OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

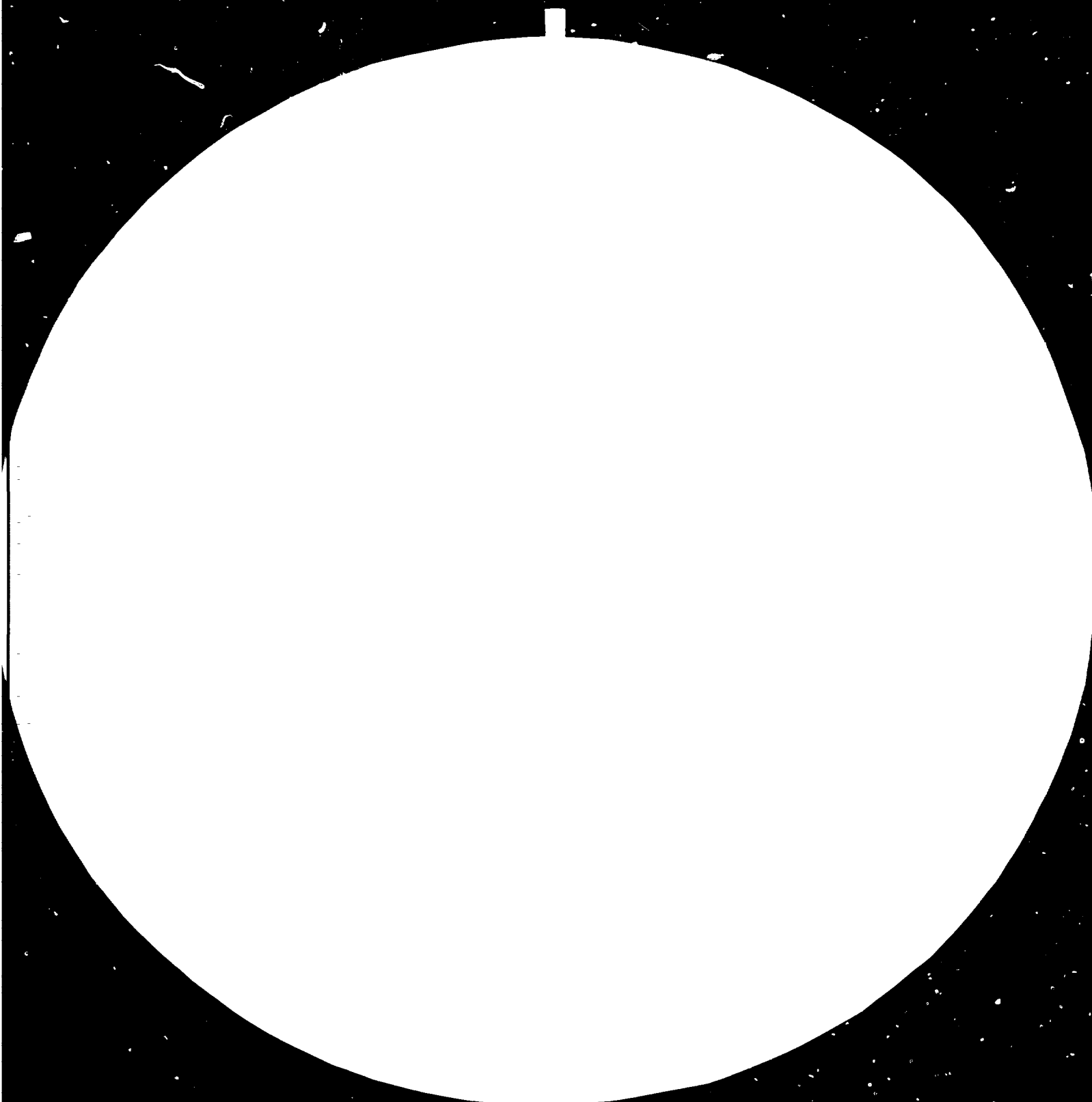
FAIR USE POLICY

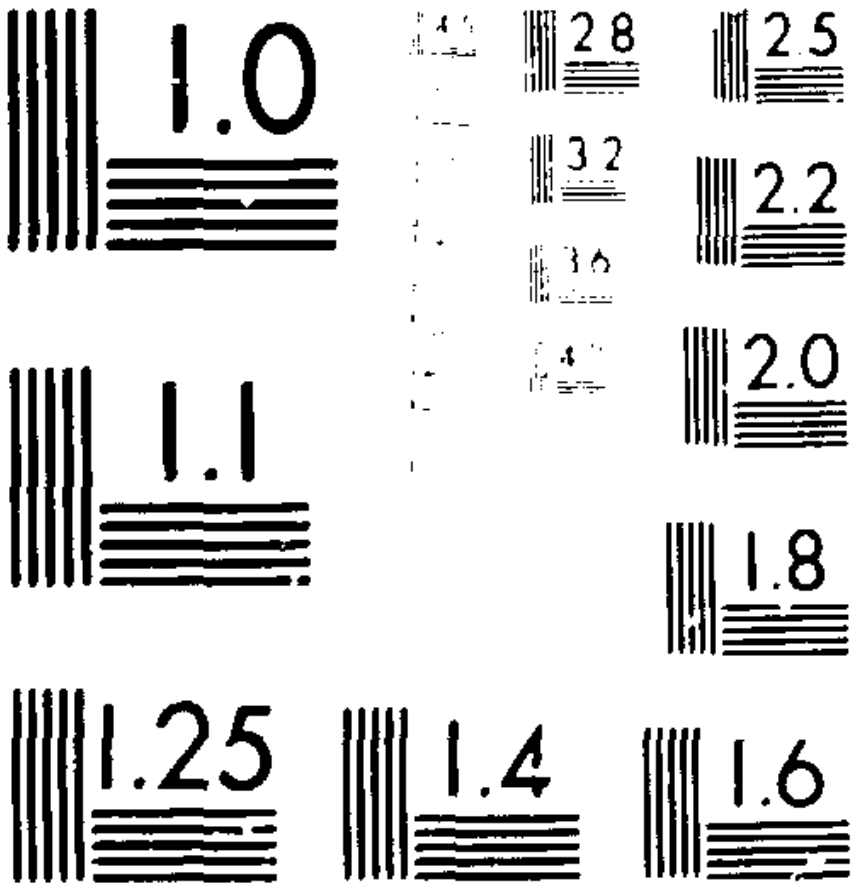
CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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





11006

Distr.
LIMITED

ID/WG.347/43
16 November 1981

ENGLISH

United Nations Industrial Development Organization

Workshop on Cement and Concrete Products
Brisbane, Australia, 18 - 29 May 1981

THE CEMENT AND ALLIED PRODUCTS INDUSTRY IN SRI LANKA*

by

G.A. Premadasa**

* The views expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

** Works Manager, Ruhunu Cement Works, Sri Lanka Cement Corporation.

C O N T E N T S

1. HISTORY

1.1 Kankesanthurai Cement Works (KCW) :- The Cement Industry in Sri Lanka dates as far back as 1950, in which year the first Cement factory with a single kiln of capacity 80,000 tons per annum was established at Kankesanthurai (KKS) in the North of the island.

In 1956 the Management of the Cement industry was transfered from the Department of Industries to the Kankesan Works Corporation under the scope of the Government sponsored Corporation Act No. 19 of 1955. Subsequently, on 1st January 1959 this wa s superseded by the Ceylon Cement Corporation, established under the purview of the State Industrial Corporation Act No. 49 of 1957 with a view to expanding this industry on an island wide basis.

The excellent site and raw material facilities at Kankesanthurai coupled with technological experience gained in the operation of the Industry offered scope for expansion of the Cement factory at Kankesanthurai. The expansion and modernisation of Kankesanthurai was undertaken in 1961 in two stages. Stage 1 of the scheme consisting of the utilisation of a new rotary kiln and accessory equipment with an annual capacity of 165,000 tons, and the Stage II expansion involved the modernisation of the old kiln at Kankesanthurai to increase its capacity to 110,000 tons per annum. Stage I expansion was completed in February 1967 while the Stage II modernisation of the old plant was commissioned in December 1968 as it had to await the completion of Stage I.

1.2 Ruhunu Cement Works & Puttalam Cement Works (RCW & PCW) :- The expansion of cement industry in Sri Lanka progressed further with the commissioning of a Grinding Plant at Galle in 1967 with a capacity of 100,000 Tons cement per annum, and subsequently with the opening of a new factory at Puttalam with 2 kilns of 220,000 tons capacity each. The first kiln at Puttalam went into commercial production in March 1970 whilst the 2nd kiln was commissioned in February 1973.

Hence by 1973 the total installed capacity for the production of clinker from both factories i.e. KCW & PCW was in the range of 710,000 per annum.

The three plants have been oriented in order to facilitate an is land wide scheme of distribution. The output from Kankesan

Cement Works is expected to supply the requirements of the Northern and eastern sectors of Sri Lanka. A part of its production is to be transported in the form of clinker to the Galle plant to be processed into finished Cement and distributed in the southern sector of the island. The Puttalam Plant located in the western coastal sector is expected to meet the requirement of the largest Cement consuming region in the island, namely the western and central sectors.

2. RAW MATERIALS

2.1 General :- Theoretically, there are a large number of raw materials which can provide essential constituents for the manufacture of Portland Cement. We are fortunate in that we have high quality raw materials in great abundance which ensure the economic production of high quality Cement based on a two component system of limestone and clay.

2.2 Calcareous Material :- The Calcareous deposits are the flat-lying sedimentary limestones of the miocene age which extends in a narrow, almost unbroken belt from Jaffna Peninsula in the North to Puttalam on the West Coast. (Please see Fig I - Annex I) These sedimentary rocks to a large extent are covered by superficial deposits, but excellert exposures are seen in the Jaffna Peninsula and in Aruakkalu, 18 miles north of Puttalam. The Geological Survey Department has established that the Jaffna limestone assay reveals 52-54 per cent of CaO corresponding to a $CaCo_3$ content of 94-96% in the rock.

Narrow seams of crystalline limestone occur in the central region of Sri Lanka but these are inadequate in quantity and contain a high proportion of Magnesia. Coral deposits occur in the South West of Sri Lanka but the quantities available are inadequate for the purpose of a Cement Industry.

2.3 Argillaceous Material : Although limestone is available in abundance in the Jaffna Peninsula, it lacks the argillaceous material clay. This is being excavated at Murunkan near Mannar and transported to the KCW factory by rail, over a distance of nearly 140 miles.

The clay for the KCW factory is obtained from the clay field in the Elluvankulam having nearly three million tons and are adequate for 1 200,000 ton cement plant for forty years.

The distribution of limestone and clay in Sri Lanka is as shown in Fig. I - Annex I.

2.4 Gypsum :- This raw material has to be imported

3. MANUFACTURE OF CEMENT

3.1 General :- In broad outline the manufacturing process comprises:

(a) Preparation of the raw materials,

(b) Proportioning, mixing and fine grinding the raw materials to obtain an intimate mixture,

(c) Burning to a state of incipient fusion,

(d) Grinding the resultant clinker (with the addition of a small quantity of gypsum) to a fine powder, and

(e) Packing and despatch.

All manufacturing processes are subject to stringent quality control.

Two processes are employed for the manufacture of Portland Cement.

1. The dry process, where the raw materials limestone and clay are ground dry to a 'raw meal'.

2. The wet process, where the raw materials are ground with water to form a 'slurry'.

From this stage the process of manufacture is substantially the same for wet or dry process. The dry process is the method of manufacture adopted in Sri Lanka as it is ideally suited for Sri Lanka where fuel economy is a prime consideration and where the cement industry on account of raw material location has necessarily to be sited in places where water is scarce.

3.2 Process of Manufacture :- The limestone is fed into a crusher where it is crushed to a size of about ½ to 1 inch and stored. The clay is fed into a clay cutter where it is cut into shreds, dried in a rotary drier and then stored.

Overhead cranes transport the dried limestone and clay from storage to their respective mill feed hoppers.

Table feeders located under the mill feed hoppers give approximate proportioning of the limestone and clay to produce the desired mix.

This limestone and clay mixture in the ratio of approximately 3.6 is to 1 is fed into a Ball Mill where the limestone - clay

mixture is ground to a fine powder called "Raw Meal".

The raw meal is then pumped to homogenising silos, where the fine adjustment of chemical composition is effected.

Analysis is known of the meal in each silo, and with independently controlled extractors on each silo perfect blending can be obtained and adjustments are made to ensure that raw meal for kiln feed is of the correct analysis. The blended raw meal is fed into the rotary kiln which is set on an incline of about 1 in 25 and lined with refractory material. The raw meal supply is controlled by a feeder synchronised with the kiln speed.

Heat is provided by special burners designed for atomised liquid fuel or alternatively for pulverised coal.

Rotation, assisted by the inclined setting, causes the raw meal to travel slowly down the kiln. During this journey it meets with ever increasing temperatures. This causes first evaporation of the water, then the dissociation of calcium carbonate, and finally at a temperature of about 2500°F partial fusion takes place in the clinkering zone. The reactions in this zone give rise to the formation of silicates and aluminates of calcium which possess chemical and physical properties vastly different from the original limestone and clay. This partially fused material is called "clinker" and consists of nodules ranging from 1/2 in. to 2 in. in size.

The white hot "clinker" passes from the kiln to a cooler where it is cooled and then by a conveyance system to storage.

The next part of the process is the grinding of clinker to produce cement. Here the milling plant is similar to that used for raw grinding. A small amount of gypsum is added with the cement mill feed (usually 3 to 5%).

The product is ground to a specified fineness.

From the cement milling department, cement is conveyed or pumped to storage silos.

Cement is drawn as required from the storage silos into a packing plant, in which bags are packed and sealed automatically and discharged on conveyors to road or rail trucks.

Cement is also transported in bulk in special road or rail wagons.

4. EXISTING CAPACITY

The present installed capacity of clinker of the KCW & KCW cement factories is a total of 710,000 MT per annum. Of this quantity approximately 80% is achievable thereby yielding a total production of around 560,000 MT of clinker.

Clinker production achieved from 1970 - 1979 is given below (i.e. Table 1) along with the respective figures for capacity utilization.

TABLE 1

Production of Clinker & Corresponding Capacity Utilization

	K.C.W.	P.C.W.	K.C.W.	P.C.W.
1970	222,375	20,268	82%	9%
1971	220,729	119,823	82%	54%
1972	215,110	130,365	80%	59%
1973	222,565	177,752	82%	40%
1974	201,913	267,442	75%	68%
1975	217,721	190,104	81%	43%
1976	189,447	185,066	70%	42%
1977	154,748	178,755	57%	41 %
1978	214,522	340,142	79%	77%
1979	235,195	349,341	87%	79%
1980	247,810	353,159	92%	80%

5. MARKET

Cement is one of the basic construction materials and its adequate supply commensurate with the growth of demand is of vital importance to the economic development of the country. The total production capacity and per capita consumption of cement is an index to the progress and prosperity of a nation. The per capita consumption in Sri Lanka - at 47 Kg in 1979, is comparatively low with Singapore achieving 544 Kg, Korea 403 Kg, Thailand 123 Kg & Philipines 73 Kg. Cement has been of late in very short supply in Sri Lanka and the comparatively low level of consumption may be attributed to finally the same reason. The present demand for cement for 1980 is reflected in the table given below which also reflects the future demand as well as short-falls in production.

The short fall in cement production as against the estimated demand is as given below in Table 2.

TABLE 2

Year	Demand	Cement Production		Shortfall
	Tons	Actual Tons	Estimated Tons	Tons
1977	340,000	355,000	-	-
1978	575,000	575,000	-	-
1979	700,000	660,000	720,000	40,000
1980	1,000,000	-	720,000	280,000
1981	1,200,000	-	720,000	480,000
1982	1,400,000	-	720,000	680,000

The estimated demand for cement records a slight drop in 1983 - due to the anticipated completion of major buildings and development programmes.

6. DISTRIBUTION OF CEMENT

At present the Corporation does not face any problem with regard to the sale of cement, as practically all the cement produced is sold due to the fact that the demand exceeds supply. Generally the Corporation issues cement direct to private house builders, contractors and also to multi-purpose Co-operative Societies. Issue of cement is generally performed on the basis of permits due to the heavy demand that is experienced. A retail sales unit is also in operation in Colombo, Puttalam & Kankesanthurai whereby multiples of 25/50 bags are issued coupled with a Home Delivery Service.

7. EXPANSION PROGRAMME OF THE CEMENT FACTORY AT KANKESANTHURAI :

Comparing the present installed capacity of the 2 factories namely K.C.F. & P.C.F. with the consumption forecast for 1982 (Please see Table 2) a deficit of 680,000 MT is indicated. In order to fulfil this deficit the Cement Corporation took steps

to formulate a plan for the construction of another factory. Due to the availability of Clay in large quantities in the Murunkan area and good quality Limestone in Kankesanthurai it was decided to set up another Factory at Kankesanthurai via the III rd Stage Expansion Programme. According to this programme a new process line with a Kiln of initial capacity of 1600 tons per day is to be installed. This Kiln is to have a capacity for expansion to 3200 tons per day, thereby being in a position to double capacity with an additional investment of around 15% of the initial. The total estimate for the construction of this factory is Rs. 698 million. The civil construction aspects of the new factory has been undertaken by Cement Corporation itself while the mechanical aspects are to be handled by M/s Klockner Humboldt Deutz of West Germany.

It is proposed to use coal instead of Furnace Fuel in this new factory for which the coal required would be imported from abroad.

This new project is expected to increase the employment potential in the Jaffna District. The total employment figure covering all grades in the new factory is expected to be around 3000 in all. In regard to training of staff no problems are envisaged as the new recruits would be trained in the existing factories.

Associated with the expansion of the cement factory at Kankesanthurai is the development of the Harbour. [According to this scheme the quay would be 900 ft. in breadth and parallel to the breakwater at a distance of 220 ft.] A total of Rs.45 million has been estimated for the development of this Harbour.

After the development of the Harbour, transport of essential goods to the cement factories would be eased considerably. Moreover transport of clinker to R.C.W. can also be sent without any difficulty via ship to Galle. A massive saving of transport costs is expected and is estimated to be in the region of Rs. 170 lakhs.

8. ALLIED PRODUCTS MANUFACTURED BY THE CORPORATION

8.1 General :- Apart from cement the Corporation also manufactures allied products which are as follows :-

(a) Masonry Cement
(b) Lime
(c) Cement/Concrete Products covering, Electrical Poles, Telegraph Poles, Fence Posts, Building Blocks and pre-stressed Concrete Sleepers.

8.2 Masonry Cement :- Masonry Cement was introduced in year 1979 as a new product of the Corporation. Masonry Cement is utilised for brick work and plastering. Upto this date Portland Cement was being used for this purpose and it was found that the mixture used was far too rich for the strength required. Hence to cut down on waste it was decided to experiment, resulting in finally the production of Masonry Cement. The production and sales for Masonry Cement is tabulated below in Table 3.

TABLE 3

1980	Production (MT)	Sales (MT)
K.C.W.	19,912	21,849
P.C.W.	47,334	47,831
R.C.W.	4,476	4,139
TOTAL	71,722	73,820

1981 - January - March (1st Quarter)		
K.C.W.	4,797	4,377
P.C.W.	12,317	11,906
R.C.W.	-	-
TOTAL	17,114	16,283

8.3 Lime :- Another product presently manufactured by the Corporation is Lime. A lime kiln has been installed at Kankesanthurai and lime is being produced from October 1980. The lime produced is used in the

building industry for plastering purposes and also in other lime consuming industries such as chemicals, paper and steel. The setting up of the lime kiln and the production of lime is also expected to aid in preventing to an extent illegal coral reefing in the coastal belt.

8.4 Concrete Products :

8.4.1 General :- The manufacture of prestressed concrete sleepers for the Ceylon Government Railway commenced in 1979.

Internationally the innovation of the Concrete Sleeper has been brought about by two main reasons. One, the faster and heavier engines on rails, and secondly, the limited supply of timber sleepers.

In Sri Lanka, however, the main reason for the introduction of the Concrete Sleepers has been due to the latter reason.

The primary function of a railway sleeper is to transmit the axle load of the carriage to the formation through the ballast and to maintain the gauge, level and alignment of the track. Considerable progress has been made in the past few decades in the design and production of sleepers and their rail fastenings and millions of sleepers have already been laid on the rail roads in many countries. Each country has adopted particular types of sleeper depending upon the cost of materials and labour, national requirements and availability of indegenous know how.

As with other prestressed concrete products, ties may be either pre-tensioned of post-tensioned. For pre-tensioned concrete ties, prestressing is accomplished by tensioning rods, strands or wires prior to placing concrete in the forms. After the concrete has reached a specified strength, the prestressing force is released and transmitted to the concrete by bond.

For post-tensioned concrete ties prestressing is accomplished by high strengths rods that are appropriately coated or encased in conduits to prevent bond with the concrete. The pre-stressing force is applied after the concrete has reached a specified strength. This

force is transmitted to the concrete by bearing.

Pretensioned concrete ties are manufactured by one of three methods. These are the long line, stress bench and individual form methods.

8.4.2 Advantages of Concrete Ties :- Concrete ties have been in use in Europe for over 30 years. More recently, Japan, Canada and United States installed concrete ties in several projects. This extensive experience has demonstrated many of the advantages of concrete ties.

These advantages are listed below :

1. Concrete tie track provides better vertical and lateral stiffness than wood tie track, due to the greater mass of concrete ties and the more rigid fastening system.
2. Concrete tie track settles more uniformly than the wood tie track, thus providing a smoother, safer ride and greater comfort for passengers.
3. Concrete tie track maintains alignment and gauge for a longer period than wood tie track.
4. Concrete ties retain gauge better on curves than do wood ties with conventional fasteners.
5. The chances of a derailment are less on a concrete tie due to the more stable track system.
6. Concrete ties have an estimated service life twice as long as that of wood ties.
7. Concrete tie track has fewer irregularities than wood tie track, thus requiring less maintenance and providing better ride stability.
8. Concrete tie track has a lower life cycle cost than wood tie track.

It should be recognised that the greater weight of concrete ties makes it more difficult to handle during installation and replacement operations. However, with the use of modern and suitable mechanical equipment, handling of concrete ties is no more difficult than wood ties.

In addition greater weight contributes to greater track stability and increased safety. Generally concrete ties are more expensive to buy than wood ties

However, because of the rigidity and larger dimensions of concrete ties they are generally placed at a larger spacing than wood ties. Furthermore concrete ties are more effective than wood ties in limiting gage widening and alignment changes. Therefore, maintenance requirements for concrete ties are less than those for wood tie track.

8.4.3 Procedure of production of prestressed concrete sleepers adopted in Sri Lanka Cement Corporation Stress bed :-

Initially the wires are laid along the ground and subsequently cut with a carborandum stone. As the length of the stress bed is 400 ft. the wires are initially laid on the ground to a length exceeding 400ft.

As each sleeper comprises of 18, 0.2 inch diameter wires and as every bed consists of twin moulds 36 wires are cut to the required length.

Then the wires are taken one by one and placed inside the moulds. Then the wires are attached to the detensioning and and the jack. The wires are first stretched to a straight position and then stressed. Each wire is to be stressed to 2.2 tons. The extension required to give this force is 28". However, to allow for slip at anchorages, and additional extension is give. The wires are attached by the Gifford Udull System.

Once all 36 (in twin moulds) wires have been stressed, cement grout is applied along the full length of the wires and then the moulds are given a coating of mould oil. The cement grout applied to the wires prevent oil from coming in contact with the wires.

Then the ends of each sleeper are blocked, so that they are separated fro m one another. Steel plates with rubber washers perform this duty of separation Holes for the stay bolts on the sleeper is provided by placing steel shafts of the appropriate diameter of the required positions. The steel moulds which are used are of double walled type and are very rigid. The mix used for concrete is 1:1½:3 (⅞"). The water : cement ratio which is allowed is 0.35. After placing the concrete in the moulds shutter vibrators are placed on the mould to ensure complete

compactness of the concrete.

One hour after concreting, steam is sent through the moulds. During this period of steam curing wet gunnies are placed on top of the moulds along the entire length of the bed to prevent the sleeper from drying out after about eight hours of continuous steam curing is done. A concrete test cube which is cast when the moulds are concreted and subject to similar steam curing is now sent to the laboratory to get the cube strength. If it has a cube strength in excess of 4000 lbs/in^2 the steam is shut off. At present the steam curing has been done away with and the sleepers are air cured, for about five to six days, thus saving the money spent on fuel.

After dentensioning the wires each sleeper is separated by flame cutting. Once this is done, the end plates are removed and the sleeper is lifted out of the mould.

9. OTHER ORGANISATIONS IN THE CONCRETE INDUSTRY

9.1 State Engineering Corporation (SEC) :- The State Engineering Corporation of Sri Lanka which was established in Sri Lanka in 1962 is today one of the largest organisations in the island engaged in civil construction works. This Corporation operates precast factories and a large panel component factory for pre-fabricated housing. Verendial poles, prestressed transmission poles, telegraph poles, fence posts, hume pipe, cylinder collars, prestressed purlins, spiral f loor slabs, cement bricks, wirecon tanks, are some of the concrete products manufactured in the above factories.

The pre-cast techniques used by the Corporation are the most advanced in Sri Lanka, and compare favourably with international standards. In most multi storey and factory buildings and housing schemes these pre-cast techniques have been reducing construction time by a very large margin. The State Engineering Corporationkeeps abreast of construction developments that have been taking place in other developing countries. The precast and prestressed techniques extensively developed by the State Engineering Corporation are being used to great advantage in the Industrial complexes constructed by the Corporation.

The construction department of this Corporation carries out all heavy constructional works of the State such as the execution of Industrial complexes, irrigation and hydro power schemes, multi storeyed secretarial buildings, Airports, Harbours, Housing Schemes etc.

Housing has always been one of the three primary needs of mankind. This Corporation has been able to considerably accelerate the nations development of housing schemes, in the production and use of precast wall panels, floor slabs and roof beams. Conspicuous by their absence in this type of construction are the tall concrete columns normally associated with such buildings. Here the specially reinforced wall components combine to provide the necessary structural strength for multi storeyed buildings.

8.1.1 Research & Development :- The Building Research Institute is an organ of the State Engineering Corporation. The research activities of this institute has been oriented broadly (a) to develop materials, designs and systems for housing for low and medium income groups in Sri Lanka & (b) to develop a n efficient building industry in Sri Lanka. The Institute also runs a testing service which undertakes continuous quality control and related studies (Like mix designs, feasibility studies).

Direct research conducted by the Institute, embraces the field of building materials construction.

The Institute has also sponsored research projects through the Civil Engineering and Architecture Departments of the University of Sri Lanka, Katubedda Campus.

Soil cement block, ferrocement corrugated roofing and flat sheets, brick production costs, are some studies in which firm results have been obtained. The concrete boat-building and Naval Architecture Department undertakes construction of ferrocement, and prestressed concrete sea-going coastal and inland navigation vessels .

Among the vessels already designed and built are 10.9 m and 8.5 m ferrocement fishing vessels, 35 tdw ferrocement sand barge, and 25 tdw concrete barge. A ferrocement has been developed in the laboratories of the Building Research Institute for the construction of these vessels. It is patented in Sri Lanka under the name "Wirecon".

FIGURE I - ANNEXE I