year		18,500	12,600	14,300
Manufacturing Cost in the 6th year		17,700	12,200	13,500

Table 28

Estimated Manufacturing Cost after 3 Years and 5 Years

Proposition B

Unit Rp/ton

		Pretensioned Concrete Members	Concrete Piles (centrifugal)	Concrete Pipes (centrifugal)
Materials	Concrete	5,000	4,000	4,000
	Reinforcement	500	1,600	1,300
	P.C. Steel	1,500	-	-
	Others	1,000	1,000	1,000
	Sub-total	7,800	6,600	6,300
Labor cost		1,700	300	400
Expenses		600	600	600
	Sub-total	2,300	900	1,000
Depreciation in the 4th year		7,900	2,300	2,400
Depreciation in the 6th year		7,500	2,100	2,100
Estimated Manufacturing Cost in the 4th year		18,000	9,800	9,700
Manufacturing Cost in the 6th year		17,600	9,600	9,400

3-2-6 Comparison of Manufacturing Costs

Table 29 compares the construction cost of a bridge erected with precast-prestressed concrete bridge girders of Proposition B with that of a bridge constructed with bridge girders made on the construction site under the same condition. Table 30 the manufacturing cost of precast concrete pipes currently manufactured and Table 31 the cost of concrete piles made on the construction site.

Table 29

Comparison of Construction Cost of Bridge Erected with Pretensioned Prestressed Concrete Bridge Girders with That of Reinforced Concrete Bridge Erected with Bridge Girders Made on Construction Site

Design Conditions:

Location	Within Djakarta City
Design Load	7 ton
Bridge Length	10 m x 2 = 20 m
Total Width	8.2 m
Other Condition	The cost shown below includes bearings and slabs but excludes pavement, railing and approaches.

(Unit: Rp)

Reinforced Concrete Bridge with Girders Made on the Site		Pretensioned Prestressed Concrete Bridge	
Preparation	300,000	Preparation	300,000
Concrete Girders	1,781,000	Concrete Girders	1,970,000
Concrete Floor Slabs	1,466,000	Girder Transportation	70,000
Bearing	600,000	Bearing	600,000
Finishing	150,000	Girder Erection	144,000
		Assembling (including slab concrete and rent of tensioning and grouting tools)	655,000
		Finishing	150,000
Sub-total	4,292,000		3,889,000
Expenses 20%	858,000		778,000
Tax 5%	215,000		194,000
Grand Total	5,365,000	Grand Total	4,861,000

Table 30

Comparison of Reinforced Square Concrete Piles of Propositions A and B with Reinforced Square Concrete Piles Made on Construction Site

(Unit: Rp/ton)

	Reinforced Square Concrete Piles of Proposition A or B		Reinforced Square Concrete Made on Construction Site
	A(non-centrifugal)	B(centrifugal)	
Materials	6,600	6,600	
Labor cost	800	300	
Expenses	1,500	600	
Depreciation	3,700	2,000	
Transportation	800	800	
Total	13,400	10,300	14,000 Rp/ton

The estimate is based on the assumption that the factory is in the suburbs of Djakarta and the price is quoted on spot delivery.

Table 31

Comparison of Costs of Reinforced Concrete Pipes of Propositions A and B with those of Plain Concrete Pipes Produced in Tangerang Districts (Ex-factory)

(Unit: Rp/ton)

	Reinforced Concrete Pipes Manufactured at Proposed Factories		Plain Concrete Pipes Manufactured in Tangerang Districts
	A(non-centrifugal)	B(centrifugal)	
Materials	6,300	6,300	2,000
Labor Cost	1,700	400	700
Expenses	1,500	600	2,300
Depreciation	6,800	3,700	-
Total	16,300	11,000	5,000

Although the plain concrete pipes are less expensive than the centrifugal reinforced concrete pipes, as shown in Table 31, the external pressure strength of the former is most probably about half that of the latter.

3-2-7 Program of Construction

The factory of Proposition B is to be constructed according to the schedule shown in Table 32.

Table 32

Program of Construction

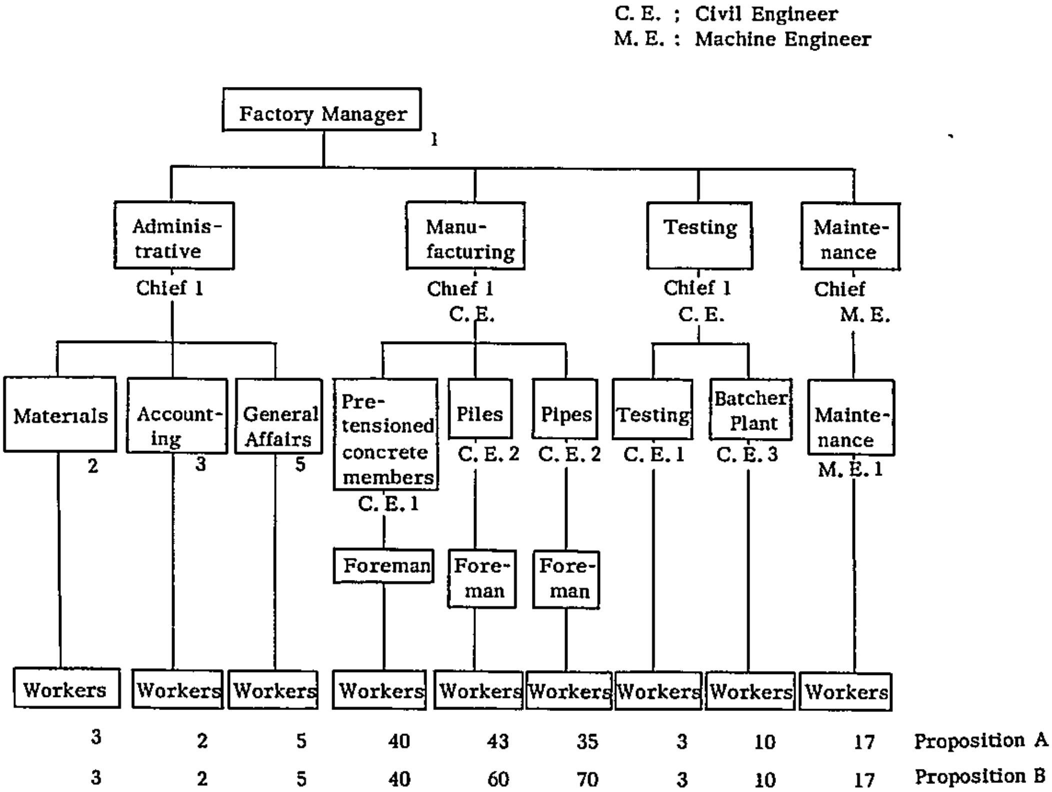
	2	4	6	8	10	12	14	16	18	20	22	24
Construction planning	—											
Acquisition of land		—	—									
Land making			—	—								
Designing		—	—									
Ordering for materials and equipment manufactured aborad				—	—	—	—	—				
Ordering for materials and equipment manufactured at home						—	—	—				
Construction of factory							—	—				
Installation of facilities and equipment									—	—		
Trial Operation											—	

3-2-8 Arrangement of Personnel

The arrangement of personnel in the factory of Proposition B is shown in Fig. 4.

Figure 4

Organization of Factory



3-2-9 Manufacturing Processes

The manufacturing processes of pretensioned prestressed concrete members, centrifugal reinforced concrete piles and centrifugal reinforced concrete pipes to be manufactured at the factory of Proposition B are shown in Figs. 5, 6 and 7.

Fig. 5 Pretensioned Prestressed Concrete Members

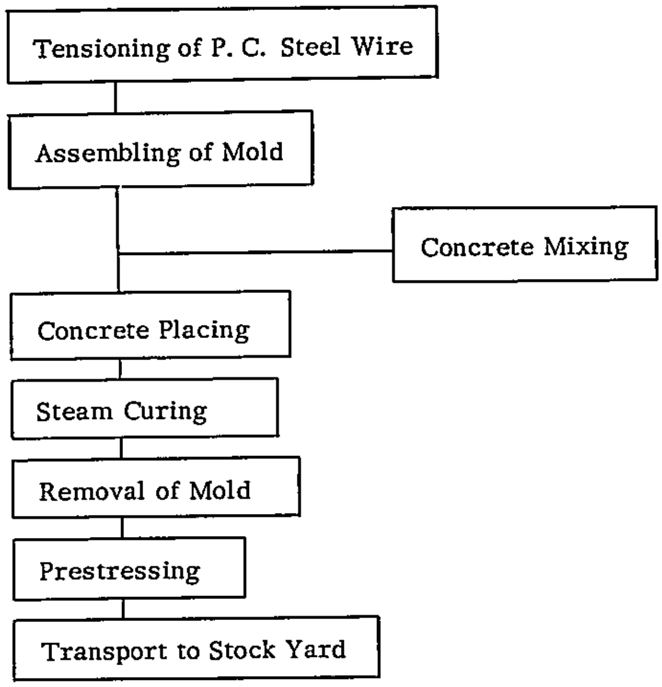


Fig. 6 Centrifugal Reinforced Concrete Piles

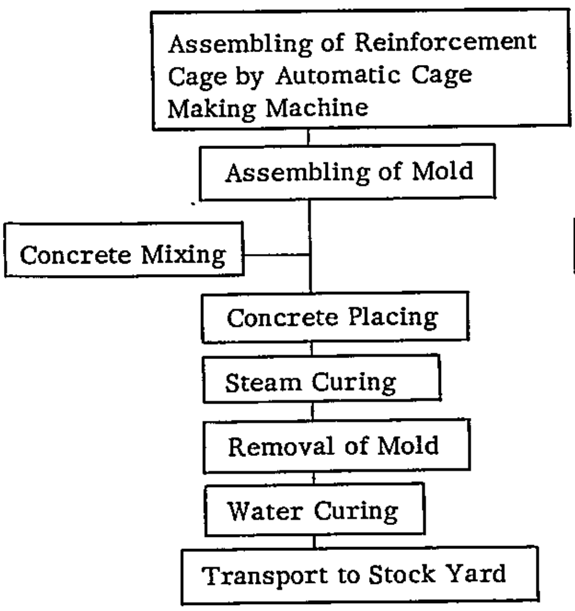
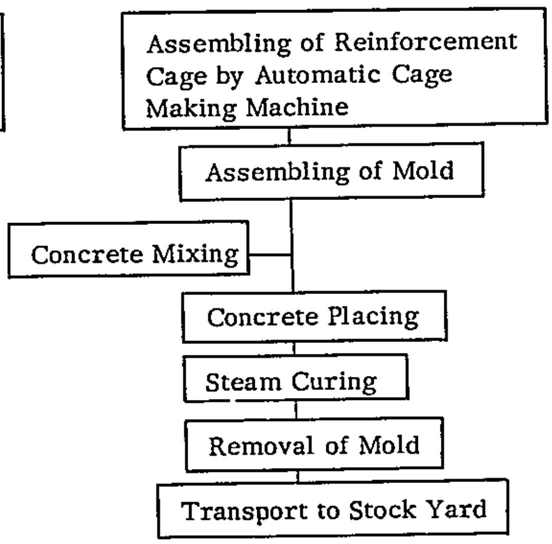


Fig. 7 Centrifugal Reinforced Concrete Pipes



SECTION 4 CONCLUSION

Chapter 1 Feasibility

4-1-1 Feasibility

Although we made efforts to forecast the future demand for precast concrete in Indonesia, we found it extremely difficult to show it in exact figures in a short time in this country which is making rapid economic progress. However, we have come to the conclusion that it is quite feasible to construct a factory of precast concrete for the following reasons.

(1) A substantial increase in the demand for concrete girders of road bridges, foundation concrete piles for buildings, concrete sleepers for railway construction, concrete pipes for water supply and sewage systems, concrete poles for electric power transmission and communication and other structural concrete members is in prospect in Indonesia where the Government has been promoting the land development, placing importance on the development of infrastructures.

(2) If a constant demand is ensured, the utilization of factory-produced concrete products reduces the construction costs to a greater extent as compared with concrete members made on the construction sites even at the present stage.

(3) When the quality is considered, precast concrete provides by far greater advantages than the concrete members made on the construction sites. For instance, a factory can produce standardized products of high quality, using the same materials in the same quantity as in the case of structural concrete members made on the construction site. These advantages have a close bearing on the cost of construction of a structure as a whole.

(4) The manufacture of standardized products makes it possible to use ready-made products, thus permitting the construction period to be reduced. Investments will receive returns in a shorter time.

4-1-2 Conditions of Construction of the Factory of Precast Concrete

It is necessary to satisfy the fundamental requirements for construction of the factory of precast concrete manufacturing. Those requirements are as follows:

(1) The Government Efforts to Promote Demand for Precast Concrete Products

The demand for those precast concrete products depends on the public investments. The Government should establish and enforce a policy of encouragement and promotion of the use of those precast concrete products.

(2) Standardization of Precast Concrete Products

The Government should promote the standardization of precast concrete products so that more economical and better products may be in wider use.

Chapter 2. Location and Scale of the Factory

We mentioned that the Government's efforts to promote the demand and standardization of precast concrete products were the conditions of construction of the factory under consideration. However, it is not advantageous to build factories far apart from each other across the country in terms of economic and managerial efficiency at present moment. It is recommended that land be secured in the suburbs of Djakarta to construct a factory of Proposition B for manufacturing centrifugal reinforced concrete piles, a factory of Proposition B for manufacturing precast prestressed concrete products and a factory of Proposition B for manufacturing centrifugal reinforced concrete pipes of higher productivity and strength than those plain concrete pipes currently available on the market in line with an increase in sewage construction works. Since the transportation cost of precast concrete products occupies a large portion of the selling expenses, it is recommended to construct its factory on a minimum but profitable scale one by one near those areas where those products will be in demand.

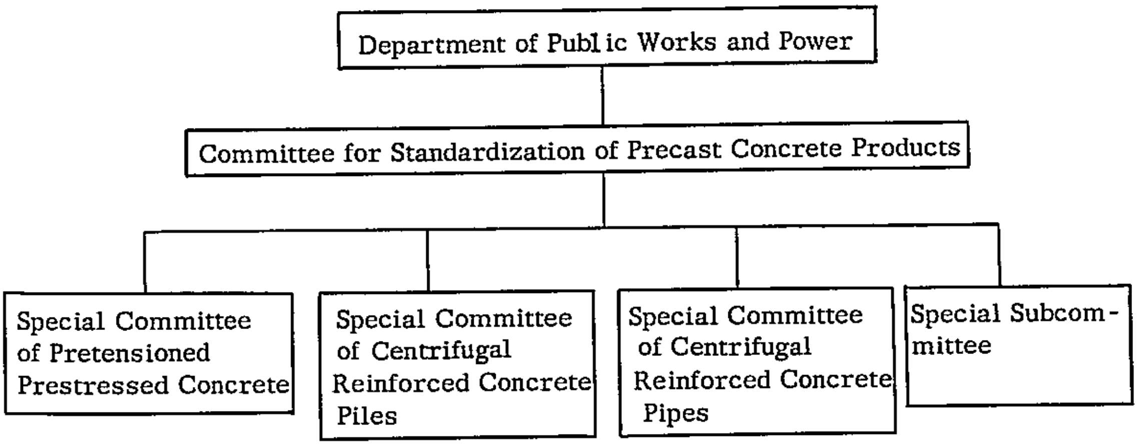
Chapter 3. Management

4-3-1 Establishment of a Committee for Standardization of Precast Concrete Products

It is recommended that the Government establish a Committee for Standardization of Precast Concrete Products in the Department of Public Works and Power in order to promote the standardization of those products.

The Committee for Standardization of Precast Concrete Products should set up special subcommittees for each group of products so that standardization plans may be discussed on the basis of reports submitted by those special subcommittees. Each special subcommittee should consist of the representatives of consumers, manufacturers and experts to draw up the drafts of standardization plans of products of the highest possible quality from all angles, design, manufacture and utilization.

A recommendable organization of the Standardization Committee is shown below.



4-3-2 Policy of Factory Management

The requirements of factory-manufactured precast concrete are a low cost, high quality and short delivery period. We have already mentioned that the cost of transportation of precast concrete products occupies a large portion of the selling expenses. In order to comply with those requirements, the factory should formulate its own standards and carry out the following control.

(1) Cost control
(2) Material control
(3) Control of manufacturing processes
(4) Quality control
(5) Control of facilities and equipment
(6) Control of shipments
(7) Labor control

(1) Cost Control

The factory should establish the standards of manufacturing cost control to maintain control of the manufacturing costs.

(2) Material Control

The factory should establish the standards of materials, purchases and storage to maintain control of the materials.

(3) Control of Manufacturing Processes

The factory should establish the standard manufacturing procedures and techniques to maintain control of the manufacturing processes.

(4) Quality Control

The factory should establish the inspection and statistical control standards to maintain control of the quality of products.

(5) Control of Facilities and Equipment

The factory should establish the control standards of the manufacturing facilities and equipment and measuring and testing equipment to maintain control of those manufacturing facilities and equipment.

(6) Control of Shipments

The factory should establish the shipping system and standards of shipment of products to maintain control of shipments.

(7) Labor Control

The factory should lay out the plan of training and education of its employees and see to it that the standards and rules of the factory are rigidly observed.

Chapter 4. Funds

As discussed above, the construction of a factory of precast concrete offers a great deal of possibilities. It will be able to operate on a profitable basis in the future, even if private funds may be introduced. At present, however, the Government funds should be used, since the standardization of its products and creation of their demand still remain to be promoted. In due course of time, the Government's funds should be replaced by private ones step by step. In this respect it is possible that the Government shold turn to other countries for borrowings in order to achieve this end.

Chapter 5. Future Survey

Our survey has made it clear that the construction of a factory of precast concrete is feasible in Indonesia. However, as the time assigned to us was limited, we do not necessarily think that our future demand forecast and proposal of optimal-scale factories to meet the demand leave nothing to be desired. On the contrary, we hope that further surveys will be conducted on the basis of this survey for more reliable and exact information.

INTERMEDIATE TEST

1. SCOPE

This standard shall specify the intermediate tests which are made of concrete for use in centrifugal reinforced concrete pipes at the stages of concrete mixing, reinforcement cage making and forming, curing and removal of the concrete pipes from the molds.

2. INSPECTION ITEMS

2-1 Concrete
- Water on the surface of aggregates
- Mixing of concrete on the construction site
- Slump test
- Compression stress test
- Measurement of air

2-2 Arrangement of tendons and reinforcement

2-3 Forming

2-4 Curing

2-5 Mixer

3. Test Frequency

4. Method of Inspection

5. Judgment and Criteria

6. Steps To Be Taken in the Failure of Products To Pass Tests

7. Inspection Report

INTERMEDIATE TEST

1. SCOPE

This standard shall specify the intermediate tests of concrete in the process of manufacturing centrifugal reinforced concrete pipes.

2. INSPECTION ITEMS

2-1 Water on the surface of aggregates

2-2 Mixing of concrete on the construction site

2-3 Slump test

2-4 Compression stress test

2-5 Measurement of air

3. TEST FREQUENCY

3-1 Water on the surface of aggregates

The water on the surface of fine or coarse aggregates shall be measured once in the morning, at noon and at night, respectively. A measurement shall be made every time rain falls.

3-2 Mixing of concrete on the construction site

The mixture ratio shall be varied according to the instruction manual for mixing concrete on the construction site every time the quantity of water on the surface of fine or coarse aggregates changes.

3-3 Slump test

The slump shall usually be measured once a day, provided a measurement is made immediately when any abnormal condition arises.

3-4 Compression stress test

Three test pieces shall be collected respectively from lots at 7 and 28 days of age once a day to conduct a compression stress test.

3-5. Measurement of air

Once a month

4. METHOD OF INSPECTION

4-1 Water on the surface of aggregates

The testing standard shall apply.

4-2 Mixing of concrete on the construction site

The inspector shall prepare an instruction manual for concrete mixing according to the amount of water on the surface of aggregates and fineness modulus and give instructions to those in charge of manufacture.

4-3 Slump test

The testing standard shall apply.

4-4 Compression stress test

The dimensions of the test specimens shall be ϕ100 x 200 for small concrete pipes and ϕ150 x 200 for medium and large concrete pipes, and the testing standard shall apply.

4-5 Measurement of air

The testing standard shall apply.

5. JUDGEMENT AND CRITERIA

5-1 Water on the surface of aggregates Nil

5-2 Mixing of concrete on the construction site Nil

5-3 Slump test

4 ± 1 cm for small concrete pipes
3 ± 1 cm for medium and large concrete pipes

5-4 Compression stress test

The test value shall not be less than 90% or more of the design standard strength at an accuracy of more than 1/20.

The test value shall not be less than the design standard strength at an accuracy of more than 1/4.

5-5 Measurement of air

2% or less

6. STEPS TO BE TAKEN IN THE FAILURE OF PRODUCTS TO PASS THE TEST

6-1	Water on the surface of aggregates	Nil
6-2	Mixing of concrete on the construction site	Adjustment shall be made immediately.

6-3 Slump test

The batch shall be disposed of, and another measurement shall be made after the instruction manual for mixing of concrete on the construction site is corrected.

6-4 Compression stress test

Concrete shall be subjected to a washing test to check the equipment and materials for factors which reduce its strength, when the strength of concrete at 7 days of age is abnormally lower than the strength aimed at.

The mixture ratio shall be modified, if the strength of concrete at 28 days of age fails to reach the control limit. The products shall be accepted, if two specimens sampled out of the products manufactured for the day comply with the requirements of the cracking test. JIS markings shall not be stamped on the products, if the two specimens fail to comply with the requirements of the cracking test. If one passes the cracking test and the other fails to comply with the requirements of it, another specimen shall be tested, and the same steps shall be taken to determine whether or not the lot is acceptable.

The products manufactured for the day shall be accepted, if their strength exceeds the control limit at 28 days of age, provided the mixture ratio is re-examined.

7. INSPECTION REPORT

7-1 Water on the surface of aggregates

The quantity of water on the surface of aggregates shall be recorded in the prescribed form, and it shall be stored.

7-2 Mixing of concrete on the construction site

The mixture ratio used on the construction site shall be recorded in the prescribed form, and it shall be stored.

7-3 Slump test

The results of slump test shall be recorded in the prescribed form, and it shall be stored.

7-4 Compression stress test

The results of a compression stress test shall be recorded in the prescribed form, and it shall be stored.

7-5 Measurement of air

The results of a measurement of air shall be recorded in the prescribed form, and it shall be stored.

INTERMEDIATE TEST

1. SCOPE

This standard shall specify the performance requirements of a mixer used in a batcher plant for use in the manufacture of centrifugal reinforced concrete pipes.

2. INSPECTION ITEMS

Difference in unit weight of mortar

Difference in unit volume of coarse aggregates

3. TEST FREQUENCY

Inspection shall be conducted every six months.

4. METHOD OF INSPECTION

The testing standard shall apply.

5. JUDGEMENT AND CRITERIA

Difference in unit volume and weight of mortar in concrete	0.8%
Difference in unit volume of coarse aggregates in concrete	5%

6. STEPS TO BE TAKEN IN THE FAILURE OF THE MIXER TO PASS THE TEST

The mixing time shall be extended or blades of the mixer shall be replaced.

7. INSPECTION REPORT

The results of tests shall be recorded in the prescribed form, and it shall be stored.

INTERMEDIATE TEST

1. SCOPE

This standard shall specify the intermediate tests of reinforcement cages in the process of manufacturing centrifugal reinforced concrete pipes.

2. INSPECTION ITEMS

2-1 Visual inspection

2-2 Inspection of dimensions

3. TEST FREQUENCY

An automatic reinforcement cage making machine is used in the manufacture of reinforcement cages for use with concrete pipes with a nominal diameter up to 1,100 mm.

The first two reinforcement cages shall be inspected as test specimens after the reinforcement cage making machine is set.

Since the reinforcement cages for use with concrete pipes with a nominal diameter 1.200 mm and over are made by hand, the whole lot shall be inspected.

4. METHOD OF INSPECTION

4-1 Visual inspection

The products shall be visually checked for twists and separation of welded portions.

4-2 Inspection of dimensions

The diameter, length and pitch of the spiral tendon shall be measured by a scale.

5. JUDGEMENT AND CRITERIA

5-1 Visual inspection

The twisting of longitudinal tendons shall be 10° or less, and the welded portions shall not be separated at more than 5 locations.

5-2 Inspection of dimensions

The tolerances shall be as specified below.

Diameter	Length	Pitch of Spiral Tendon
± 3	± 10	± 20 mm

6. STEPS TO BE TAKEN IN THE FAILURE OF THE PRODUCT TO PASS THE TEST

The automatic reinforcement cage making machine shall be stopped to check it up until normal reinforcement cages can be produced. The unaccepted products shall not be used.

INTERMEDIATE TEST

1. SCOPE

This standard shall specify the assembly of molds in the process of manufacturing centrifugal reinforced concrete pipes.

2. INSPECTION ITEMS

Visual inspection

The leaks at seams, coating of the separating agent and distortion of the mold, presence of a reinforcement cage and tightening of bolts shall be inspected.

3. TEST FREQUENCY

The whole lot of products shall be tested.

4. METHOD OF INSPECTION

Visual inspection or sound inspection by means of a test hammer.

5. JUDGEMENT AND CRITERIA

Clearance of seams	Clearance: within 1 mm
Coating of a separating agent	The separating agent shall be spread on the whole surface of mold in contact with concrete, and no oil shall be deposited on the reinforcement cage.
Distortion of molds	Distortion of the surface of molds
Presence of a reinforcement cage	The reinforcement cage shall be used at a correct position.
Tightening of bolts	Striking the mold with a test hammer shall not produce an unusual sound.

6. STEPS TO BE TAKEN IN THE FAILURE OF THE MOLD TO PASS THE TEST

The mold shall be reassembled. The use of a faulty mold shall be prohibited until repairs are made to it after reporting to the person in charge of the maintenance of manufacturing equipment.

7. INSPECTION REPORT

The unaccepted molds shall be marked x with chalk and transferred to the shop of removal of concrete pipes from molds.

INTERMEDIATE TEST

1. SCOPE

This standard shall specify the intermediate tests of the temperature of steam curing in the process of manufacturing centrifugal reinforced concrete pipes.

2. INSPECTION ITEMS

2-1 Rise and fall of the temperature in the curing chamber

2-2 Maximum temperature in the curing chamber

3. TEST FREQUENCY

Inspection shall be conducted every hour, and immediately after the operation is resumed, when it is stopped.

4. METHOD OF INSPECTION

4-1	Temperature gradient	Thermometer
4-2	Maximum temperature	Thermometer

5. JUDGEMENT AND CRITERIA

5-1	Temperature gradient	$15^{o}C$ or less per hour.
5-2	Maximum temperature	$65^{o}C$ or lower.

6. STEPS TO BE TAKEN IN THE FAILURE OF THE TEMPERATURE TO COMPLY WITH THE REQUIREMENTS

The opening of the valves of each curing chamber shall be adjusted.

JAPANESE INDUSTRIAL STANDARD
Centrifugal Reinforced Concrete Pipes

1. SCOPE

This standard shall specify the reinforced concrete pipes (hereinafter referred to as the RC pipes) manufactured through application of centrifugal force.

2. TYPE

The RC pipes shall be classified into ordinary and pressure types according to the purpose of use and Types A, B and C according to the shape as shown in Table 1.

Table 1

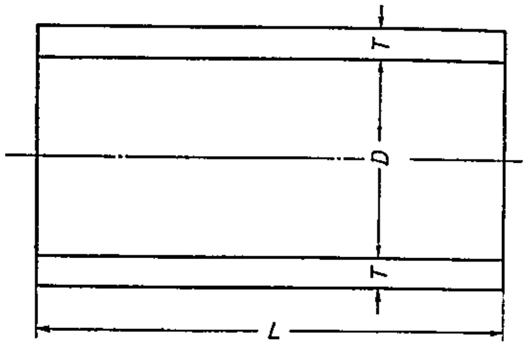
Type		Nominal Diameter (mm)			Purpose of Use
		Type A	Type B	Type C	
Ordinary Pipe		75 ~ 1800	75 ~ 900	900 ~ 1200	Internal pressure not applied
Pressure Pipe	Testing Hydraulic Pressure (kg/cm^2)				Internal pressure applied
	1	75 ~ 1800	75 ~ 900	—	
	2	75 ~ 1800	75 ~ 900	—	
	3	75 ~ 1800	75 ~ 900	—	
	4	75 ~ 1800	75 ~ 900	—	
		75 ~ 1000	75 ~ 900	—	
	6	75 ~ 800	75 ~ 800	—	
	8	75 ~ 600	75 ~ 600	—	
	10	75 ~ 100	75 ~ 100	—	

NOTE: 1. It is recommended to use in the pressure piping pressure pipes which resist a pressure higher than the test pressure, that is, total of twice the hydrostatic pressure and shock pressure.

3. SHAPE, DIMENSIONS AND APPEARANCE

3-1 The shape and dimensions of the RC pipes shall be in principle as shown in Figs. 1 - 3, except that the RC pipes may be 1/2 shorter.

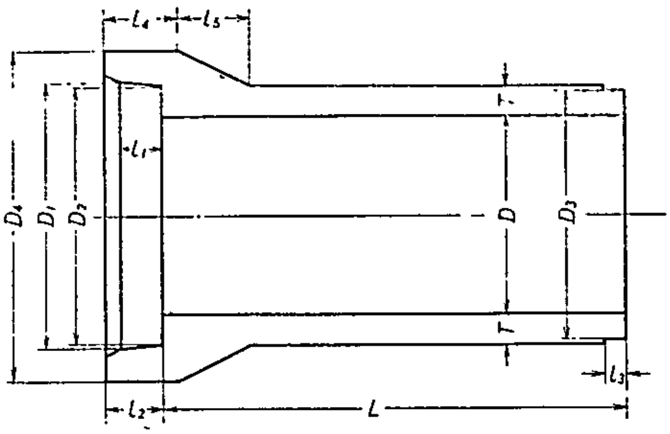
Fig. 1 Type A



Unit mm

Nominal Diameter	Inner Diameter *D*	Thickness *T*	Length *L*
75	75	25	2000
100	100	25	2000
125	125	25	2000
150	150	26	2000
200	200	27	2000
250	250	28	2000
300	300	30	2000
350	350	32	2000
400	400	35	2430
450	450	38	2430
500	500	42	2430
600	600	50	2430
700	700	58	2430
800	800	66	2430
900	900	75	2430
1000	1000	82	2430
1100	1100	88	2430
1200	1200	95	2430
1350	1350	103	2430
1500	1500	112	2430
1650	1650	120	2430
1800	1800	127	2430

Fig. 2 Type B

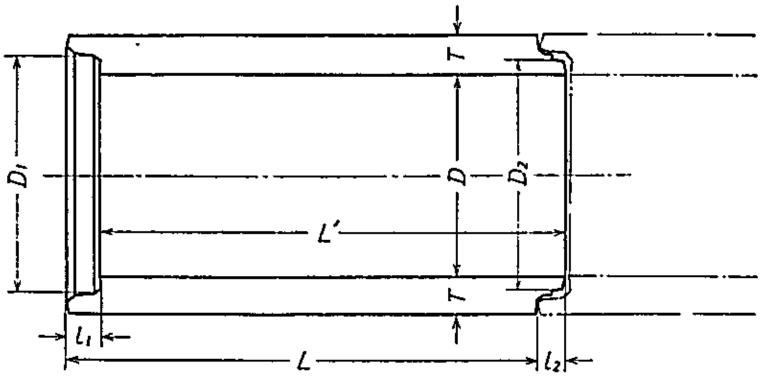


Unit mm

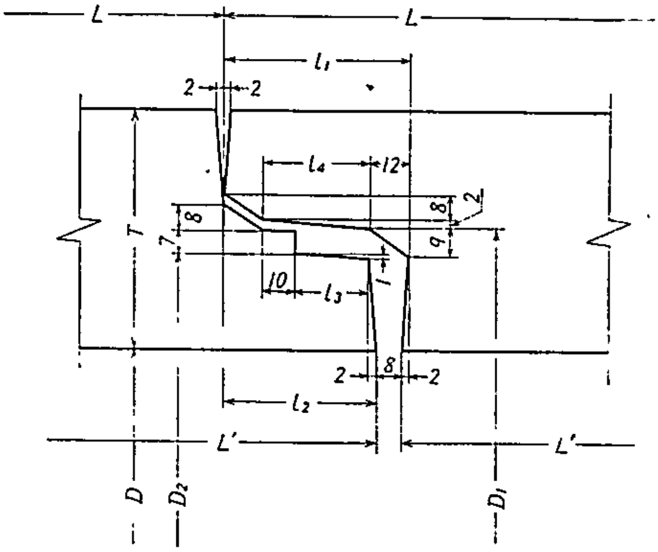
Nominal Diameter	Inner Diameter D	D_1	D_2	D_3	D_4	Thickness T	* l_1	* l_2	* l_3	l_4	l_5	Length L
75	75	133	129	117	183	25	55	75	32	100	40	2000
100	100	158	154	142	208	25	65	90	32	100	40	2000
125	125	183	179	167	233	25	65	90	32	100	40	2000
150	150	210	206	194	262	26	65	90	32	100	40	2000
200	200	262	258	216	316	27	65	90	32	110	55	2000
250	250	314	310	298	370	28	65	90	32	110	55	2000
300	300	368	364	350	424	30	65	90	36	110	55	2000
350	350	422	418	404	482	32	65	90	36	110	55	2000
400	400	478	474	460	544	35	70	95	36	120	70	2130
450	450	534	530	516	606	38	70	95	36	120	70	2130
500	500	592	588	574	672	42	70	95	36	120	70	2130
600	600	708	704	690	804	50	75	100	36	130	90	2130
700	700	824	820	802	936	58	75	105	44	130	90	2130
800	800	940	936	918	1068	66	80	110	44	130	90	2130
900	900	1058	1054	1036	1204	75	85	115	44	140	90	2430

* The values of l_1, l_2 and l_3 may be changed for the time being, if approved by the orderer.

Fig. 3 Type C



Details of Joint of Type C



Unit mm

Nominal Diameter	Inner Diameter D	D_1	D_2	Thickness T	l_1	l_2	l_3	l_4	Length L	L'
900	900	976	960	75	57	47	23	33	2360	2352
1000	1000	1080	1064	82	57	47	23	34	2360	2352
1100	1100	1184	1168	88	57	47	23	33	2360	2352
1200	1200	1290	1274	95	57	47	23	33	2360	2352
1350	1350	1448	1432	103	62	52	27	37	2360	2352
1500	1500	1604	1588	112	62	52	27	37	2360	2352
1650	1650	1760	1744	120	62	52	27	37	2360	2352
1800	1800	1914	1898	127	62	52	27	37	2360	2352

* L must be 1145 mm, when the length is reduced by 1/2.

3-2 The tolerances of dimensions shall be as specified in Table 2.

Table 2. Type A

Unit mm

Nominal Diameter	Inner Diameter D	Thickness T	Length L
75 ~ 250	± 3	+3 −2	+10 −5 ± 10 only when the length is reduced by 1/2.
300 ~ 900	± 4	+4 −2	
1000 ~ 1350	± 6	+6 −3	
1500 ~ 1800	± 8	+8 −4	

Type B

Unit mm

Nominal Diameter	Inner Diameter D	D_1	D_2	D_3	D_4	Thickness T	l_1	l_2	l_3	l_4	l_5	Length L
75 ~ 250	± 3	± 2			+tolerance is not specified	+3 −2	± 4	± 5	± 4	+ tolerance is not specified. −5		+10 −5
300 ~ 600	± 4					+4 −2						
700 ~ 900		+3 −2					± 5		± 5			

Type C

Unit mm

Nominal Diameter	Inner Diameter D	D_1	D_2	Thickness T	l_1	l_2	l_3	l_4	Length L	L'
900	± 4	± 2	± 1	+4 −2	± 2		± 1		+10 −5	
1000 ~ 1200	± 6			+6 −3						
1350		± 3	± 2							
1500 ~ 1800	± 8			+8 −4						

3-3 The inner and outer periphery of RC pipe cross section shall form a practical concentric circle, and the end surface of the RC pipe shall be practically at a right angle to its axis.

3-4 The RC pipe shall be free from injurious defects, and its inner surface shall be smooth.

4. MATERIALS

4-1 Cement

Cement complying with the requirements of JIS R 5210 (Portland Cement), JIS R 5211 (Blast-furnace Cement), JIS R 5212 (Silica Cement) or JIS R 5213 (Fly-ash Cement) shall be used.

4-2 Aggregates

Aggregates shall be clean, strong, durable and of proper granularity and shall not contain dust, mud, organic substance or thin or slender stone fragments to an injurious extent.

4-3 Tendons and Reinforcement

Tendons and reinforcement shall comply with either one of the following standards or their mechanical properties shall be equivalent to them, except that auxiliary iron wires may be annealed.

(1) Ordinal Iron Wire specified in JIS G 3532 (Iron Wire)
(2) JIS G 3521 (Hard Steel Wire)
(3) JIS G 3112 (Steel Bar for Concrete Reinforcement)

5. MANUFACTURE

5-1 Measurement of Materials

All concrete materials shall be measured by weight except that water may be measured by volume.

5-2 Forming

Assembled tendons and reinforcement shall be placed into a metal mold, and a concrete mixture mixed by a mixer shall be packed into the metal mold and compacted by the centrifugal force to form the RC pipe.

5-3 Curing

5-3-1 The RC pipes shall be cured by the method which will produce satisfactory results.

5-3-2 The following requirements shall be met in principle, when low pressure steam is employed to cure the RC pipes.

(1) The RC pipe shall be placed in the curing chamber together with the mold. Steam shall be supplied in such a manner that the temperature of the curing chamber may rise uniformly.

(2) Seam curing shall begin 3 hours or more after the concrete mixing is completeted.

(3) The temperature of the curing chamber shall be raised by 20°C or less an hour, and the maximum temperature shall not exceed 65°C.

(4) The RC pipe shall be taken out of the curing chamber when its temperature is lowered down to a level much the same as that of the outside atmospheric temperature.

6. STRENGTH

6-1 External Pressure Strength

The ordinary RC pipes shall show a higher external pressure strength than the values given in Table 3, when subjected to the external pressure test specified in Paragraph 7-1.

Table 3

Nominal Diameter (mm)	External Pressure (kg/m)	
	Crack	Breaking
75	2300	3300
100	2000	3000
125	1800	2700
150	1600	2500
200	1100	2200
250	1300	2000
300	1400	2000
350	1500	2200
400	1600	2400
450	1700	2700
500	1800	3000
600	2000	3600
700	2200	4300
800	2400	4900
900	2600	5500
1000	2800	6100
1100	2900	6700
1200	3000	7300
1350	3200	8300
1500	3400	9300
1650	3600	10300
1800	3800	11300

6-2 Internal Pressure Strength

The RC pressure pipes shall show the external pressure strength which withstands the testing hydraulic pressure shown in Table 1, when subjected to the hydraulic pressure test specified in Paragraph 7-2.

7. TEST

7-1 External Pressure Test

A test specimen is placed on a solid stand evenly with it, and a quality rubber plate about 20 mm thick is placed under and on top of it. A square lumber of hard wood about 150 mm thick is placed on top of the rubber plate.

As shown in Fig. 4, a load shall be perpendicularly applied to the whole area of the top of the pipe for Type A, while a load shall be perpendicularly applied to the straight-line portion of the pipe for Types B and C so that the load may be distributed as evenly as possible.

By the cracking load is meant a load which caused the RC pipe to develop cracks 0.25 mm wide, and by the breaking load is meant the maximum load the testing machine indicates.

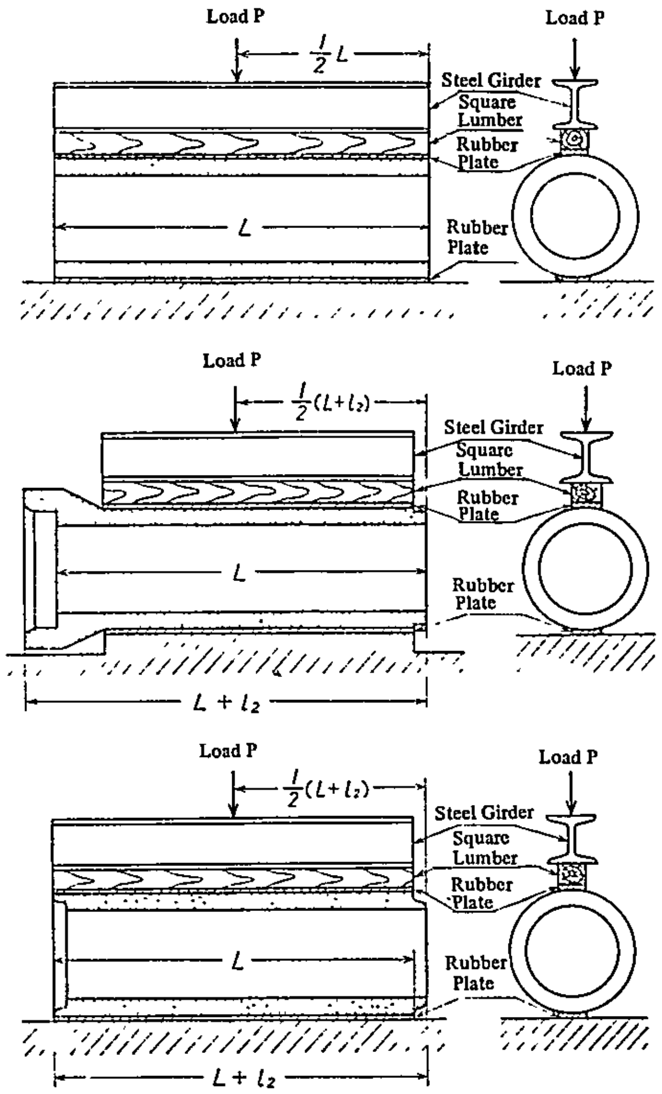
The external pressure strength is given by dividing load P by length L of the RC pipe.

Fig. 4

Type A

Type B

Type C



7-2 Hydraulic Pressure Test

A test specimen, saturated with water, shall be subjected to the hydraulic pressure test shown in Table 1 for 3 minutes to check the specimen for leaks of water. Water which oozes out of the RC pipe in spots or drops shall not be considered as leaks of water.

8. INSPECTION

8-1 The shape, dimensions and appearance of the RC pipes shall be inspected, and the ordinary and pressure RC pipes shall be further inspected with respect to external pressure strength and internal pressure strength, respectively.

8-2 The whole lot of products shall be inspected with regard to the shape, dimensions and appearance and shall be accepted if they comply with the requirements of Article 3.

8-3 One specimen selected at random from a lot consisting of 200 or 200 and its fractions of RC pipes for each nominal diameter shall be subjected to an external pressure test, and the whole lot represented by the specimen shall be accepted, if it complies with the requirements of Paragraph 6-1.

8-4 One specimen selected at random from a lot consisting of 30 or 30 and its fractions of RC pipes for each nominal diameter and testing pressure shall be subjected to an internal pressure test, and the whole lot represented by the specimen shall be accepted, if it complies with the requirements of Paragraph 6-2.

8-5 The RC pipe may be tested again, if its specimen fails to pass the test of Paragraph 8-3 or 8-4. When another test is to be made, another two specimens shall be selected at random from the same lot, and the lot shall be accepted, if the two specimens pass the test, provided the specimen which failed to pass the first test is excluded, The whole lot shall be refused, if one of the two specimens fails to pass the second test.

9. MARKING

The RC pipes shall have the following markings in clear and legible form; name of the manufacturing plant or its abbreviation, date of forming, nominal diameter and length. The RC pressure pipes shall also bear the marking of testing hydraulic pressure.

NOTE 2. The rubber ring for use with the RC pipe joint shall comply with the requirements of JIS K 6353 (Rubber for Service Water Pipes).

ANNEX COLLAR FOR CENTRIFUGAL REINFORCED CONCRETE PIPES

1. SCOPE

This annex shall specify the collars for use with the joints of Type A (hereinafter referred to as collar) of the centrifugal reinforced concrete pipes (hereinafter referred to as the RC pipes).

2. TYPE, MATERIALS AND MANUFACTURE

The provisions set forth for the RC pipes shall apply.

3. SHAPE, DIMENSIONS AND APPEARANCE

3-1 The shape of collar shall in principle be as specified in the following figure, and its dimensions shall conform to Table 1.

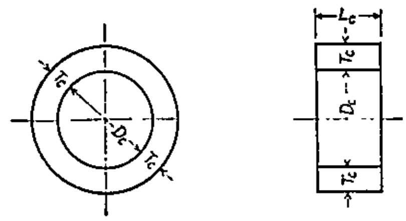


Table 1

Unit mm

Nominal Diameter	Inner Diameter D_c	Thickness T_c	Length L_c	Reference: Dimensions of RC pipes Inner Diameter D	Thickness T
75	149	25	150	75	25
100	174	25	150	100	25
125	199	25	150	125	25
150	226	28	150	150	26
200	278	30	150	200	27
250	330	31	150	250	23
300	390	33	150	300	30
350	444	35	150	350	32
400	500	38	150	400	35
450	556	42	200	450	38
500	614	46	200	500	42
600	730	50	200	600	50
700	846	58	200	700	58
800	962	66	200	800	66
900	1080	75	200	900	75
1000	1200	82	250	1000	82
1100	1312	88	250	1100	88
1200	1426	95	250	1200	95
1350	1592	103	250	1350	103
1500	1768	112	250	1500	112
1650	1934	120	250	1650	120
1800	2093	127	250	1800	127

3-2 The dimensional tolerances shall conform to Table 2.

Table 2

Unit mm

Nominal Diameter	Inner Diameter D_c	Thickness T_c	Length L_c
75 ~ 250	+3 −2	+3 −2	+10 −5
300 ~ 900	+4 −2	+4 −2	
1000 ~ 1350	+5 −3	+5 −3	
1500 ~ 1800	+6 −3	+6 −3	

3-3 The inner and outer periphery of the collar cross section shall form a practical concentric circle, and both ends shall practically be at a right angle to its axis.

3-4 The collar shall be free from injurious defects.

4. QUALITY OF CONCRETE

The quality of concrete for use in the manufacture of collars shall be the same as or superior to that of concrete for use in the manufacture of the RC pipes of the same type.

5. INSPECTION

The collars shall be inspected with respect to the shape, dimensions and appearance and shall be accepted, if they comply with the requirements of Article 3.

6. MARKING

The collars shall have the following markings in clear and legible form; name of the manufacturing plant or its abbreviation, date of forming and nominal diameter. The collars for use with the RC pressure pipes shall also bear the marking of testing hydraulic pressure.

JIS A 5303-1965

CENTRIFUGAL REINFORCED CONCRETE PIPES

EXPLANATION

1. Scope

The reinforced concrete pipe manufactured through application of centrifugal force means what is called Hume concrete pipe. This standard shall not apply to the cylinder pipes, PC pipes and the water collection pipes, semi-tubular pipes, bent pipes and extra-thick pipes of a special shape, even if the centrifugal force is employed in their manufacture, not to mention the reinforced concrete pipes (JIS A 5302) manufactured by the vibrating machine or compacting machine. As for the reinforced concrete collars for use with joints of the RC pipes, however, they are specified in the Annex, since they are different from the RC pipes and are not always used. The provisions set forth in the Annex shall be part of this standard.

The socket joint pipe and faucet joint pipe which have been specified for the first time in the present standard shall be used with a rubber ring.

2. Type

The RC pipe has two types, ordinary RC pipe and pressure RC pipe. The ordinary RC pipes are used as sewer pipes, culvert pipes, drain pipes and penstock which receive little or no internal pressure, while the RC pressure pipes are used as water-conveyance pipes and penstock which receive an internal pressure. The RC pressure pipes are further classified into several types of a different internal pressure strength depending on the pressure of water used. The RC pressure pipe is called by its testing hydraulic pressure. An RC pressure jpipe which withstands a testing hydraulic pressure of 4 kg/cm^2 is, for instance, called a 4-kilo pipe.

In the present revision, the RC pioes are classified into three types, Type A, Type B and Type C, according to the shapes of their joints. Type A is used with the c conventional collar joint, Type B the socket joint and Type C the faucet joint. The specifications of the faucet joint pipe shall apply to the ordinary RC pipes which receive no internal pressure.

The RC pipes of a small diameter, being thin-walled, are not fit for use with the faucet joint. It is therefore specified that the inner diameter of Type C fall within the range from 900 mm to 1800 mm and that the inner diameter of Type B fall within the range from 75 mm to 900 mm.

The high-pressure RC pipes have been limited in diameter, because the wall thickness cannot be made to increase in proportion to the diameter, the necessity of more reinforcement reduces economic returns and high-pressure RC pipes with a large diameter causes inconvenience in their manufacturing processes.

3. Shape, Dimensions and Appearance

3-1 The RC pipes of Type A shall have the same shape and dimensions as before, However, as all RC pipes 400 mm in nominal diameter are manufactured in a length of 2430 mm, the note mentioning "the length may also be 2400 mm" has been deleted in the present revision, and a length of 2430 has been decided upon.

The RC pipes of Type B are widely manufactured in the same length and thickness as those of Type A. However, the shape and dimensions of their joints vary with the manufacturers to such an extent that it was extremely difficult to standardize them. Accordingly, it has been decided to strictly specify the inner and outer diameters, D_1, D_2 and D_3, of the joints which have the most important bearing on the interchangeability of the RC pipes and mitigate. Instead, other conditions in view of the prevailing condition of manufacturing. In other words, a note meaning that the present dimensions of the socket and spigot, l_1, l_2 and l_3, may also be used for the time being has been added to the standard, primarily because it is not easy to change a great number of molds possessed by the manufacturers at a time, although it is desirable to standardize those molds to a uniform size.

Although differences in those dimensions become the cause of variations in the bending angle of the joints, the variations are not vital. The present standard provides that the specified dimension of l_1, l_2 and l_3 shall attain an angle of bend of 7^o - 2^o against the inner diameter of the joint, 75 mm - 900 mm and that the joints shall be made watertight by means of a rubber ring.

The present standard specifies the lower limits of the socket dimensions, D_4, l_4 and l_5, leaving it at the option of manufacturers to use larger dimensions, since they have no effect on the performance of the RC pipes, so long as the sockets are made sufficiently strong.

The RC pipes of Type C used to be specified by the Water Service Association. They have been specified by JIS for the first time in the present revision. The length of a faucet joint pipe is the dimension of a part shown in Fig. 3, that is, effective length of the RC pipe of Type C. When its length is reduced by 1/2, its effective length becomes 1145 mm.

The faucet joint is made watertight by means of a rubber ring. The angle of bend of faucet joints with a small inner diameter is about 1^o, and that of faucet joints with a large inner diameter about 0.5^o.

3-2 The tolerances for Type A have the same specifications as before, while the tolerances for the dimensions, especially diametrical dimensions, of the joints for Types B and C have been strictly specified in the present revision, since the interchangeability and watertightness secured by a rubber ring are particularly important for the RC pipes of Types B and C.

3-3 The RC pipes which have an uneven wall, when viewed from the outside, may be considered as poor in quality as well. If the end surface of the RC pipe is not at a right angle to its axis, RC pipes cannot be connected in a straight line. This is particularly important, when RC pipes are buried by the forcing method.

3-4 Those defects which will have an adverse effect on the strength, watertightness and durability of the RC pipes must be eliminated. RC pipes with gravel jutting out of their inner surface are not acceptable, since it impedes the water flow. The stipulation mentioning "its inner surface shall be smooth" is set forth with respect to the water flow within the RC pipe, and it is therefore not necessary to coat the inner surface with cement to make it smooth. The inner surface of the socket and outer surface of the spigot for the RC pipes of Type B must be smooth, since the socket and spigot are made watertight by means of a rubber ring.

4. Materials

4-1 Cement

It is general prectice to use Portland cement. The use of blast-furnace cement and silica cement has been approved in consideration of the pipe manufacturing processes and purposes of use of RC pipes. The use of fly-ash cement has also been approved in the present revision.

Mixed cement is inferior to Portland cement in early strength. Adequate care must be used in their initial curing and handling immediately after removal from the mold.

The test complying with the requirements of JIS R 5201 (Physical Test Method of Cement) should be conducted at regular intervals.

The materials to be mixed with concrete should be sufficiently studied before use.

4-2 Aggregates

Aggregates may be natural gravel, sand, crushed stone or crushed sand, whichever it is. Although the present standard specifies them in a general way, proper combination of granularity, specific gravity and mixing ratio is of great significance to the facilitation of concrete compacting by the centrifugal force and efficiency of cement utilization.

4-3 Tendons and Reinforcement

Although the former standard specified only the steel wires, the revised standard also specifies the steel bars in accordance with JIS G 3112 (Steel Bar for Concrete Reinforcement).

This is because JIS G 3112 now specifies the steel bar 6 mm in diameter which is easy to use and ordinary steel bars and shaped steel bars have come into use for RC pipes with a thick wall.

The steel wires which are used as oblique tendons and binding wires having no direct influence on the strength of the RC pipe may be annealed.

The tensile strength of steel wires must be tested at regular intervals.

5. Manufacture

The quality of the RC pipes cannot be determined only by the quality and quantity of materials used. The quality of molds, ratio of a concrete mixture, methods of mixing and placing, speed and time of compacting rotation by the centrifugal force, way of transportation of RC pipes and curing method are respectively an important factor. However, it is extremely difficult to codify those factors and the present standard specifies them in a general way, except that a little detailed provisions have been set forth for the curing method, since it has a significant bearing on the strength of concrete.

The present standard does not particularly specify the method of assembling tendons and reinforcement. Either binding by annealed steel wires or spot welding may be used to assemble the tendons and reinforcement.

In recent years welded mesh has been widely used in assembling tendons for RC pipes with a small diameter. The use of welded mesh is accepted, if its quality complies with the requirements of Paragraph 4-3 and the overlapping and binding of both ends of the welded mesh can maintain the required strength of the RC pipes.

5-3 Curing

5-3-1 The curing of concrete has a serious influence on the quality of finished products.

It is most desirable to employ the curing methods specified in the Standard Instruction Manual of the Civil Engineering Society. However, the majority of concrete pipe plants use steam curing.

It is desirable to keep the RC pipes, especially pressure concrete pipes, moist, even if they are cured by steam.

5-3-2 The steam curing of the RC pipes has such a serious influence on their quality that steam curing, if imporperly used,m ay reduce the long-term strength of the RC pipes or damage its watertight quality. Accordingly, the steam curing method has been specified as in the present revision on the basis of a great deal of data of experiments and experience, that is, 3 hours' time has been specified as the period required between concrete mixing and steam supply. However, it is not necessarily required to abide by this condition, when steam is used to keep the products warm on account of cold weather. The critical temperature between warming and steam curing may be considered about 35°C. The reason for employing the terms "low pressure steam curing" is that these requirements need not necessarily be adhered to when the RC pipes are cured at high pressure and temperature.

6. Strength

6-1 External Pressure Strength

The values of external pressure strength shown in Table 3 have been adopted in the present standard, because it is believed that the RC pipes must have such sufficient strength. The values shown in Table 3 plus a load by the unloaded weight of the RC pipe must be its minimum resistance. It is considered as a generally safe value as compared with the standard load of the city water service pipes. However, the larger the diameter of RC pipes, the lower the safety factor becomes. It is uncommon that the safety factor of the RC pipes with a large diameter should exceed 1.0. Special attention should therefore be paid to the use of RC pipes with a large diameter.

The maximum bending moment which an external pressure load causes to the RC pipe is given by the following formula:

$$M_1 = 0.318\ Pr\ (\text{kg-m})$$

where,

P = test load (kg/m)
r = radius of pipe (distance from the mpipe center to the pipe wall center) (m)

The bending moment Md caused by the unloaded weight of the RC pipe is added to the test in an external pressure test.

$$Md = \frac{1.5W \cdot r}{2\pi} = 0.239W \cdot r (kg\text{-}m)$$

where,

W = unloaded weight of the RC pipe (kg/m)

Therefore, the minimum resistance bending moment M_r which the RC pipe should possess is given by the following formula:

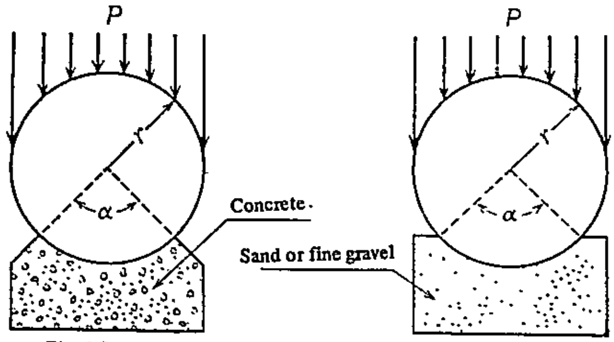
$$Mr = 0.318P \cdot r + 0.239W \cdot r (kg\text{-}m)$$

Supposing that the unloaded weight of the RC pipe and side pressure to it cancel out each other, the maximum bending moment which is caused to a buried RC pipe with a uniform load of $9kg/m^2$ is given by the following formula:

$$M = Kq \cdot r^2 (kg\text{-}m)$$

Coefficient K varies as shown below depending on the supporting surface.

Width of Supporting Surface Central Angle	Fixed Supporting Surface Value of K	Free Supporting Surface Value of K
30°	—	0.567
40°	—	0.510
60°	—	0.457
90°	0.303	0.368
120°	0.231	0.293
180°	0.107	0.250



Fixed Support
(The foundation does not easily become deformed.)

Free Support
(The foundation becomes deformed as the RC pipe becomes so.)

The standard uniform load (q) used for city water service pipes is as shown in the following table.

Standard Uniform Loads of City Water Service Pipes

Nominal Diameter (mm)	r (m)	Standard Uniform Load (kg/m^2)	(Reference) Unloaded Weight of Pipe (kg/m)
250	0.139	3400	63
300	0.165	3600	75
350	0.191	3700	93
400	0.218	3800	116
450	0.244	3900	141
500	0.271	4100	173
600	0.325	4300	247
700	0.379	4400	334
800	0.433	4500	434
900	0.488	4600	553
1000	0.541	4800	672
1100	0.594	4900	795
1200	0.648	5100	940
1350	0.727	5200	1140
1500	0.806	5300	1370
1650	0.885	5400	1670
1800	0.964	5500	1860

7. Test

7-1 External Pressure Test

The external pressure test is conducted mostly by the linear loading presser of the hydraulic type. Rubber plates and a square lumber of hard wood are used in the test to avoid uneven distribution of the load. The rubber must not be a poor quality and the square lumber must not be bent. The pressure should be increased by 1000 kg/m or so a minute, preferably as evenly as possible. It is good practice to use a dial gauge or strain meter to measure changes in the amount of deformation caused by the application of pressure, since it helps to judge cracks and inspect the quality of RC pipes.

The load which causes the RC pipe to develop cracks 0.25 mm has been designated the cracking load, because tens of years of experience has proven that the reinforced concrete pipes used in the ordinary sewage systems do not easily become corroded, even if they have developed cracks 0.25 mm wide. The width 0.25 mm has therefore been considered a sufficiently safe limit. Cracks which have become as wide as 0.25 mm can be seen with the unaided eye clear enough.

A cleat, if used, must be removed so as not to prevent the deformation of the RC pipe in increasing the test load pressure.

7-2 Hydraulic Pressure Test

The RC pipes are kept in water or in a moist condition to cure them. In a hydraulic pressure test, however, the concrete must be saturated with water, and the surface of the RC pipe must be kept dry. Both ends of the RC pipe must be sealed up with a packing and panel board. Air is let out of the RC pipe, and it is filled with water before it is subjected to a test pressure. Pressure is usually applied by a manual hydraulic compressor or electric pump and control valve. The pressure is increased by about 2 kg/cm^2 a minute, preferably as evenly as possible.

Water which oozes out of the RC pipe in spots or drops is not considered leaks of water, because the hydration of the unhydrated cement in the concrete gradually takes place, when the RC pipe is used, stopping up the clearance of cement paste.

8. Inspection

8-1 Shape, Dimensions and Appearance

The shapes of RC pipes indicated in the present standard are nothing but standard ones. Grooves, inclination and notches provided at the end of RC pipes do not run counter the specifications of this standard. The method of measuring the thickness of the RC pipes often poses a problem. The pipe thickness may be measured at any point, but it appears appropriate that the RC pipe should be measured by a tool like calipers at 4 points about 70 mm from one end where two straight lines intersect the RC pipe. Its inner diameter may also be measured referring to these two straight lines. It is' convenient to measure the inside of the RC pipe to determine its length. It is determined by the deviation of pipe thickness or uneven wall of the RC pipe whether or not its cross section is practically a concentric circle. If the maximum difference in pipe thickness exceeds 10% of the average thickness, when measured at the four points, the RC pipe cannot be said to have a cross section which is practically a concentric circle.

When it is specified that the end surface of the RC pipe be practically at a right angle to its axis, it is meant that the RC pipes are acceptable if the internal joint clearance between two RC pipes of Type A put together in a straight line does not exceed 5 mm.

The injurious defects of the RC pipe may be considered as follows:

(1) Longitudinal hair cracks which have a length of 1/4 or more of the pipe length (1/2 or more for the half pipes).
(2) Peripheral hair cracks which extend over 1/10 or more of the periphery.
(3) Plane area of the end surface is damaged by 3% or more.
(4) 5% or more of the pipe surface is rugged or aggregates put out of the pipe surface.
(5) Spots due to tendons and reinforcement can be seen on the pipe surface (excluding the end surface). By a smooth inner surface is meant the surface without aggregates jutting out or holes left by fallen aggregates and the finished surface which is not extremely uneven.

8-3 External Pressure Strength

The external pressure test shall be a sampling test. Unless otherwise specified, 5% of each lot, that is, one specimen per lot of 200 or 200 and its fractions of RC pipes shall be selected at random. It is a metter of course the cost of test specimens and labor required by the test should be borne by the manufacturer. However, when more than 5% of each lot is to be tested upon request by the orderer, it is recommended that the share of the test expenses will be mutually agreed upon by the manufacturer and orderer.

8-4 Hydraulic Pressure Strength

The hydraulic pressure strength test shall also be a sampling test, since pressure is applied to the RC pipe till it is almost broken. However, this test is more important, 3.3% of each lot, that is one specimen per lot of 30 or 30 and its fractions of RC pipes shall be selected at random. The same conception as mentioned above may apply with regard to the testing expenses. When the whole lot must be tested, 1/2 or less of the test hydraulic pressure, that is, hydraulic pressure of use, should be used. In such a case, it is necessary that the manufacturer and orderer should discuss and agree on the method of testing beforehand.

If concrete lacks strength, the RC pipes become cracked, permitting water to leak before a specified hydraulic pressure is applied. If RC pipes have cavities, water spurts under a small hydraulic pressure. These RC pipes will be refused as the pipes which leak.

9. Marking

The date of forming which shall be marked on the RC pipe shall be the date of placing concrete.

It is recommended to indicate the marking of insertion limit on the spigot side for the RC pipes of Type B.

NOTE 2. The rubber ring which complies with the requirements for Class 2 No. 3 B specified in JIS K 6353 (Rubber for Water Service Pipes) has a sufficient resistance to ordinary filthy water.

Cautions

(1) Adequate care must be used when the RC pipes are transported or moved. Since concrete pipes are easily cracked, care should be taken not to let them strike against anything or fall during transportation. Even if straw or straw-mat is used as a cushion, it must be avoided to let them fall. They must be in principle rolled down to the ground or lifted off the truck down on the ground. When they are to be loaded on a truck or freight car, a sufficient amount of pads or packing must be used.

(2) It should be avoided to give excessive vibrations due to excessive flow rate or excessive vehicle load to the pipe-line. Since the pipe joints are of vital importance to the pipe-line, it is most advisable to avoid excessive vibrations due to excessive vehicle loads and turbulence of flowing water and use efficient vibration-proof joints.

(3) When buring the RC pipes, the back-filling of the joints, foundation and RC pipes must be carried out with utmost care. Careful connection of joints is not sufficient. It is most important to assign skilled workers to jointing work. The

burial of RC pipes need special attention, when water springs or the ground subsides to a considerable extent. The amount of foundation work must be determined very carefully taking into consideration the loads and nature of the soil. Moreover, it is necessary to become familiar with the purpose and meaning of the design and secure as large a supporting area as possible. In the foundation wooden materials such as pads, shell lumber, through beams, piling end rafts or gravel, broken stone and concrete slabs.

A concrete split muff foundation (90^o, 120^o, 180^o fixed support) may also be used to reinforce the RC pipes.

The back-filling has a considerable effect on the load on RC pipes. What is required is to sufficiently compact the soil on both dise of the RC pipe and fill back soil on the top of it after sheet piles are removed.

JAPANESE INDUSTRIAL STANDARD

Centrifugal Reinforced Concrete Piles

1. Scope

This standard shall specify the reinforced concrete piles (hereinafter referred to as the RC piles) manufactured through application of centrifugal force.

2. Type

2-1 The RC piles shall be classified into Type A and Type B.

NOTE: Type A shall be principally so designed as to support axial loads, and Type B shall be so designed as to support horizontal as well as axial loads.

2-2 The RC piles of Type A shall be further classified as shown in Table 1 according to the dimensions (outside diameter and length).

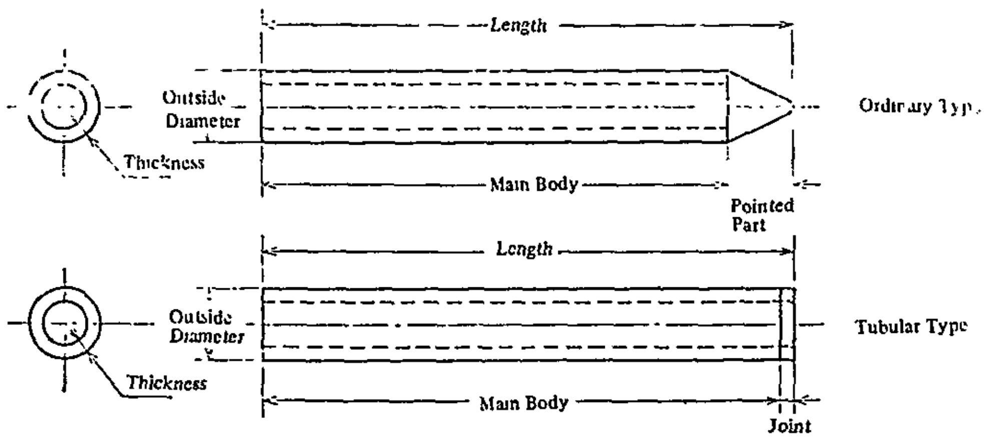
2-3 The RC piles of Type B shall be further classified as shown in Table 2 according to the standard bending moment.

3. Shape, Dimensions and Designation

3-1 Shape

The main body of the RC piles shall be of a hollow-cylinder construction as shown in Fig. 1, and they shall be provided with a pointed part(1) or joint (2) as required. The outside diameter and thickness of the cross-section of the main body must be uniform over the entire length.

Fig. 1



NOTES: (1) The pointed part has two designs, that is, closed type and open type. A pointed part may be attached to the main body of piles of the tubular type.

(2) The joint shall be included in the pile length.

3-2 Dimensions

The dimensions of the RC piles shall be as shown in Tables 1 and 2 (See Fig. 1), and the tolerance shall be as shown in Table 3.

Table 1 (Type A)

Outside Diameter (mm)	Thickness (mm)	Length (mm) and Standard Bending Moment (3) (t.m)												
		3	4	5	6	7	8	9	10	11	12	13	14	15
200	50	0.3	0.3	—	—	—	—	—	—	—	—	—	—	—
250	50	—	0.6	0.6	0.6	0.8	—	—	—	—	—	—	—	—
300	60	—	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.6	1.9	—	—	—
350	65	—	—	—	1.1	1.1	1.1	1.1	1.7	2.1	2.5	2.9	3.3	—
400	70	—	—	—	—	1.6	1.6	1.6	2.1	2.6	3.1	3.6	4.2	4.8
450	75	—	—	—	—	—	2.1	2.1	2.6	3.1	3.7	4.4	5.1	5.8
500	80	—	—	—	—	—	—	2.8	3.3	4.1	4.5	5.2	6.1	7.0
600	90	—	—	—	—	—	—	4.8	5.4	6.3	—	—	—	—

Table 2 (Type B)

Outside Diameter (mm)	Thickness (mm)	Standard Bending Moment (3)		Length (4) (m)								
		Moment (t.m)	Marks	7	8	9	10	11	12	13	14	15
300	60	2.5 3.5 4.0	A B C	○	○	○	○	○	○	—	—	—
350	65	3.5 5.0 6.5	A B C	○	○	○	○	○	○	○	○	—
400	70	5.5 7.5 9.0	A B C	○	○	○	○	○	○	○	○	—
450	75	7.5 10.5 12.0	A B C	—	○	○	○	○	○	○	○	○
500	80	9.0 12.5 17.0	A B C	—	—	○	○	○	○	○	○	○
600	90	10.0 18.0 27.0	A B C	—	—	○	○	○	—	—	—	—

NOTES: (3) Refer to Paragraph 7-2 for specification of the standard bending moment. Examples of the sectional area of axial tendons arranged in the axial direction and axial reinforcement are shown in reference Tables 1 and 2.

(4) It is possible to manufacture RC piles shorter than 7 meters for outside diameters of 300 mm, 350 mm and 400 mm, 8 meters for outside diameter of 450 mm and 9 meters for outside diameters of 500 mm and 600 mm, respectively, if approved by the orderer.

Table 3

Unit mm

	Tolerance
Length	±0.3% of Length
Outside Diameter	$^{+5}_{-2}$
Thickness	−1

NOTES: 1. The outside diameter of the RC pile shall be the average of the values of two measurements made of a cross section along the orthographic axis.

2. The thickness of the RC pile shall be the average of the values of four measurements made of a cross section along the orthographic axis.

3. The + tolerance of the thickness shall not be specified.

3-3 Designation

The RC piles shall be designated in symbols which indicate the outside diameter (mm) and length (m) for Type A and outside diameter (mm), length (m) and standard bending moment for Type B.

Example: 500-10
500-10-A

4. Materials

4-1 Cement

Cement complying with JIS R5210 (Portland Cement), JIS R5211 (Blast-furnace Cement), JIS R5212 (Silica Cement) or JIS R5213 (Fly-ash Cement) shall be used with the RC piles.

4-2 Aggregates

Aggregates shall be cleap, strong and durable and shall not contain dust, mud or organic substances to an injurious extent. The maximum size of the coarse aggregate shall be less than 25 mm and less than 2/5 of the thickness of the RC pile.

4-3 Tendons

The axial and spiral tendons for use with the RC piles shall comply with any one of the following standards:

(1) JIS G3101 (Rolled Steel for General Structure)
(2) JIS G3112 (Steel Bar for Concrete Reinforcement)
(3) JIS G3521 (Hard Drawn Steel Wire)
(4) Ordinary iron wire specified in GIS G3532 (Iron Wires)

5. Manufacture

5-1 Tendons and Reinforcement

5-1-1 The steel ratio by the total sectional area of tendons and reinforcement arranged in the axial direction shall be 0.8% or more. They shall be uniformly arranged along the periphery of the concentric circle of the RC pile cross section over its entire length as far as practicable. The net spacing of tendons and reinforcement shall be equal to or in excess of the diameter of the tendon and more than 4/3 of the maximum size of the coarse aggregate.

5-1-2 The additional bar shall be spiral in shape and arranged outside the axial tendons. The additional bar shall be more than 3 mm in diameter and less than 150 mm in pitch, except that the additional bars for use with the RC piles 250 mm or less in outside diameter may be 2.5 mm or more in diameter.

5-1-3 The covering shall be more than 15 mm, except that the covering for the RC piles 200 mm in outside diameter may be more than 10 mm.

5-1-4 The tendons shall be finished to the specified shape and dimensions.

5-1-5 Loose rust or oil which may harm the adhesion of concrete must be removed from the tendons before assembling, and the tendons shall be assembled in such a manner that they shall remain fixed at the correct positions.

5-1-6 The axial tendons shall be arranged in such a manner that their ends may be on the same plane at a right angle to the RC pile axis, and some provision shall be made to protect them from shocks.

5-1-7 The use of joints with the axial tendons shall be avoided, if possible. The joints which are to be used with axial tendons shall have 100% efficiency and shall not coverage to one cross section of the RC pile.

5-2 Concrete

5-2-1 The concrete for use in the manufacture of the RC piles shall have a compressive strength of 500 kg/cm^2 at 28 days of age. The compressive strength test shall be conducted according to JIS A 1132 (Method of Marking and Curing Concrete Specimens) and JIS A 1108 (Method of Test for Compressive Strength of Concrete), provided that the specimen is 10 cm in diameter and 20 cm in height.

5-2-2 The materials shall be measured by weight except that water may be measured by volume.

5-2-3 Concrete shall be mixed up in a mixer.

5-2-4 The quality of concrete for use at the end of the RC pile shall be as specified in Paragraph 5-1-1.

5-3 Forming

5-3-1 The RC pile shall be formed according to a procedure in which the assembled tendons and reinforcement are placed in the mold and then mixed concrete is placed in it in such a way that the thickness of the RC pile may become uniform before concrete is compacted by the centrifugal force.

5-3-2 The pointed part which is to be provided at the end of the main body shall either be formed by compacting concrete by means of a vibrating machine or shall simultaneously be formed with the main body by the centrifugal force. The pointed part provided at the end of the main body shall not be eccentric but be solid with the main body.

5-4 Curing

5-4-1 The RC pile shall be cured by the method which will produce satisfactory results.

5-4-2 The following requirements shall be met in principle, when low pressure steam is employed to cure the RC pile.

(1) The RC pile shall be placed in the curing chamber together with the mold. Steam shall be supplied in such a manner that the temperature of the curing chamber may rise uniformly.

(2) Steam curing shall begin 2 hours or more after the concrete mixing is completed.

(3) The temperature of the curing chamber shall be raised by 20°C or less an hour, and the maximum temperature shall not exceed 65°C.

(4) The RC pile shall be taken out of the curing chamber when its temperature is lowered down to a level much the same as that of the outside atmospheric temperature.

5-4-3 The RC pile shall in principle be cured in water, when taken out of the mold. It shall be cured in water for more than six days, but for more than three days when cured in low pressure steam.

6. Joint

6-1 The structural quality of the joint for the RC pile shall be the same as or better than that of the RC pile body.

6-2 The end surface of the joint shall practically be at a right angle to the axis of the RC pile.

7. Products

7-1 Appearance

The RC pile shall be a dense quality and be free from defects such as injurious flaws and cracks.

7-2 Bending Strength of Main Body

The RC pile shall not develop cracks 0.2 mm or more wide at any point, when subjected to the bend test specified in Paragraph 8-1. and applied with the standard bending moment specified in Tables 1 and 2. The breaking bending moment for Class B shall be 2 times or more as great as the standard bending moment.

7-3 Bending Strength of Joint

The bending strength of the joint shall be as great as or greater than the bending strength specified in Paragraph 7-2.

8. Bend Test

8-1 The process of the bend test shall consist in supporting three-fifths of the pile length as the span and applying a vertical load P to the center of the span.

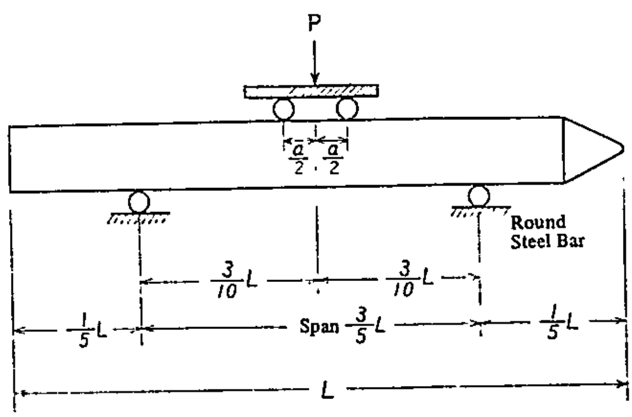
The bending moment shall be calculated by the following formula:

$$M = \frac{1}{40} WL + \frac{P}{4}\left(\frac{3}{5} L - a\right)$$

where,

M = bending moment (t.m)
P = load (t)
L = pile length (m)
W = pile weight (t)
a = 0.6 m (when L = 3m or 4m)
1.0 m (when L = 5m or more)

Fig. 2 Loading Method in Bend Test



8-2 The breaking bending moment shall be calculated by Formula in Paragraph 8-1, using the maximum value given by load P before the RC pile breaks.

8-3 The bend test of the joint shall be conducted with the joint positioned to the center of the span in the manner described in Paragraph 8-1.

9. Inspection

9-1 The appearance, shape, dimensions, bending strength of the main body and joint and arrangement of RC tendons and reinforcement shall be inspected.

9-2 The whole lot of products shall be inspected with respect to the appearance, shape and dimensions and shall be accepted if the requirements provided in Paragraphs 3 and 7-1 are satisfied.

9-3 Bending Strength of the Main Body and Joint

9-3-1 Two RC piles shall be sampled from each lot and subjected to a cracking test. The whole lot shall be accepted, if the two RC piles satisfy the requirements provided in Paragraph 7-2. The lot may be inspected again, if one of the two RC piles fails to satisfy the said requirements. Another four RC piles shall be sampled from the same lot when it is to be reinspected. The lot shall be accepted, if all the four RC piles satisfy the said requirements. The number of RC piles per lot shall be agreed upon by the manufacturer and orderer.

9-3-2 One of the first two RC piles sampled from each lot shall be subjected to a breaking test in accordance with the provisions of Paragraph 8-1, and the whole lot shall be accepted, if the test pile satisfies the requirements of Paragraph 7-2.

The breaking test may be omitted, if approved by the orderer.

9-3-3 The RC piles subjected to the breaking test shall be inspected with respect to the thickness, overlap and tendons and reinforcement.

9-3-4 The joint shall be inspected according to the procedures of inspection of the main body.

The inspection of the joint may be omitted, if approved by the orderer.

10. Shipment

The RC piles, in principle, shall be shipped, when it is confirmed that the concrete possesses a strength of 400 kg/cm^2 or more and well resist shocks.

11. Marking

The RC piles shall have the following markings in clear and legible form.

(1) Designation
(2) Name of the manufacturing plant or its abbreviation
(3) Quality of axial tendons and reinforcement
(4) Date of formation

Reference Table 1 (Class A)

Outside Diameter (mm)	Weight (1) (t)													Cross Section of Axial Tendons (2) As (cm²)	Examples of Axial Tendons(2) Diameter (mm) x Number of Tendons	
	3 m	4 m	5 m	6 m	7 m	8 m	9 m	10m	11m	12m	13m	14m	15m			
200	0.18	0.24												1.93	6	7
250		0.33	0.41	0.49										2.55	6	9
					0.57									2.83	6	10
300		0.47	0.59	0.71	0.82									3.82	9	6
						0.94								5.09	9	8
							1.06							6.36	9	10
								1.18						7.63	9	12
									1.29					9.29	13	7
										1.41				11.94	13	9
350				0.91	1.06	1.21								5.09	9	8
							1.36							7.00	9	11
								1.51						8.27	9	13
									1.66					10.62	13	8
										1.82				11.94	13	9
											1.97			15.92	13	12
												2.12		17.25	13	13
400					1.32	1.51								6.36	9	10
							1.70							7.63	9	12
								1.89						8.90	9	14
									2.07					10.62	13	8
										2.26				13.27	13	10
											2.45			15.92	13	12
												2.64		18.58	13	14
													2.83	21.23	13	16
450						1.84	2.07							7.63	9	12
								2.30						10.62	13	8
									2.53					11.94	13	9
										2.75				14.60	13	11
											2.98			17.25	13	13
												3.21		19.91	13	15
													3.44	22.56	13	17
500							2.47							8.90	9	14
								2.74						10.62	13	8
									3.02					13.27	13	10
										3.29				14.60	13	11
											3.57			18.58	13	14
												3.84		21.23	13	16
													4.11	23.89	13	18
600							3.37							11.94	13	9
								3.75						13.27	13	10
									4.12					15.92	13	12

NOTES: (1) The values 2.6t/m³ and 3.14 are assigned as the weight per unit volume and , respectively, in the calculation of these weights by the following formula. They are rounded off to second figure after decimal point in accordance with JIS Z 8401 (Rules for Rounding-off of Numerical Values) for convenience of use.

$$W = 2.6\ \pi t l(D - t)$$

where,

W = weight (t)
t = thickness (m)
ℓ = length (m), provided the pile is tubular in shape over its entire length.
D = outside diameter (m)

(2) The cross section of the axial tendon and number of axial tendons are calculated in accordance with SR24 provided in *JIS G 3112 (Steel Bar for Concrete Reinforcement).*

Remarks: This table is intended for use as a guide in the use and handling of the RC piles and shall not be considered as part of this standard.

Reference Table 2 (Class B)

Outside Diameter (mm)	Classification	Weight (3)									Amount of Axial Tendons (4)				Radius of Axial Tendon (mm)
		7 m	8 m	9 m	10m	11m	12m	13m	14m	15m	Cross Section (cm^2)	Diameter x Number of Tendon	(	)	
300	A	0.85	0.97	1.09	1.21	1.33	1.45				15.92	13×12	(12.67	13×10)	120
	B	0.88	1.00	1.13	1.25	1.35	1.50				22.12	16×11	(20.27	13×16)	
	C	0.90	1.02	1.15	1.28	1.41	1.54				28.15	16×14	(27.80	16×14)	
350	A	1.09	1.24	1.40	1.55	1.71	1.86	2.06	2.17		18.58	13×14	(13.94	13×11)	145
	B	1.12	1.28	1.44	1.60	1.76	1.92	2.08	2.24		26.14	16×13	(21.54	13×17)	
	C	1.16	1.32	1.49	1.65	1.82	1.98	2.15	2.31		36.20	16×18	(35.75	16×18)	
400	A	1.37	1.56	1.76	1.95	2.15	2.34	2.54	2.73		25.21	13×19	(17.74	13×14)	165
	B	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80		34.19	16×17	(29.79	16×15)	
	C	1.43	1.64	1.84	2.05	2.25	2.46	2.66	2.87		44.21	16×22	(43.69	16×22)	
450	A		1.90	2.13	2.37	2.61	2.84	3.08	3.32	3.56	30.17	16×15	(23.83	16×12)	190
	B		1.96	2.21	2.45	2.70	2.94	3.19	3.43	3.66	44.24	16×22	(35.75	16×18)	
	C		1.98	2.23	2.48	2.73	2.98	3.22	3.47	3.72	52.29	16×26	(47.66	16×24)	
500	A			2.54	2.82	3.10	3.38	3.67	3.95	4.23	34.02	19×12	(23.83	16×12)	210
	B			2.59	2.88	3.16	3.46	3.74	4.03	4.31	45.36	19×16	(37.24	19×13)	
	C			2.67	2.99	3.27	3.57	3.86	4.16	4.46	62.37	19×22	(63.03	19×22)	
600	A			3.37	3.74	4.11					34.02	19×12	(25.52	16×13)	255
	B			3.53	3.93	4.32					60.82	22×16	(46.45	22×12)	
	C			3.65	4.05	4.46					83.62	22×22	(77.42	22×20)	

NOTES

(3) The values 2.5t/m^3, 3.14 and 7.85t/m^3 are assigned as the weight per unit volume, and weight of tendon in the calculation of these weights by the following formula. They are rounded off to second figure after decimal point in accordance with *JIS Z8401* (Rules for Rounding-off of Numerical Values) for convenience of use.

$$W = \left[2.5 \{\pi t(D-t) - As\} + 7.85As\right] \ell$$

where,

W = weight (t)
t = thickness (m)
D = diameter (m)
As = cross section of tendon (m^2)
ℓ = length (m)

(4) The amount of axial tendons is calculated in accordance with SR24 provided in JIS G 3112 (Steel Bar for Concrete Reinforcement), and the values in parentheses are calculated in accordance with SD30.

Remarks: This table is intended for use as a guide in the use and handling of the RC piles and shall not be considered as part of this standard.

JIS A 5310 - 1970

CENTRIFUGAL REINFORCED CONCRETE PILES

EXPLANATION

Introduction

The factory production of centrifugal reinforced concrete piles started in late 1920's. By the piles were generally meant wooden piles in those days, and the concrete piles were mostly the ones formed on the construction site such as pedestal piles.

After World War II, however, concrete piles took the place of wooden ones partly because the former were more durable and partly because it became necessary to preserve the forestal resources. A policy of rationalization of forestal resource utilization was decided upon by the Cabinet to preserve the Japanese forestal resources, and, as a result, the utilization of durable materials instead of wooden materials was promoted.

As the result of recognition of the excellent quality of the centrifugal reinforced concrete piles among other things, their mass production obtained general acceptance, permitting them to come into wide use in large quantities.

As general interest in the design and manufacturing techniques of those piles grew, every subsequent year witnessed another improvement, both quantitative and qualitative, in those piles. In line with this movement, JIS A 5310-1955 (Centrifugal Reinforced Concrete Foundation Piles) was established in March, 1955.

In later years, as the marking system was established in conformity to the Industrial Standardization Law, factories licenced to put JIS marking on their products increased in number. As the undertakings of construction work grew active, more constructive and active suggestions and comments continued to be offered despite of the first revision of the standard in 1960. The manufacturers also carried on researches to improve the materials, designs and manufacturing methods, and in May 1965 a second revision took place.

As the demand for concrete piles grew, the manufacturing factories, large and small, increased in excess of 100. As a result, variations in the quality of the centrifugal reinforced concrete piles became noticeable. On the other hand, the centrifugal prestressed concrete piles came into being around 1962, making it difficult to maintain equilibrium between the former and the latter. In view of this tendency and advancement of the technical studies of the joint and pointed part of the piles and researches into the phenomenon of percussion, three propositions of amendment were discussed from July 1967, and the final revision as seen in the body text of the present standard was adopted. Accordingly, the present revision of the standard is by far more advanced and strict than the previous ones. These efforts to improve the standard stemmed from the idea of supplying proper centrifugal reinforced concrete piles to the market.

The Institute of Industrial Technology entrusted the Association of Concrete Poles and Piles with drafting the present revision. The Drafting Committee headed by Mr. Junji Yamada prepared the original draft of revision, which was reviewed by the Special Committee headed by Mr. Masatane Kuniwaki, and the present revision was adopted as the final revised standard. (The article number prefixed to eachheading below is the same as that used in the present revised standard.)

The centrifugal reinforced concrete pile and centrifugal pressressed concrete pile shall hereinafter be referred to as RC pile and RC pile, respectively.

1. Scope

The second revision of JIS of 1966 approved the use of the moment pile, but failed to specify its requirements and method of testing, not serving the practical purposes. They are clearly specified in the present revision.

2. Type

In the past the foundation concrete pile and moment concrete pile were classified as Type A and Type B, respectively.

The specifications of the outside diameter were the same as those of the present revision for Type A, and the outside diameters specified for Type B were 300 mm and 600 mm. Type B is now classified further into A, B, and C for each outside diameter.

Although there is a relationship between the axial force and bending moment which simultaneously act on the pile, the standard bending moment adopted in the present revision is a moment produced when no axial force acts on the pile, as indicated in Paragraph 8-2. Given an axial force and bending moment in designing a structure, the calculation must be made in such a way that a proper choice may be made among those two types of piles and three classes A, B and C, classified according to the outside diameter. An expedient to facilitate this calculation is to prepare a diagram which clarifies the relationship among the axial force, bending moment and amount of tendons to be used.

For ease of calculation, the present standard contains Reference Tables 1 and 2 in which the cross section of axial tendon and number of axial tendons required when SR24 is used for Type A and SR24 and SD30 for Type B are shown for reference. Reference Table 2 also mentions the radius of axial tendon. According to the past experience, a steel ratio by the total sectional area of tendons and reinforcement upto 8% was employed. It was asserted by some that the ratio should be reduced to 3% to 4% for the piles used as a pillar. Although a ratio as high as 8% is approved in the U.S.A., the maximum steel ratio of 6% was finally decided upon, partly because a hollow pile, when compressed to break, has its cross section broken at a time unlike a solid pile and partly because a higher steel ratio reduces economic returns. Prior to determination of the final steel ratio, centrifugal concrete pile specimens 300 mm in outside diameter and 960 mm in height were used to conduct compression breaking tests at steel ratios of 1%, 3% and 6% so as to determine their strength.

The former requirements of concrete pile strength were such that the unloaded weight of a concrete pile must not develop cracks as large as 0.2 mm or more with 95% of its entire length considered as the span. In the present standard, however, a more rational method of testing has been adopted as discussed in Paragraph 7-2. The standard bending moment (Reference Tables 1 and 2) which serves as a criterion in this method of testing uses either Mrc or Mrs, whichever smaller, on the basis of the arrangement of tendons and reinforcement shown in the reference tables.

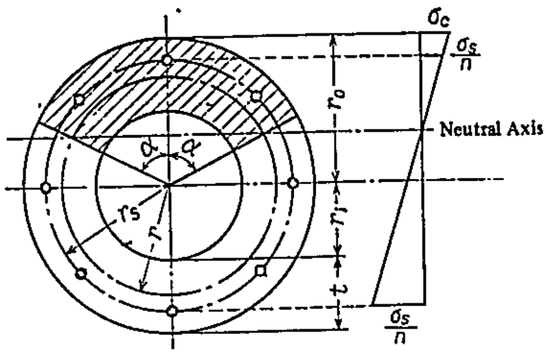
Mrc is a bending moment which is determined by the stress intensity of concrete and is given by the following formula:

$$Mrc = \frac{\sigma c I}{(r_o - r \cos\alpha)}$$

Mrs is a bending moment which is determined by the stress intensity of tendon and is given by the following formula:

$$Mrs = \frac{\sigma s I}{n(r_s + r \cos\alpha)} \quad \cdots\cdots\cdots$$

Exploded View 1



In these formulas, is the stress intensity of bending compression of concrete, and is the stress intensity of tendon tension. The values 200 kg/cm^2 and 2100 kg/cm^2 were temporarily assigned as and , respectively, in the calculation of the pile strength. The meaning of the other symbols is as follows: n = t, r = central radius of concrete thickness, r_o = outside radius of pile, Y_s = radius of circle formed by tendons and l = secondary moment of cross section determined by the position of neutral axis.

When the bending moment of 8-m or less long piles 200 mm, 250 mm and 300 mm in outside diameter is calculated by these formulas, they give a much smaller value than the bending moment obtained by a test which permitted cracks 0.2 mm wide to develop. Accordingly, one and half times the value obtained by these formulas has been adopted as the standard bending moment in the present standard.

Seventeen member companies of the Association of Concrete Poles and Piles conducted joint experiments in 1968 to make clear the relationship between these values and width of cracks. (Refer to the Discussion of the Bending Strength Standard of Centrifugal Reinforced Concrete Piles of the Technical Committee of the Association of Concrete Poles and Piles.) According to these experiments, every calculation gave a smaller value than the bending moment obtained by a test which permitted cracks 0.2 mm wide to develop.

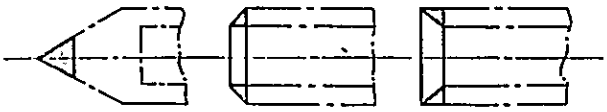
3. Shape, Dimensions and Designation

3-1 Shape

Since piles are driven into different kinds of soils, a rational construction should be employed for their pointed part and joint , taking into due consideration the construction method and nature of the soil of the construction site.

The present standard does not make any mention of the details of the construction of the pointed part and joint of the RC pile. A large number of RC piles provided with a shoe on their pointed part are available on the market. The prevailing type of shoe

Exploded View 2



has such a construction as shown in Exploded View 2, but shoes of a special construction are also used depending on the purposes of use.

Two concrete piles or more are often jointed, when driven, for ease of transportation and driving. The filling method, bolt method and welding method are now in use to joint concrete piles at the construction site.

Besides, some concrete piles have a steel sheet wound round the head, some have a band provided for use with the joint, and some provision is made for ease of driving for some types of concrete piles. However, these types of concrete piles do not run counter to the provisions of this article.

3-2 Dimensions

Much discussion was devot to the determination of the thickness of the RC pile, Some insisted that a larger thickness should be employed. However, part of the standard was revised in view of the ratio of thickness to outside diameter, that is, 60 mm was increased to 65 mm for the RC pile 350 mm in outside diameter and 70 mm 75 mm for the RC pile 450 mm in outside diameter. The thickness of the RC pile 200 mm in outside diameter was increased from 40 mm to 50 mm in consideration of the overlap.

Nothing has been changed as to the dimensional tolerances except that they are now expressed in percentages and the method of measurement is specified.

Some advanced an opinion which asserted that the tolerance -1 for the RC pile thickness should be changed to 0, since the value -1 was of no significance. However, the opinion has not been adopted, partly because the worst combination of an outside diameter and a thickness has little or no effect on the axial load, especially on the standard bending moment and partly because the change from -1 to 0 alters the standard itself, since the tolerance is so determined as to spread both ways with 0 in between.

3-3 Designation

The RC pile used to be designated in symbols which indicate the length and outside diameter in the order given, but the order has been reversed for ease of pronunciation. Besides, it has been decided to add to the end of the designation a symbol indicating the class of standard bending moment. It is advisable to designate the RC pile as follows, when two RC piles or more are jointed, when driven.

Example: 500-23 (upper 10 + middle 5 + lower 8)

4. Materials

4-3 Tendons and Reinforcement

Formerly it was stipulated that all steel materials for use with concrete piles should meet JIS requirements or they should be equivalents to the products meeting JIS requirements with regard to mechanical properties. In the present revision, however, only the axial tendons and reinforcement as well as spiral tendons which require a specific strength have been specified in order to rationalize the standard. Although it has been decided that JIS "Recycled Steel Bar for Concrete Reinforcement" should be established for recycled steel materials, they may be used as auxiliary tendons and reinforcement for the time being.

5. Manufacture

5-1 Tendons and Reinforcement

Concrete piles may develop cracks due to shocks during transportation, driving and other operations. The former JIS stipulated that concrete piles pass a static bending test, and, accordingly, the number of axial tendons was determined by the bending moment caused by an unloaded weight, in this case it is only natural that shocks should permit cracks to develop. Although it was insisted by some that one and half times this unloaded weight moment should be employed as is the case with ASSHO (American Society of State Highway Organizations), the modification has been limited to the increase of the steel ratio by the total sectional area of tendons and reinforcement from 0.4% or more to 0.8% or more, because cracks mostly develop in thin and short concrete piles and such phenomena do not occur in concrete piles with much reinforcement. However, this modification serves as a prescription of concrete piles which are thinly reinforced.

It is preferable to use axial tendons of 9 mm ø or more. Tendons of 6 mm ø may be used with concrete piles 200 mm and 250 mm in diameter, but some provision must be made, in this case, to prevent the main reinforcement from declining in strength due to welding undercut. Adequate care should also be taken of tendons of 6 mm ø or more, since welding may cause their cross section, and accordingly their strength, to be reduced.

The overlap is specified for both inner and outer surfaces of concrete piles except the end surface. Although it was requested by the construction industry that the overlap from the axial tendon to the pile surface be 20 mm or more, the originally proposed value has been adopted, because the arrangement of an axial tendon at the center of pile thickness satisfies the requirement in question.

The stipulation of the provision to be made at the end of axial tendons against shocks suggests that the ends of concrete piles should be evenly arranged and an adequate amount of overlap should be provided. No definite conclusion has however been reached as to whether the tendon end should be bent or cut off. There are some other means to secure its necessary strength against shocks: a steel sheet may be wound round it; more additional bars per pile may be used.

Flush welded joints, preferably welded by an automatic welding machine, will provide more reliable connection. Needless to mention, it is necessary to test the tendon joints at all times.

Formerly the tendons for use at the end of concrete piles were not prescribed at all all. In recent years, however, the strength of tendon ends has been a problem. Accordingly, the present standard stipulates that 6 tendons or more 6 mm or more in diameter be used and be bound round an axial tendon in proper length. Adequate attention should also be paid to the overlap of tendons at the pile end and they must be properly arranged.

5-2 Concrete

Formerly JIS stipulated that the concrete for use in the manufacture of concrete piles possess a strength of 350 kg/cm^2 at 28 days of age. In the present revision of the standard, the strength was increased to 400 kg/cm^2. This revision was made, partly because the shock strength of concrete in driving concrete piles and concrete strength required by repeated loading were taken into consideration and partly because a number of factories actually use concrete with strength of 400 - 500 kg/cm^2 despite the standard value of 350 kg/cm^2. By the concrete strength of 400 kg/cm^2 or more is meant that specimens collected from a concrete mixer have a compression strength of 400 kg/cm^2 or more.

A tubular specimen measuring 10 cm x 20 cm was used for convenience' sake.

Although the provisions under this heading should be set forth using concrete packed and cured under the same conditions, the revision was made in such a manner as mentioned above in order to maintain uniformity between the RC pile and PC pile.

As it is necessary to use the same type of concrete for both pointed part and main body of concrete piles, provisions to that effect have been added in the present s standard.

5-3 Forming

It is common practice to manufacture the pointed part and main body separately and bind the pointed part to an axial tendon by means of additional bars so that the pointed part and main body are formed simultaneously by the centrifugal force. In this operation, however, special attention must be used to make the connection of the pointed part to the main body concrete solid enough. There are some other means by which to form the pointed part and main body at the same time.

5-4 Curing

Formly it was stipulated that concrete piles be cured in steam 3 hours or more after completion of concrete mixing. The time has however been reduced to 2 hours, because it was made clear that 2 hours is sufficient for the concrete pile made of concrete of small slump in high proportion to acquire the required strength.

Concrete piles must in principle be cured in water after they are taken out of the mold. The moisture curing method which produces the same curing effect may also be employed. A simple water spraying machine is not sufficient to cure concrete piles. A proper type of curing equipment which permits concrete piles to moisten in sufficient water must be employed.

It does not run counter to the provisions of this article to apply steam to concrete piles to keep them warm, provided the maximum warming temperature is 35°C.

When concrete piles are to be cured at high temperature and pressure, it is necessary to conduct sufficient researches and experiments to make sure that the curing may not adversely affect the products and satisfactory results may be obtained.

6. Joint

One of the principal disadvantages of the concrete pile is the joint. In recent years, however, almost perfect joints such as bolt type and welded type have been brought into being. The provisions of this article mean, to be concrete, that the joint must be of such a construction that it is capable of resisting the actual compression, bending force and tension, when attached to the main body and has a smaller deflection than the main body, when bent. The clearance between the end surface of a bent axial tendon and head of the RC pile, that is, overlap is usually not reinforced with steel. It is naturally necessary to use some reinforcement, when RC piles are to be jointed. The anchor tendons of joint fittings generally serve as this reinforcement, and accordingly these anchor tendons must firmly be fixed to the joint fittings. The joints of the filling type must be of such a construction as to permit the stress of an upper pile to be transmitted to a lower one. However, the joints of the filling type cannot generally show the same performance as the main body of RC piles before about a fortnight after the jointing is completed. Paragraph 6-2 which reads "end surface of the joint shall practically be at a right angle to the axis of the RC pile" has been inserted for the purpose of maintaining the axis of the joint pile as rectilinear as possible. From this point of view, the provisions in Paragraph 6-2 may be construed in the same context as those of the RC pile. In practice, however, it is not so easy to maintain the axis of the RC pile orthogonal as that of the PC pile, and accordingly an error within the range of 1° is tolerated in the present revision.

7. Products

The RC piles generally develop cracks when bent. The permissible limit of the width of cracks remains unchanged, that is, 0.2 mm or less, since this size of crack is the limit beyond which the tendons and reinforcement may become corroded.

8. Bending Strength Test

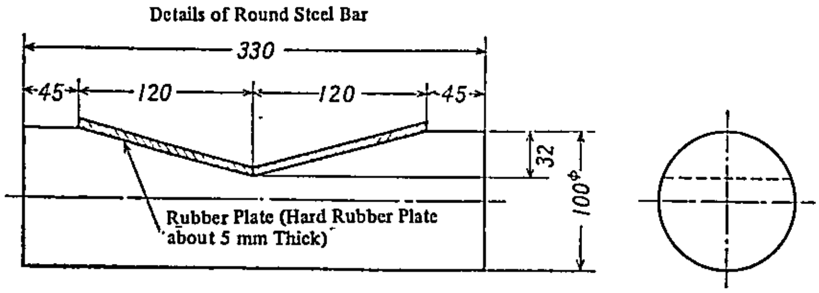
The present revision of standard stipulates that the RC pile be subjected to the same bending strength test as the PC pile. In other words, 3/5 of the pile length is considered its span and is loaded at two points in the test. When an extra-long concrete pile is to be tested, it should be arranged in such way that the supporting roller on one end may move horizontally.

A round steel bar shown in Exploded View 3 is suitable as a pad to be used in loading in the bending strength test in Fig. 2.

Exploded View 3

Pads Used at Loading and Supporting Points (Round Steel Bars)

Unit mm



9. Inspection

Formerly emphasis was placed on the strength of concrete in the inspection of concrete piles. In view of the overseas tendency, however, emphasis is shifted to the product itself in the present revision. And yet, the data concerning the strength of concrete must always be made available, since the strength of concrete is the most fundamental of all information in the inspection of concrete piles.

The sampling test of the RC piles is to be conducted in the same manner as in the case of the PC piles.

The breaking test and joint test may in principle be omitted, if approved by the orderer, provided manufacturers conduct their own tests to obtain the data which may serve the orderer as information for judgment.

The RC piles of Type A are usually used as foundation piles, and it is hardly necessary to subject them to a breaking test, and it is even possible to omit it to save the testing expenses, if they comply with the requirements of the standard bending moment. However, when a breaking test is to be conducted upon request of the orderer, the breakdown bending moment of the RC piles of Type A should be 1.8 times or more as large as the standard bending moment.

Accordingly the joints for the RC piles of Type A may be inspected in the same manner as in the case of the main body. The number of RC piles of Type B per inspection lot shall be agreed upon by the manufacturer and orderer, but it usually contains 200 to 300 RC piles.

10. Shipment

Care should be used as follows prior to shipment of RC piles. It is said that RC piles are not able to resist shocks when they are relatively fresh, even if the concrete has attained a strength of 400 kg/cm^2. It is therefore advisable to drive RC piles into the soil when the concrete is 3 weeks or more of age. However, RC piles may be used earlier, if forcing cure is employed. RC piles cured at high temperature and pressure, for example, may be driven at a matter of days of age.

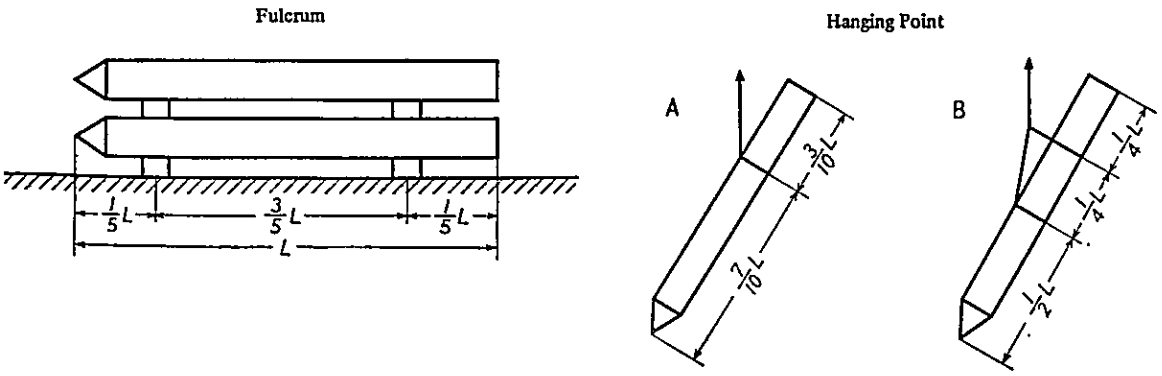
11. Marking

The present revision stipulates that the quality (e.g. SR24, SD30, etc.) of tendons and reinforcement be also marked. Although not expressly provided in the standard, it is recommended to indicate the fulcrums and hanging point as well. The marking of fulcrum and hanging point will prevent the RC piles from being damaged during storage or hanging.

The fulcrums and hanging points are shown in Fig. 4 as general information.

Fig. 4

Example of Fulcrum and Hanging Point



JAPANESE INDUSTRIAL STANDARD
Prestressed Concrete Girders For Slab Bridge

1. SCOPE

This standard shall specify the prestressed concrete bridge girders (hereinafter referred to as bridge girders) manufactured through pretensioning for use in the construction of road bridges of the slab type 12 m or less wide.(1)(2)

NOTES: (1) The specifications of these bridge girders shall apply to loads of 20t and 14t of the road bridges prescribed in Article 32, Road Construction Ordinance.

(2) Snow load of 100 kg/m^2 is considered in the specifications of these bridge girders.

2. TYPE

The bridge girders shall be classified as in Table 1.

Table 1

Designation	Conditions of Application	
	Span (m)	Class of Bridge (Design Live Load)
S 105	5	Bridge of Class A (T—20)
S 106	6	
S 107	7	
S 108	8	
S 109	9	
S 110	10	
S 111	11	
S 112	12	
S 113	13	
S 205	5	Bridge of Class B (T—14)
S 206	6	
S 207	7	
S 208	8	
S 209	9	
S 210	10	
S 211	11	
S 212	12	
S 213	13	

3. MATERIALS

3.1 Cement complying with the requirements of JIS R 5210 (Portland Cement) shall be used.

3.2 Aggregates

Aggregates shall be clean, strong and durable and shall not contain dust, mud or organic substances to an injurious.extent.

3.3 Water

Water shall not contain any acid, salt or organic substance to such an extent that it may have an adverse effect on the quality of products.

3.4 PC Steel Wire

The PC steel wire shall comply with the following requirements with respect to dimensions, appearance and strength.

Diameter	$2.9\ ^{+0.04\,mm}_{-0.02\,mm}$
Tensile Strength	195 kg/mm^2 or more
Yield Stress(3)	165 kg/mm^2 or more
Elongation(4)	3% or more
Relaxation(5)	3.5% or less
Appearance	Products shall be free from injurious defe defects.

NOTES: (3) The yeild stress specified here is a stress which produces 0.2% residual strain.

(4) The distance between marked points shall be 100 mm.

(5) Measurement shall be made ten hours after stress equivalent to 80% of yield stress is given.

3.5 Tendons and Reinforcement

The tendons and reinforcement complying with the requirements of either one of the following standards shall be used.

(1) JIS G 3101 (Rolled Steel for General Structure)
Steel Bar of Class 2 (SS 41), Class 3 (SS 50), Class 4 (SS 39) or Class 5 (SS 49)

(2) JIS G 3110 (Shaped Steel Bar)

(3) JIS G 3532 (Iron Wire) Ordinary Iron Wire

4. MANUFACTURE

4.1 Concrete

4.1.1. Concrete shall have a strength of 500 kg/cm^2 or more at 28 days of age, necessary durability and the least possible variations in quality.

4.1.2. The least possible water per unit weight of cement shall be used, so long as the concrete is workable, taking into consideration the required strength and durability.

4.1.3. A batch mixer shall be used for mixing concrete and concrete shall be mixed in such a way that mixed concrete may be plastic and homogeneous.

4.1.4. A vibrating machine of high frequency shall be used for placing concrete, and concrete shall be sufficiently compacted.

4.1.5. When concrete is compacted, the bridge girder shall be cured with sufficient steam. The curing temperature shall be below 60°C, when steam or hot water is used.

4.2 Mold

4.2.1. The inner surface of the mold shall be cleaned and coated with a proper material before placing concrete in it.

4.2.2. The mold shall be of such a construction as to resist compacting by vibrations and not to permit mortar to leak at the joints.

4.2.3. The construction of the mold shall be such that the bridge girders may freely contract when prestressed.

4.3 Pretensioning

4.3.1. Oil shall be wiped off the surface of the PC steel wire prior to pretensioning so as to uniformly produce rust on its surface. Floating rust or other substance which may reduce the adhesion of the PC steel wire to the concrete shall be removed.

4.3.2. The PC steel wires shall be properly arranged and subjected to pretensioning. Both ends of the PC steel wire shall be completely fixed to avoid its loosening till prestress is exerted.

4.3.3. The initial tension to be applied to the PC steel wire shall be 870 kg per wire in consideration of the friction at tension and slip of the gripping device.

4.3.4. The gripping device at one end of the PC steel wire shall be made to slowly loosen its grip when prestress is exerted. The compressive strength of concrete shall be 400 kg/cm^2 or more when the gripping device is made to loosen its grip.

4.3.5. The PC steel wires shall be cut so that they may stick out 5 mm or less from the end of the bridge girder and shall be coated with mortar or the like to protect them.

5. PRODUCTS

5.1 Appearance

The bridge girder shall be free from injurious flaws, cracks and twists and look normal.

5.2 Dimensions

The dimensions of the bridge girders shall be as specified in Attached Drawings 1 - 4, and their tolerances shall be as specified in Table 2.

Table 2

Item	Tolerance
Length	± 10 mm
Outer Dimension of Cross Section	+ 5 mm − 3 mm
Maximum Longitudinal Deflection	(2*l* - 6) mm The deviation shall not exceed 10 mm. *l* = Span (m)

5.3 Bending Strength

The bending strength of the bridge girders shall be such that they may resist the cracking test load and breaking test load shown in Table 3.

Table 3

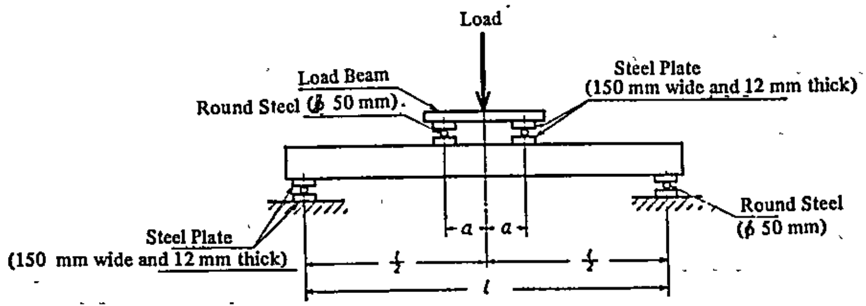
Designation	Cracking Test Load (t)	Breaking Test Load (t)
S 105	4.8	11.4
S 106	5.1	12.1
S 107	5.1	12.2
S 108	5.2	12.9
S 109	5.7	13.6
S 110	6.2	16.2
S 111	6.8	17.3
S 112	7.1	18.0
S 113	7.8	19.5
S 205	3.7	8.5
S 206	3.7	9.3
S 207	4.1	9.6
S 208	4.2	10.4
S 209	4.4	11.0
S 210	5.1	12.6
S 211	5.4	14.3
S 212	5.8	14.8
S 213	6.3	16.4

6. TESTING

6.1 A quality test[6] shall be of cement, aggregates, water, PC steel wires, tendons and reinforcement and concrete.

6.2 The bending strength test shall be made by the loading method shown in Fig. 1 to determine the cracks and breakdown of the bridge girders. The test shall be made when the bridge girders are at 28 days or more of age.

Fig. 1



a = 0.5 m (in case of $l \leq 9$ m)

= 0.75 m (in case of $l \geq 10$ m)

l = Span (m)

7. INSPECTION

7.1 The bridge girders shall be accepted, if they pass the tests of quality, appearance, dimensions and bending strength.

7.2 The whole lot of products shall be inspected with regard to their appearance and dimensions.

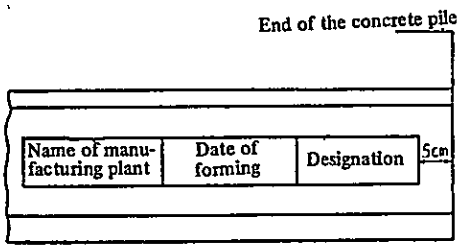
7.3 A sampling test shall be conducted with regard to the bending strength of products.

8. MARKING

The products shall have markings such as the designation, name of the manufacturing plant or its abbreviation and date of forming as shown in Table 1.

The markings shall be indicated as shown in Fig. 2.

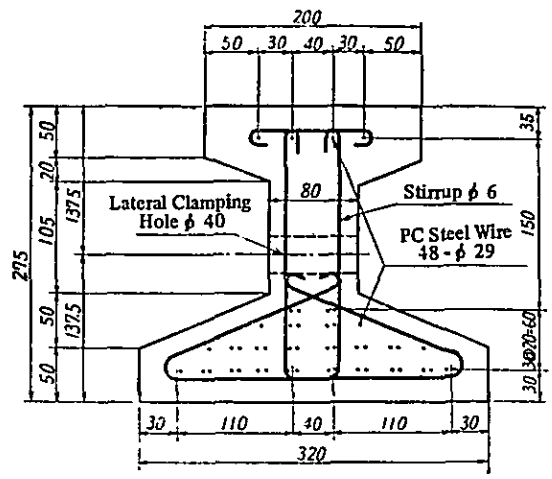
Fig. 2



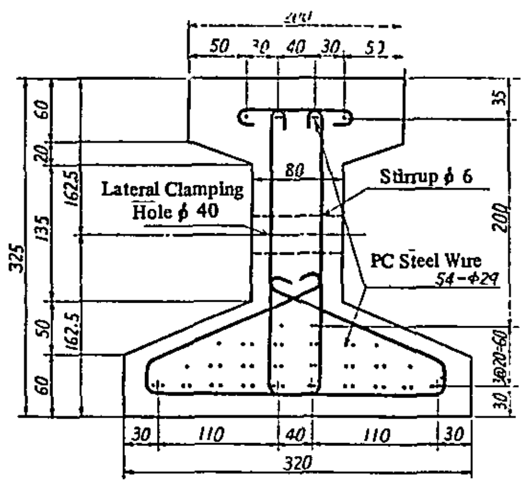
Attached Figure 1

Cross Section of Bridge Girder

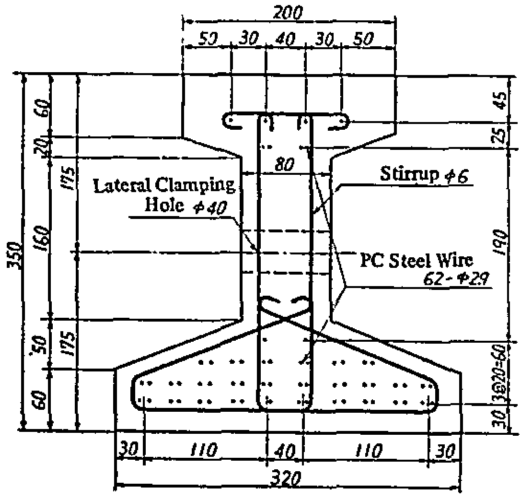
S 105



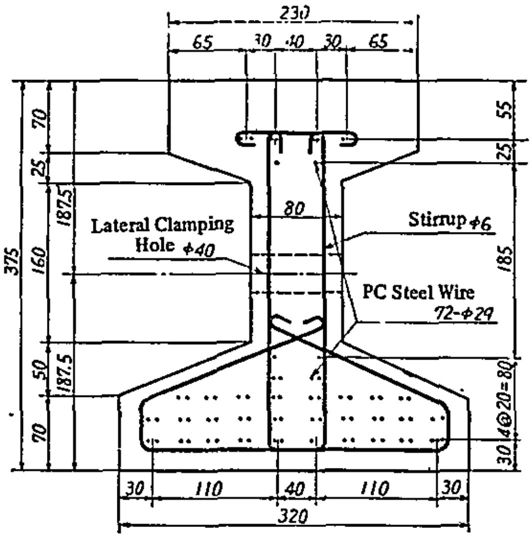
S 106



S 107



S 108



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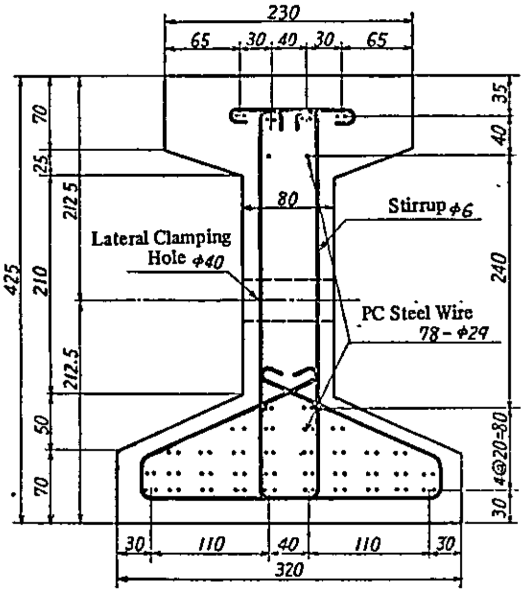

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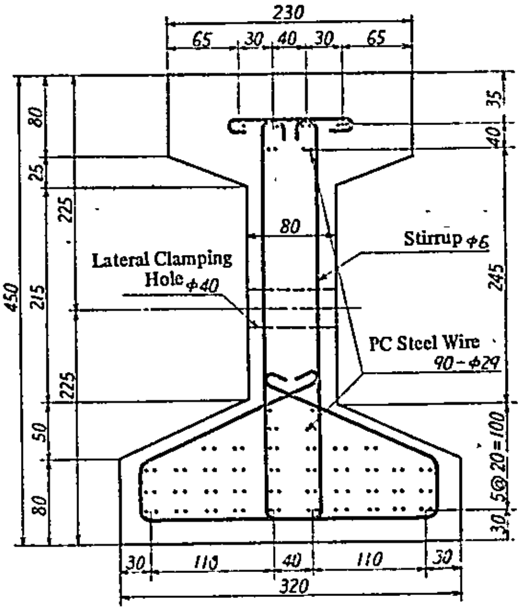
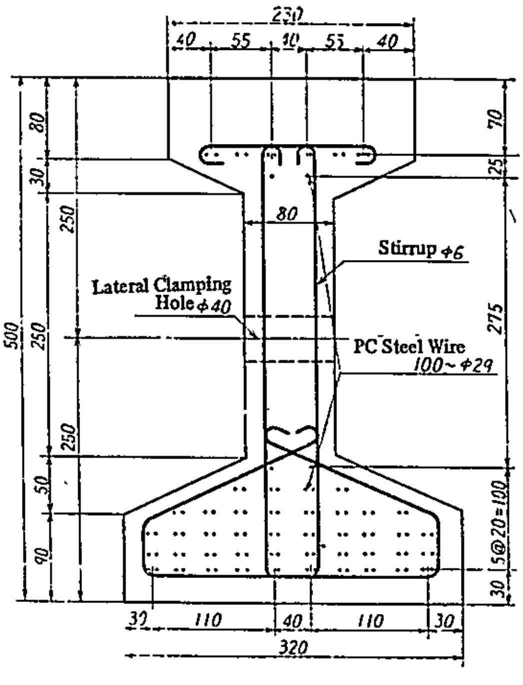


S 111



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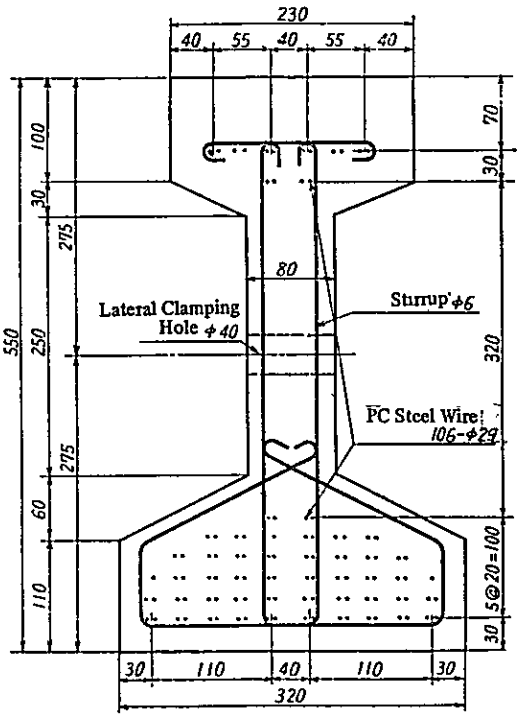
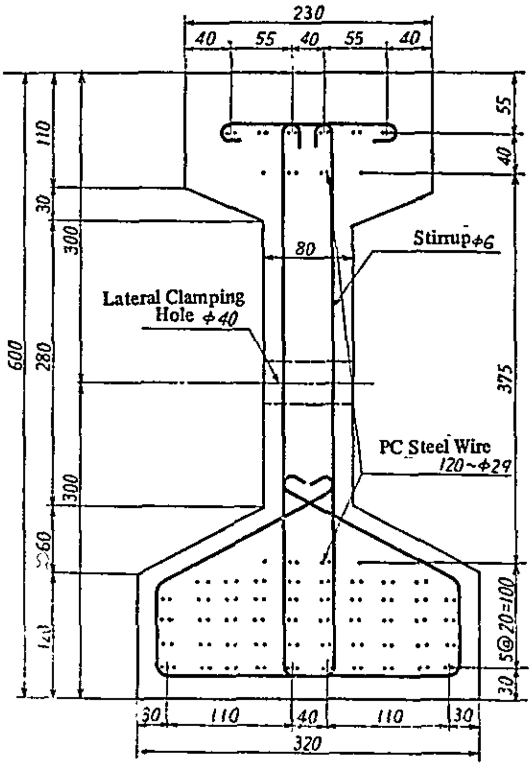
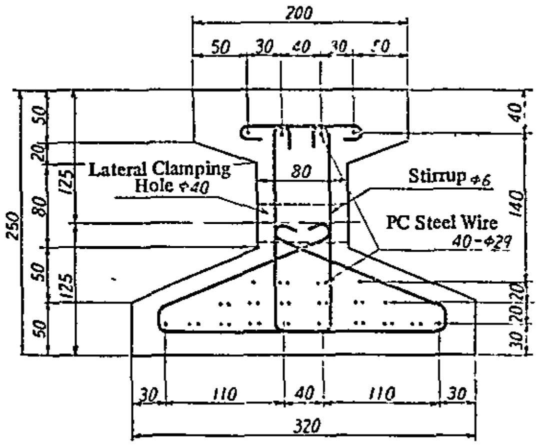


S 113



S 205



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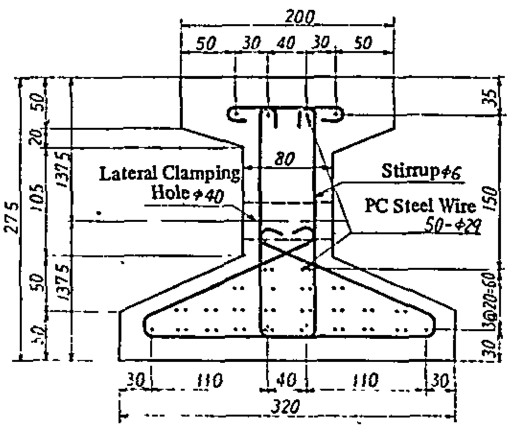
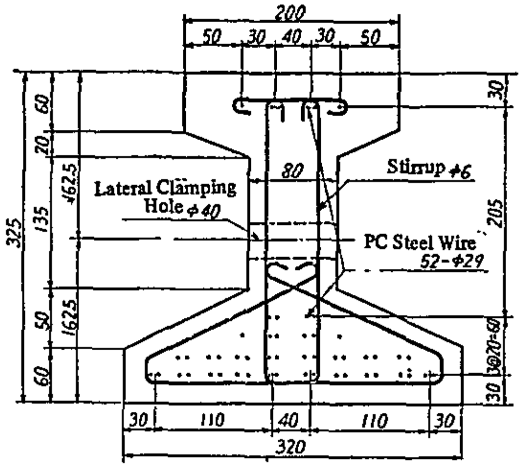
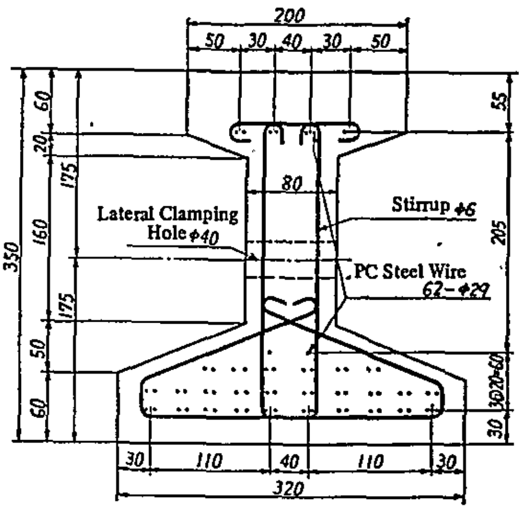


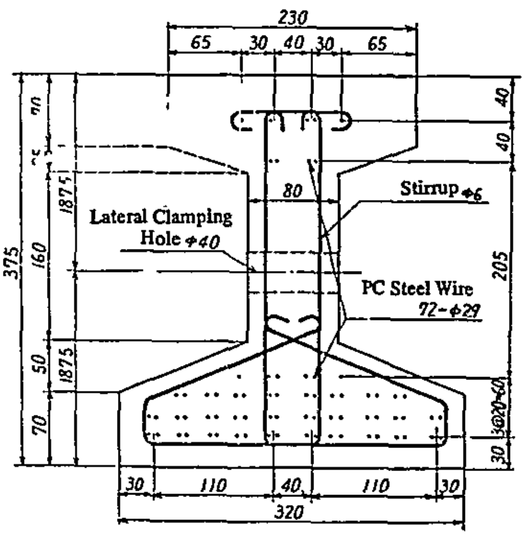
S 207



S 208



S 209



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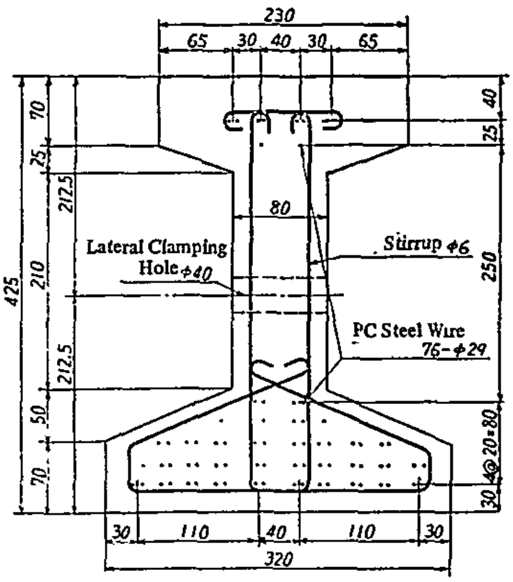
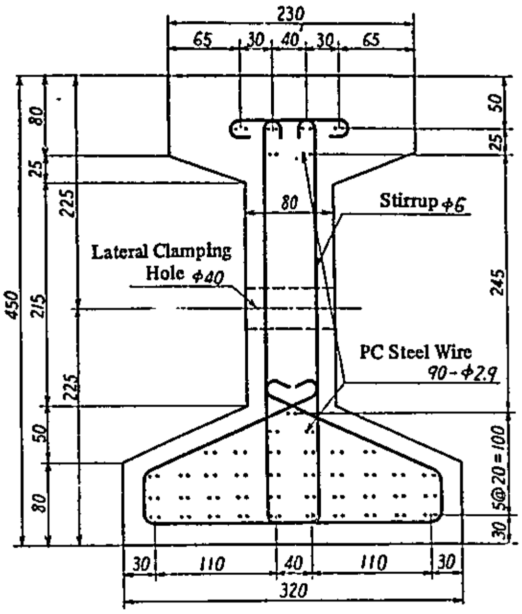
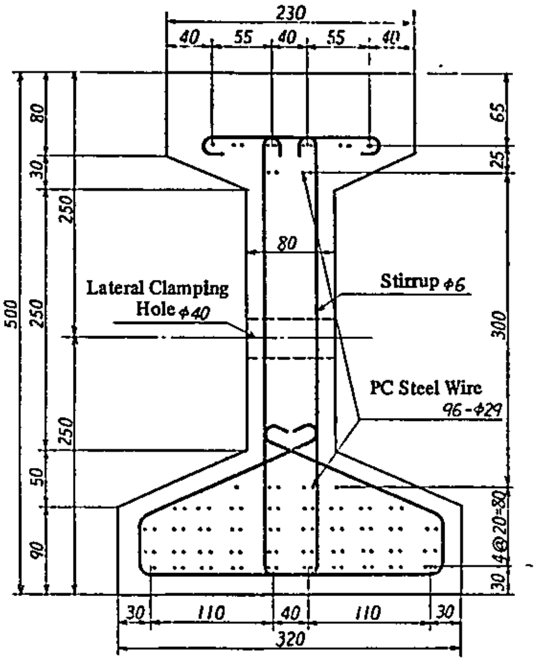


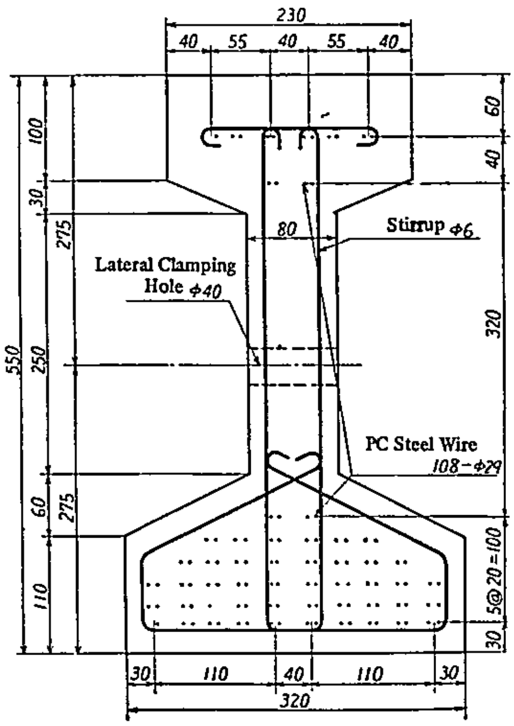
S 211



S 212

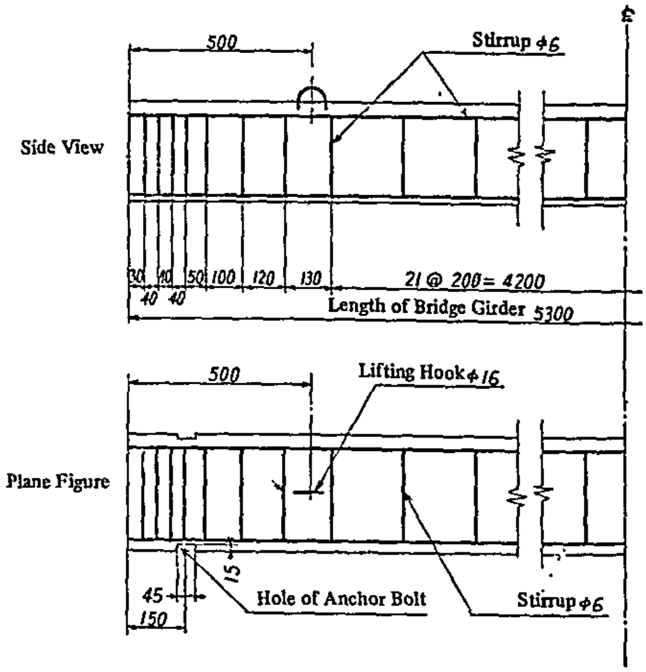


S 213

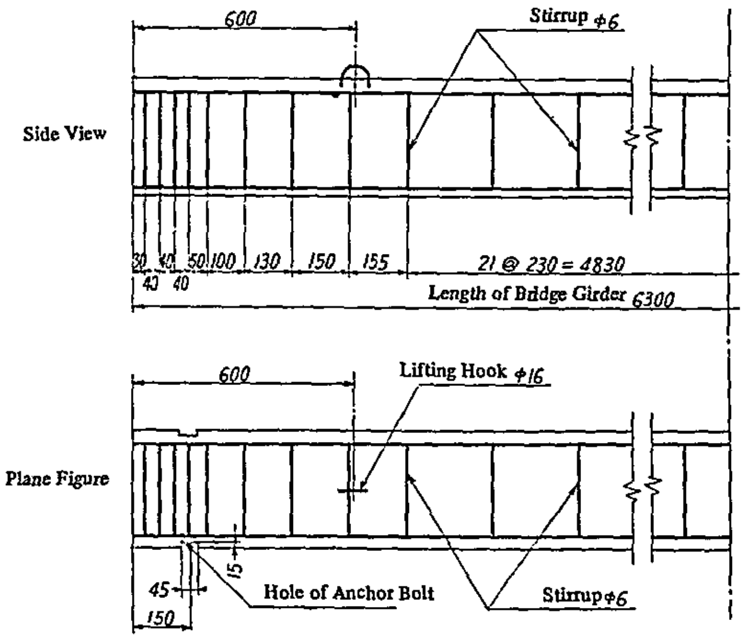


Attached Figure 2. Arrangement of Tendons and Reinforcement in Bridge Girder

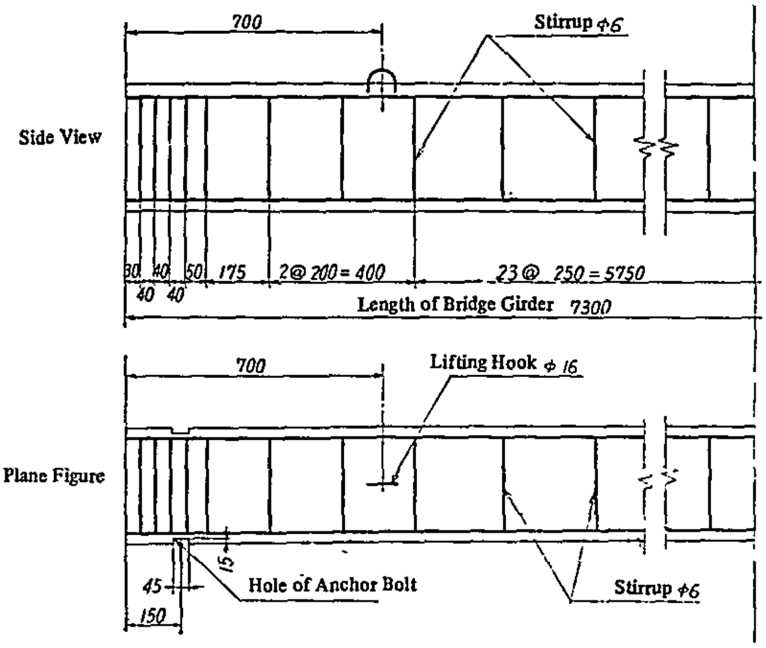
Span 5 m



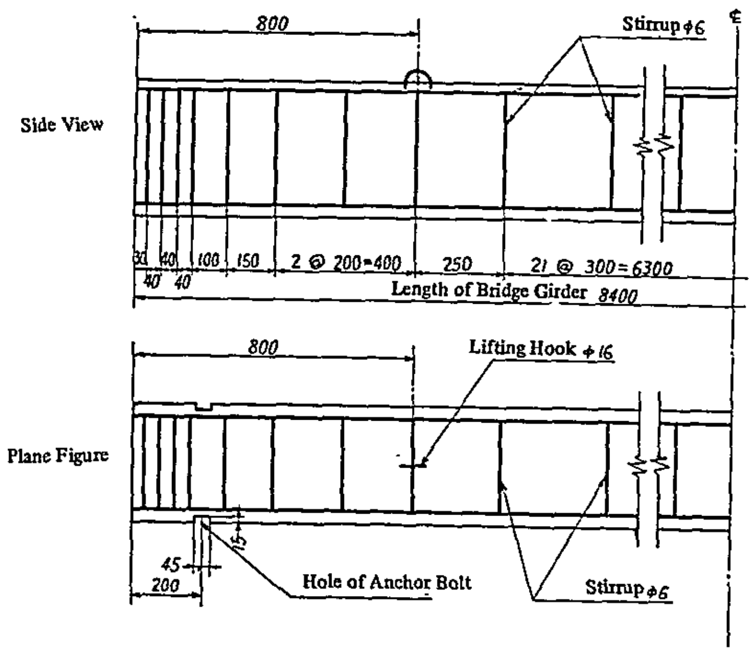
Span 6m



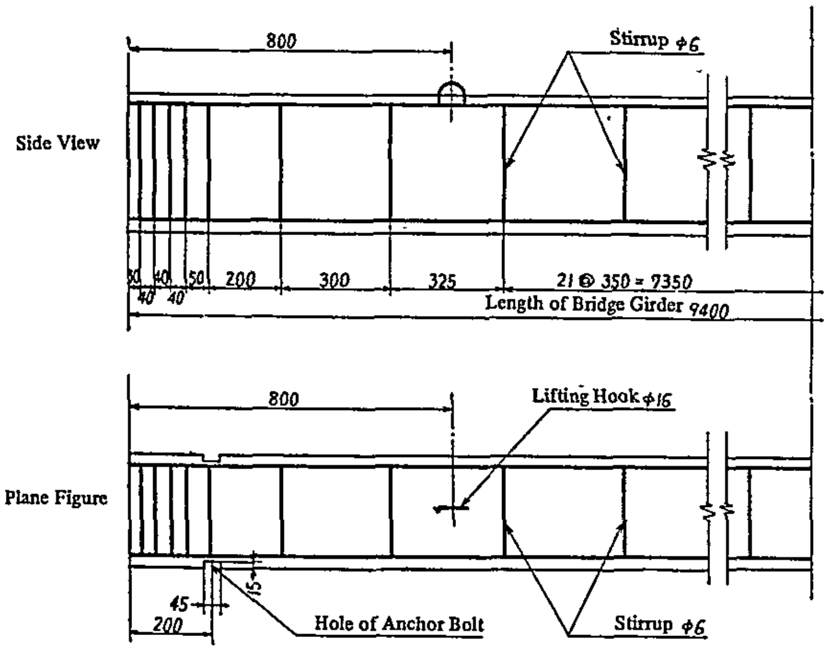
Span 7 m



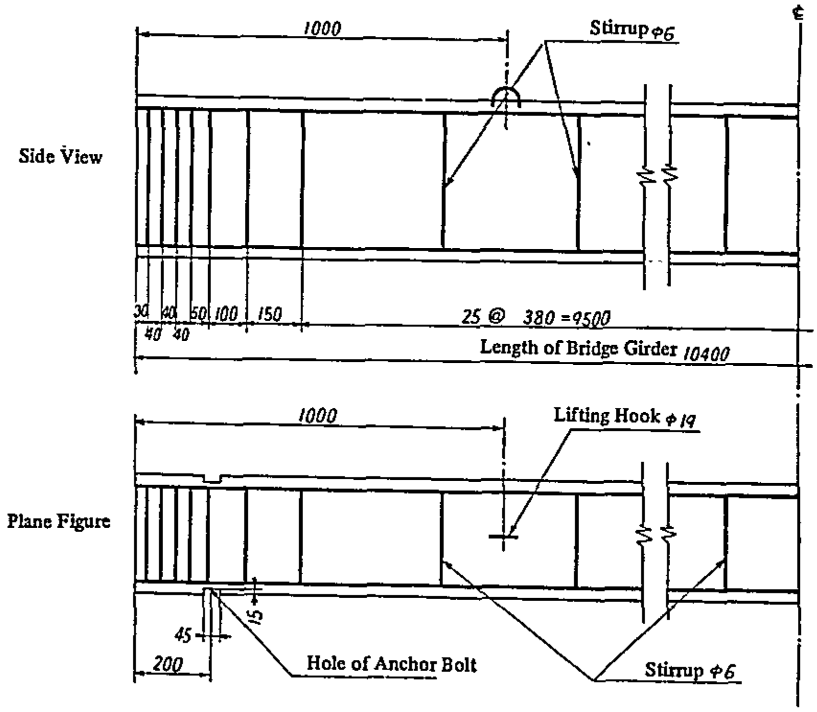
Span 8 m



Span 9 m



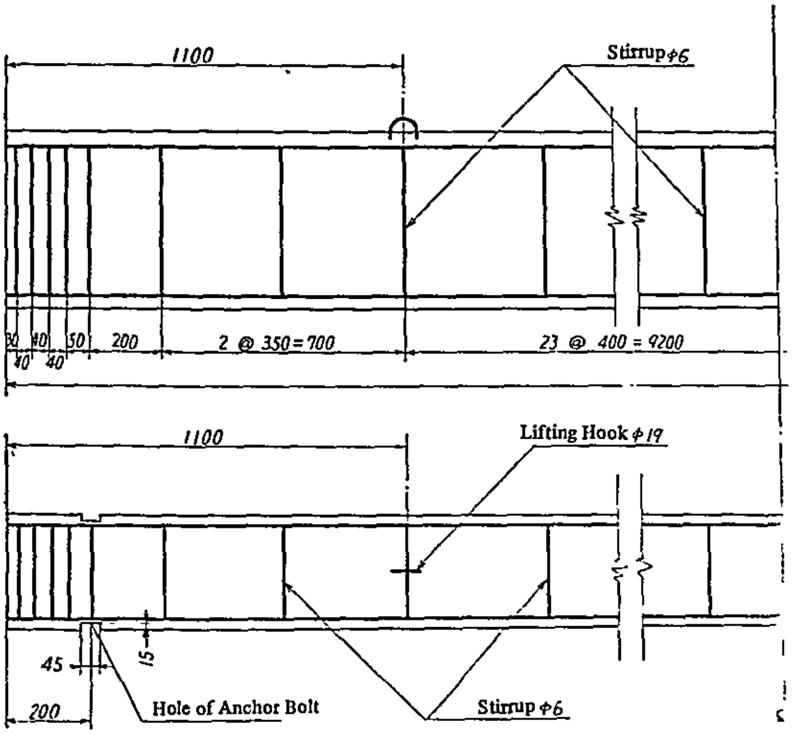
Span 10 m



Span 11 m

Side View

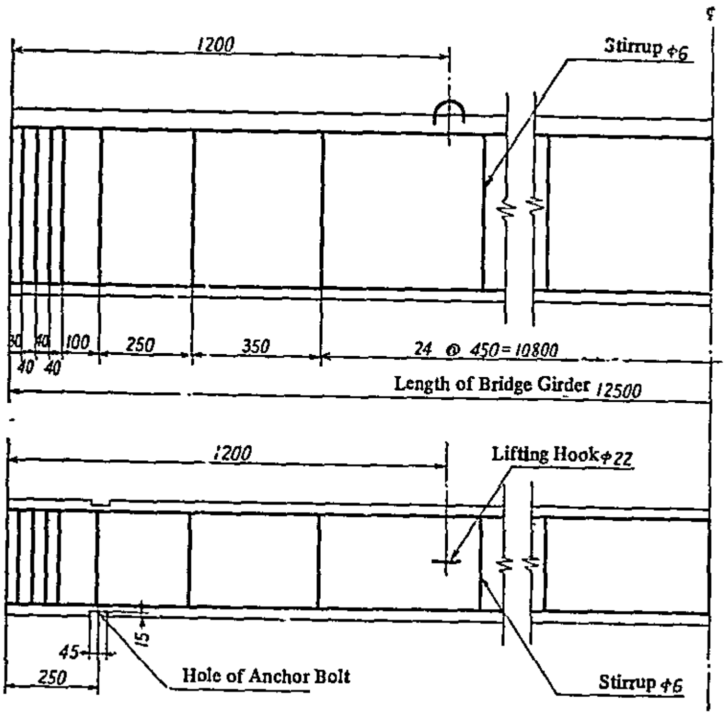
Plane Figure



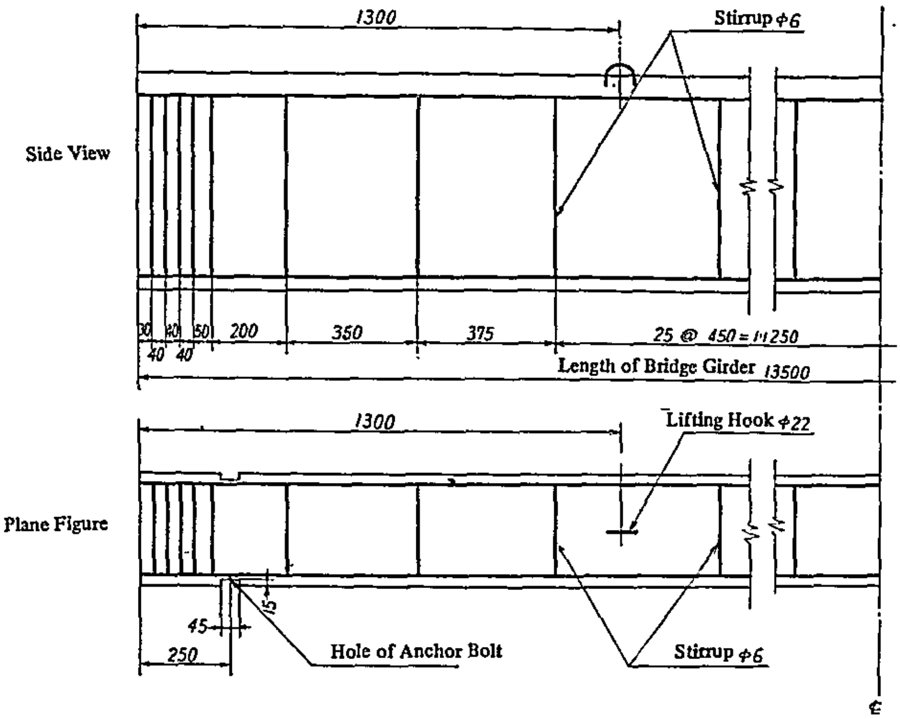
Span 12 m

Side View

Plane Figure

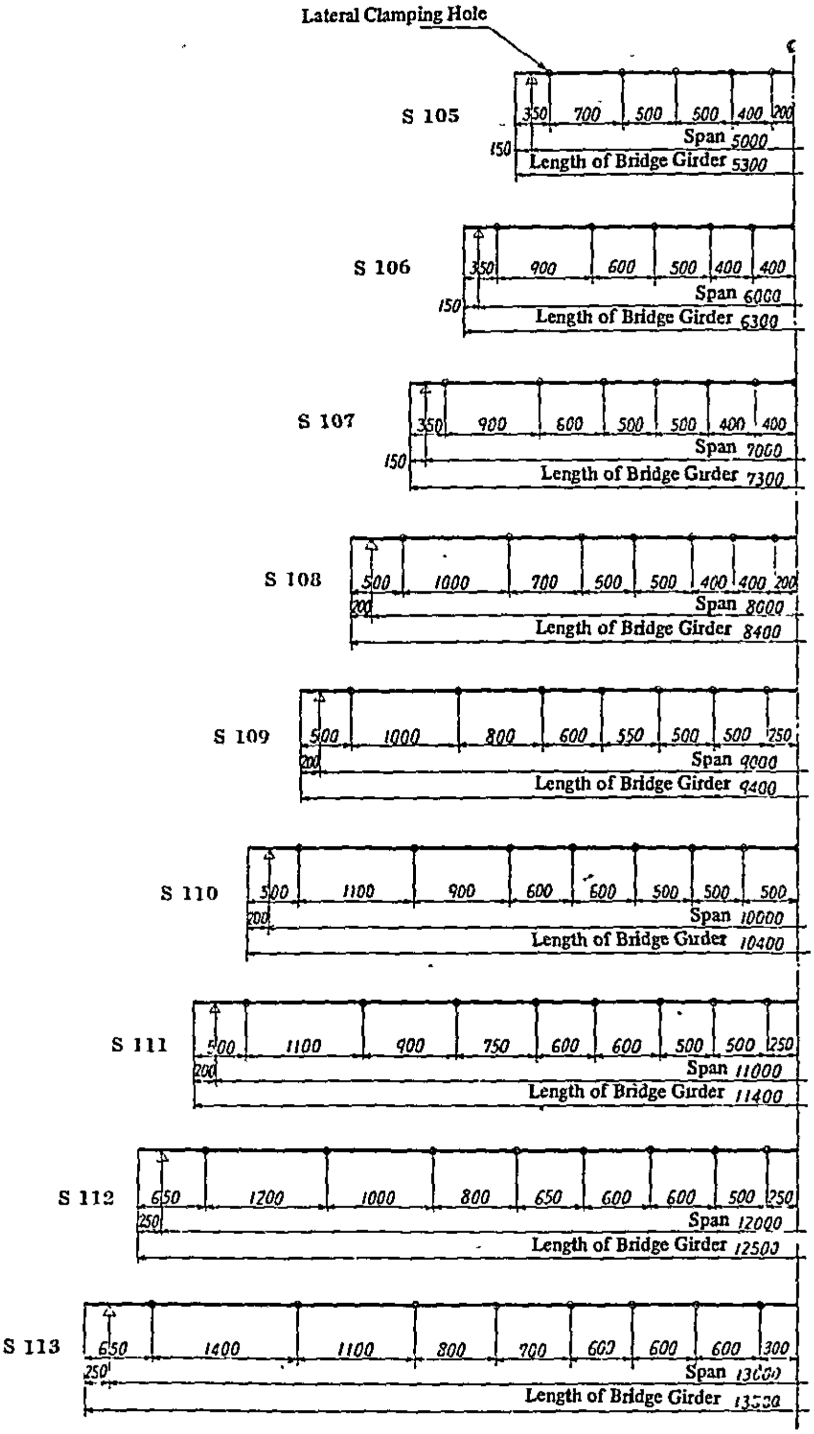


Span 13 m


1300
Stirrup φ6
Side View
30 40 40 40 50 200 350 375 25 @ 450 = 11250
Length of Bridge Girder 13500
1300
Lifting Hook φ22
Plane Figure
15
45
250
Hole of Anchor Bolt
Stirrup φ6

Attached Figure 3

Arrangement of Lateral Clamping Holes (Bridge of Class A)



Attached Figure 4

Arrangement of Lateral Clamping Holes (Bridge of Class B)