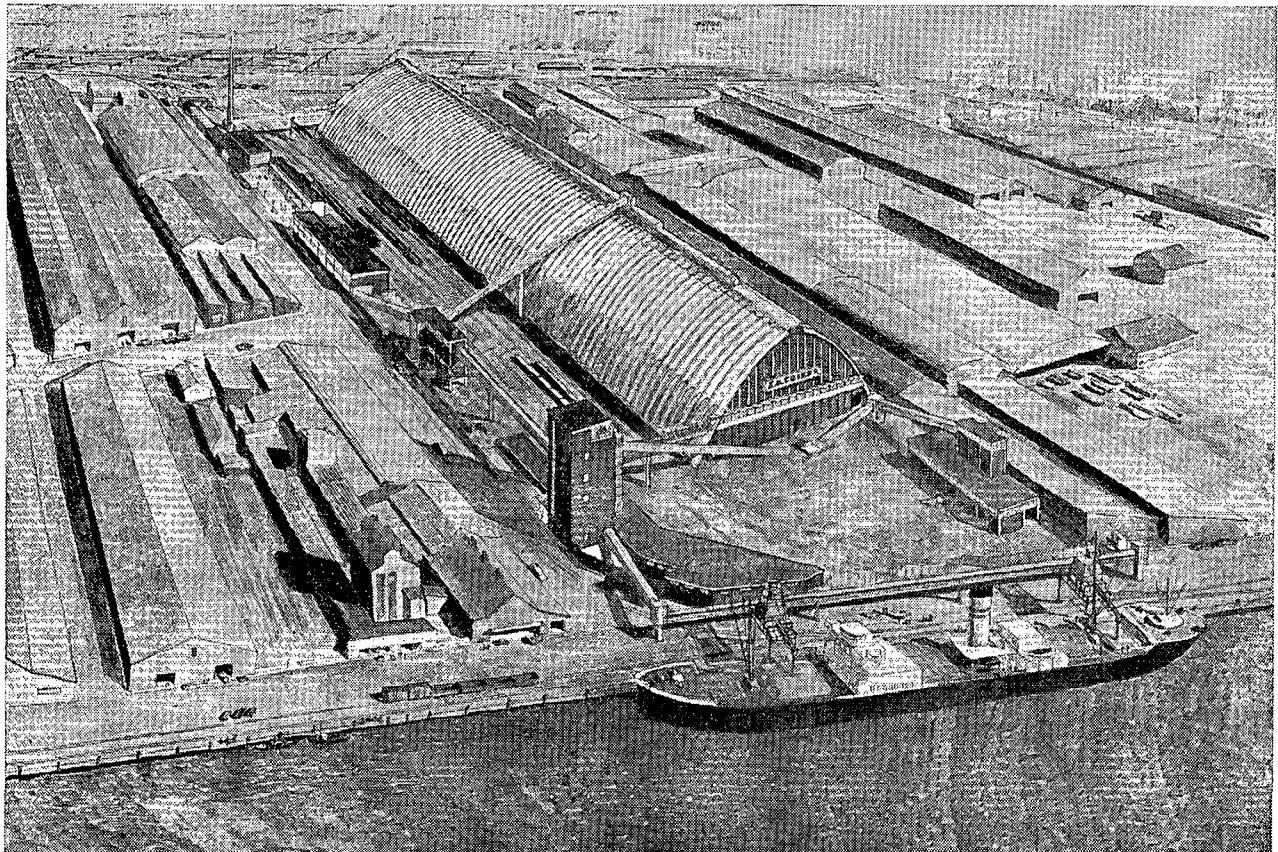


THE BULK SUGAR TERMINAL BEING CONSTRUCTED AT MAYDON WHARF, DURBAN

FOR

SOUTH AFRICAN SUGAR TERMINALS (PROPRIETARY) LIMITED

By J. de K. BOSCH.



PROPOSED INSTALLATION AS VIEWED FROM DURBAN BAY

The decision to proceed with the construction of this new R4 million Bulk Sugar Terminal marks an important advancement in the growth of the South African sugar industry and in particular emphasises the confidence of the industry in its future. It also underlines the industry's determination to increase materially the exports of South African sugar and compete in the world sugar markets on an equal footing with the other major sugar exporting countries.

In this paper, the author attempts to describe briefly the operation of this Bulk Sugar Terminal and the various technical considerations which influenced the design of the installation.

INTRODUCTION

The modern trend in shipping of raw materials is to make greater use of large bulk cargo carriers for all commodities which can be handled in bulk. The economies of this system are decidedly attractive and, as a result, facilities for the storage and handling of

various materials in bulk are fast becoming a feature of all the major ports in the world.

During the last decade, exporters and importers of sugar in many overseas countries have become increasingly aware of the substantial savings which accrue from the bulk handling of their commodity, especially so in the face of the keen competition which exists in the world sugar market between sugar producing countries. The result has been that bulk installations for the handling of sugar have been established in many of the ports of the world.

The South African sugar industry made a careful study of the economic advantages of these installations and, in order to compete for world markets on an equal footing, decided last year to proceed with the construction, in Durban, of a Bulk Sugar Terminal with a storage capacity of 200,000 short tons of raw sugar and equipped to load a ship at the rate of 500 tons per hour.

GENERAL DATA

Site: Opposite No. 2 Berth, Maydon Wharf, Durban, alongside Maydon and Leuchars Roads.

Area of Site: 9.7 acres.

Water Depth at No. 2 Berth: 32 ft. 6 ins. at L.W.O.S.T.

Sugar Silo

Structure: 80 reinforced concrete fluted shell arches.

Foundations:

(a) Superstructure founded on 110×36" diameter Hochstrasse-Weise piles taken down to bedrock at depths between 100' to 140'.

(b) Silo floor founded on *in situ* soil compacted by Vibro-flotation process to depth of 25' and 35' and employing 3210 compactions.

Storage capacity = 200,000 short tons

Area covered = 4 acres (approximately)

Floor area = 3½ acres (approximately)

Overall length = 816' 6"

Overall width = 207'

Maximum height = 120'

Span of arches = 203'

Rise of arches = 90' 6"

Conveyor Equipment

Maximum bulk intake capacity = 500 tons/hour

Maximum bulk outloading capacity = 500 tons/hour

Bagging Plant

Capacity = 100 tons/hour × 210 lb. bags.

Railway Sidings Staging

Normal operation, 36 "fulls" and 36 "empties"

Emergency operation, 60 "fulls" and 12 "empties".

Extra Facilities Provided

1. Bulk sugar intake from road motor vehicles.
2. Bulk sugar outloading facilities to railway and road vehicles.
3. Closed circuit television for central control of operation.
4. Public relations facilities provided for conducted tours by the public.
5. Administrative building.

Estimated total cost of Project including purchase of site = R3,963,108.

Consulting Engineers

Sir Eric Millbourn, C.M.G.

In association with:

Moreland Technical & Engineering Consultants, Ltd.

Consulting Architects

Franklin and Garland

Quantity Surveyors

J. Walters and Simpson

Main Civil Engineering Contractors

O. Grinaker (Pty.) Ltd.

Main Mechanical/Electrical Engineering Contractors

Spencer (Melksham) Ltd.

Foundation Contractors

(a) Piling — Christiani & Nielsen (Pty.) Ltd.

(b) Soil Consolidation — The Cementation Co. (Pty.) Ltd.

SELECTION OF SITE

Various sites along Maydon Wharf were investigated by the Consulting Engineers, with particular reference to size and shape of site, rail and road facilities, foundation conditions and ship berthing facilities, and finally a 9.7 acre site, opposite No. 2 berth Maydon Wharf and adjacent to the Congella railway marshalling yards, was recommended.

Negotiations for the purchase of a long term lease of this property, which is situated on the corner of Maydon and Leuchars roads, were successfully concluded during 1962 and an immediate start was made by the sellers on the demolition and re-erection elsewhere of their factory buildings and stores which were situated on the site at that time.

SCHEME OF OPERATION AND GENERAL LAYOUT OF THE TERMINAL

The general arrangement for the installation is as shown on the accompanying drawing and, referring thereto, the scheme for the operation of the terminal is briefly as follows:

1. Intake of Sugar transported by Rail

Export sugars will be railed from the mills to the Congella railway marshalling yards and from there the South African Railway's locomotives will shunt the full sugar trucks to the private staging roads at the terminal and also remove the emptied trucks.

Shunting tractors will be provided for the internal operation of the private siding and a specially designed railway traverser will convey each truck from the "fulls" staging roads to a point opposite the Wagon Tippler building and on its return trip take away an empty truck for placing in the "empty" staging roads.

The full truck will be drawn into the wagon tippler building where the tarpaulin cover will be stripped off and stored by semi-mechanical means. The truck will then be placed on the combined wagon tippler *cum* weighbridge and its contents discharged into the receiving hopper.

The empty truck will then be weighed and drawn out to a point beyond the traverser track ready for placing on the traverser and return to the "empty" staging roads.

From the tippler building the sugar will be conveyed on belt conveyors via junction tower "A" to the top of the silo where it will discharge onto a reversible conveyor which in turn can discharge at either end, as required, onto a shuttle conveyor which distributes the sugar via a sugar thrower to any point along the length of the silo.

2. Intake of Sugar Transported by Road

It is anticipated that several of the nearer mills will convey their sugar in bulk to the terminal by road transport and provision will be made at junction tower "A" for a weighbridge and a receiving hopper into which the road motor bulk transporters can tip their cargo of sugar.

A separate conveyor system will carry this sugar to the top of junction tower "A" from whence it will be conveyed and distributed within the silo as previously described.

3. Outloading of Sugar in bulk to Ships

A series of louvered hoppers, located centrally in the floor of the silo and extending along the greater part of its length, will permit the controlled extraction of sugar from any part of the silo by gravity flow.

These extract hoppers will discharge onto a reclaim conveyor in a tunnel running under the full length of the silo floor and terminating in a junction pit outside the eastern end of the silo. From the junction pit the sugar will be conveyed to the top of the Servo-Balans weigher tower and in passing down the tower it will be automatically weighed. The sugar will then be conveyed to the wharfside conveyor gantry which is designed to transfer the sugar simultaneously at any two points onto two travelling outloaders which run on rails along the wharf.

These travelling outloaders will be equipped with telescopic chutes which are fitted with sugar throwers for distributing the sugar evenly in the ship's hold

and the equipment is so designed as to permit the uninterrupted loading of a ship irrespective of weather conditions.

The plant is designed to extract sugar from the silo and load a ship at the rate of 500 tons per hour.

4. Outloading of Bagged Sugar

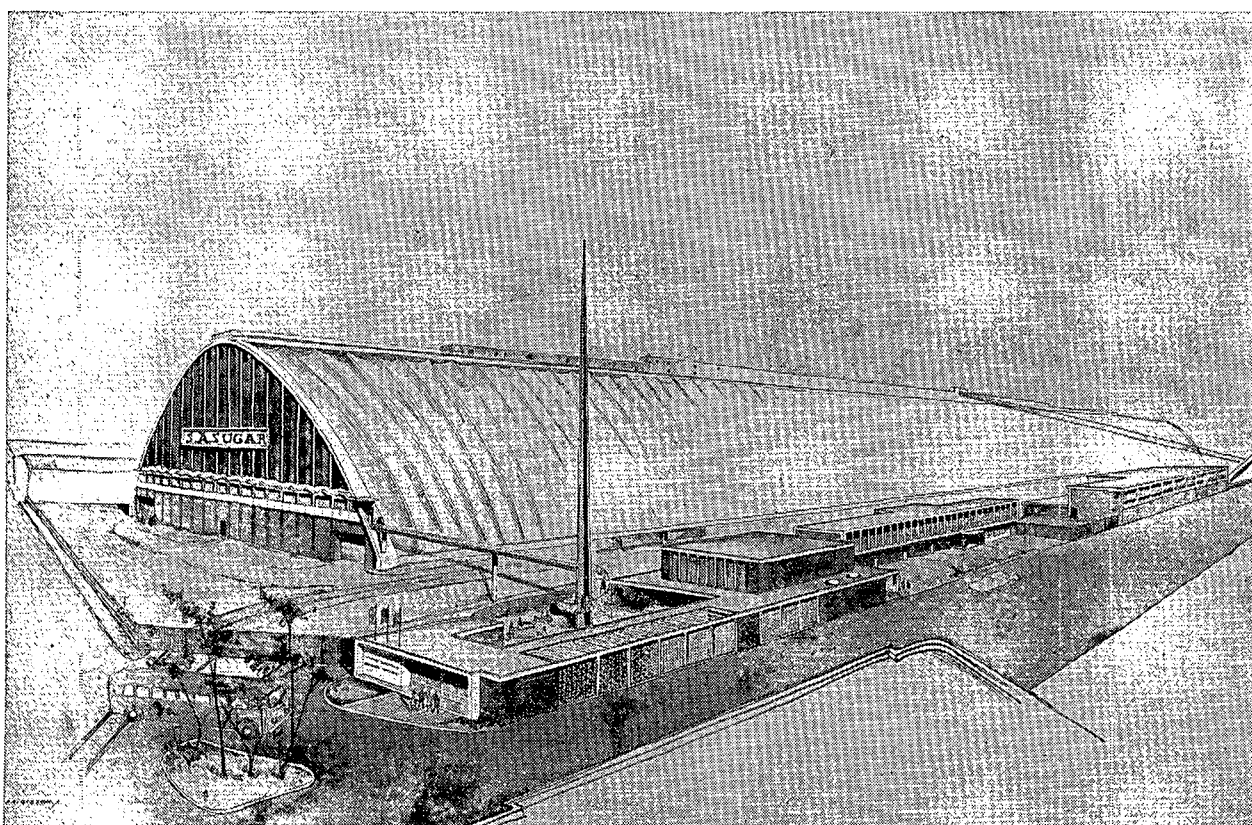
Certain countries to which sugar is exported are not yet equipped to receive sugar in bulk and provision has therefore been made in the design of the installation for bagging sugar for export to these markets.

When bagged sugar is required, the flow of sugar from the reclaim conveyor will be directed at the junction pit onto the conveyors which will take it via junction tower "C" to discharge into the hoppers provided in the building, which will house the bagging unit and sack store. This plant is designed to weigh and bag sugar at the rate of 100 tons per hour.

5. Outloading Sugar in bulk to Rail or Road vehicles

Sugar conveyed from the silo to the top of the Servo-Balans weigher tower can be diverted back to junction tower "A" which is fitted with hoppers designed to discharge into either railway trucks or road vehicles.

These road or rail vehicles will be weighed on the same weighbridge used by the road motor vehicles transporting sugar in bulk to the terminal as previously discussed.



VIEW OF PROPOSED TERMINAL FROM VICINITY MAYDON ROAD

6. Re-distribution of Sugar in the Silo

The previously mentioned conveyor, linking the Servo-Balans weigher tower with junction tower "A" can, if necessary, transfer the sugar to the conveyor between junction tower "A" and the silo thus permitting the re-distribution of sugar within the silo.

7. Control of Operations

A comprehensive system of electrical recording and control equipment together with telephonic inter-communication between all points of operation is incorporated in the designs and a master control panel will be installed in the control room in the Servo-Balans weigher tower.

This room will be the nerve centre for controlling the operation of the terminal and closed circuit television equipment will be provided to enable the controller to observe the activities within the silo and also inside the ship's holds.

MAIN DESIGN FEATURES

1. Architecture

This terminal will rank as one of the largest of its type in the world and the enormous silo structure, dominating the surrounding buildings at Maydon Wharf, will form one of the distinctive features of the skyline along Durban harbour.

It is envisaged that the installation will become one of the tourist attractions of the City of Durban and as such it will serve as a valuable advertisement to the progress of the South African sugar industry.

In view of these considerations, a great deal of thought has been given to the architectural appearance of the silo in considering the selection of a functional and economical engineering design embodying the best engineering principles to meet the design criteria imposed by site conditions and structural loadings, due to the contained sugar pile and other outside influences, such as wind, etc.

This principle has been applied equally to the design of the public relations building, administrative block and ancillary engineering structures. In addition, the layout provides for enclosing the site with decorative perimeter fences and walls and for the planting of gardens, trees, shrubs and lawns on vacant areas within the site.

2. Sugar Silo

(a) *General Description:* This enormous structure, which ranks possibly as the largest reinforced concrete silo of its type in the world, is designed to store 200,000 tons of sugar and measures 817 ft. long by 207 ft. wide, covering just under 4 acres, and rises to a height of 120 ft. at the top of the intake conveyor gantry.

The design of a structure of these proportions on a site strictly limited in size and subject to adverse foundation conditions, posed a complex engineering problem.

Designs of sugar silos, with capacities ranging up to 150,000 tons, which had been constructed elsewhere

in the world were examined and the capital and maintenance costs of various types of concrete and steel framed structures were analysed and compared. Careful consideration was given to the suitability of each type of structure to local climatic and foundation conditions.

These considerations led to the decision that the silo should be constructed in reinforced concrete and that its cross-sectional shape should conform as closely as practicable to the profile of the sugar pile.

In view of the limited area available for the silo, it was, however, clearly evident that irrespective of the cross-sectional shape, the sugar pile would have to be retained to a considerable height by the walls of the structure.

Upon consideration of all factors, it was decided that the structure should be a three pinned tied arch utilizing the self weight of the two concrete arch segments to counteract the internal pressure of the sugar pile, whilst the floor of the structure would be designed to provide the necessary tie force to the arch.

A series of arch profiles with various springing angles and rise-to-span ratios were analysed and estimates of construction cost, expressed in terms of the unit cost per ton of sugar stored, were prepared and plotted graphically.

These graphs provided criteria, which permitted the selection of the most economical arch profile and rise to span ratio for the widest structure which could be accommodated on the site.

Architectural features and construction techniques were considered and finally a profile approximating to an inverted catenary, as shown on the accompanying drawing, was selected.

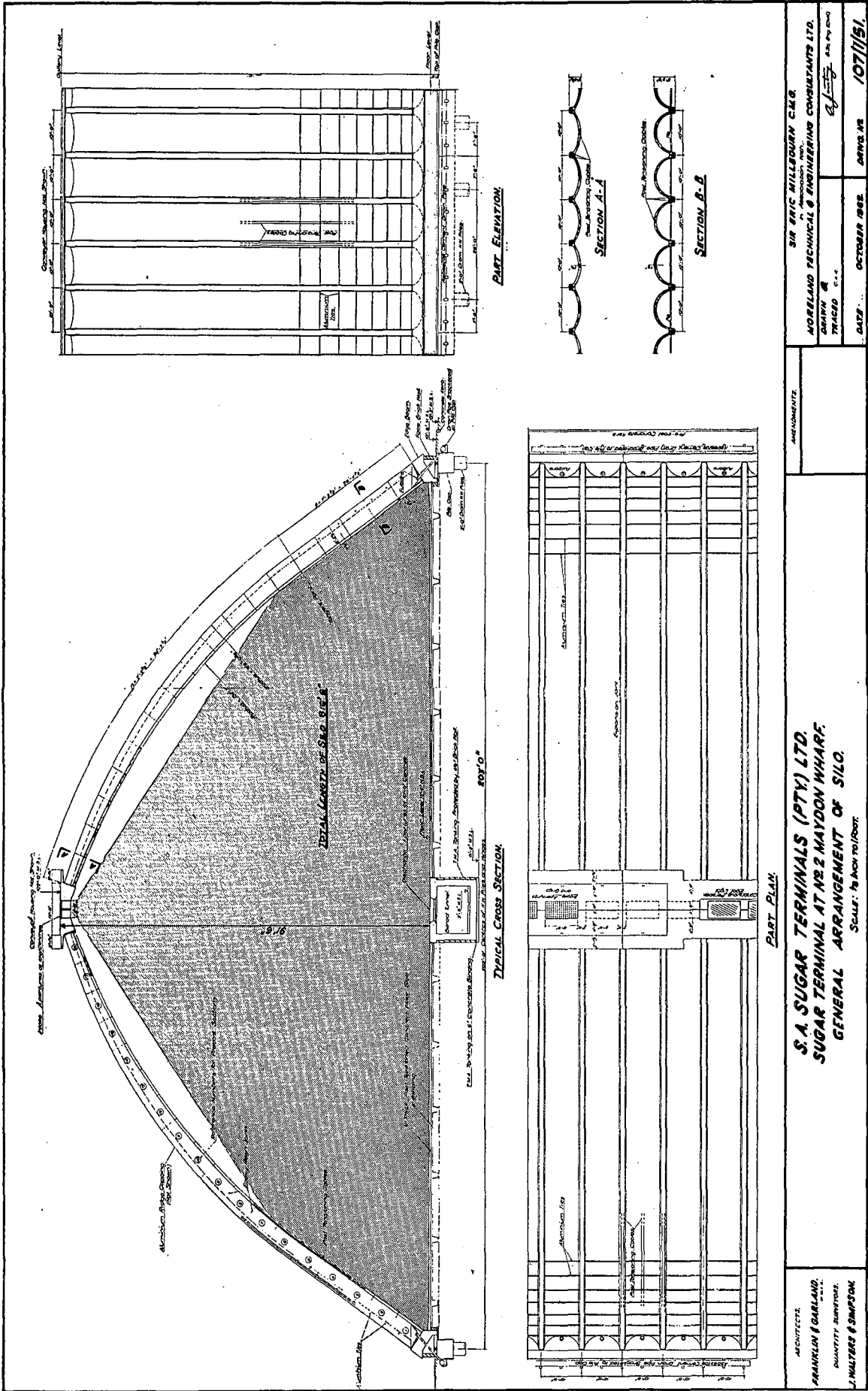
The silo will be comprised of 80 arch units, each 10 ft. wide constructed side by side and joined together in groups of four by the crown beam at the top and by edge beams at the springings. A central hinge will be provided within the crown beam and the edge beam will rest on roller bearings on top of the pile caps.

In preference to the usual rib and slab construction, it was decided to construct each arch in the form of a concave semi-circular shell, 10' wide and varying in depth from 5' 2½" at the springing to 2' 8½" at the crown.

The thickness of concrete in these semi-circular shells varies from 5" at the sides to 7½" in the centre and the edges are thickened out as shown on the accompanying drawing.

This concave cross-sectional shape provides the required rigidity to the primary arch and, in the lower regions where the sugar pile is retained, the secondary arching action is structurally of material benefit. The horizontal thrust in the secondary arches is resisted by means of aluminium tie rods.

Expansion joints are provided at 40 ft. intervals in the crown and edge beams, between which each arch



is structurally independent of its neighbour. Thus the whole superstructure is very effectively articulated both in cross-section and in its length. An aluminium ridge capping, incorporating a specially designed water seal, is fitted over the joints between the adjacent arches.

Each arch will be constructed by assembling, on a movable centering, 36 precast concrete shell segments weighing approximately 4 tons each. These units will be joined together with epoxy resin and subsequently post-tensioned by cables inserted in the ducts provided for this purpose and as shown on the drawing. The floor of the silo, which ties the arch, is constructed in the form of two post-tensioned 6" thick concrete slabs cast on either side of the extract tunnel and attached thereto by steel ties. The outer edges of the floor panels are attached to the edge beams of the arch by means of specially designed steel ties which can accommodate settlement of the silo floor adjacent to the edge beams.

Special precautionary measures have been incorporated in the design of the silo floor to ensure maximum frictional resistance to sliding between the sugar and the floor and between the floor and the earth. An effective barrier has been provided to check the rise of capillary water and water vapour through the floor into the sugar pile.

The extract tunnel has been designed to articulate at the expansion joints spaced at 40 ft. intervals in order to accommodate small differential settlements and specially designed waterproof joints have been provided to transfer the load from one 40 ft. section to the next.

The end walls to the silo have been designed in the form of a cellular concrete retaining wall 8' 3" wide by 22 ft. high and with an observation gallery situated at that level. Above this level, the end wall is continued to the full height in the form of a folded face brick panel between concrete columns.

Prior to the purchase of the site an extensive foundation investigation was carried out and it was found that the middle ecca shales, which form bedrock lay at a depth varying from 90 ft. on the inland boundary of the site down to 140 ft. at the harbour end. Above this bedrock is a deposit of cretaceous sandstone and clay varying in depth from 20 ft. to 45 ft., followed by a layer of sand of varying depth, which in turn is followed by a layer of thixotropic black clay approximately 10 ft. thick overlain by approximately 60 ft. of sand and silt.

It was decided that the arched superstructure of the silo and the end walls should be founded firmly on bedrock and 36 in. diameter Hochstrasse-Weise caisson type bored concrete piles were selected as being the most suitable type to ensure positive results at that great depth and under the particular site conditions described above.

It was furthermore decided that the floor of the silo together with the extract tunnel should be designed to accommodate a limited amount of settlement and in order to reduce the differential settlement and en-

sure uniform conditions, it was deemed necessary to consolidate and form a firmly consolidated raft of the weaker upper 25 ft. to 30 ft. layer of sandy soil by the vibro-flotation compaction process.

(b) *Special Investigations of Interest*

Foundations

It was evident that when settlement of the silo floor occurred, due to the 200,000 ton load of sugar upon it, a "downdrag force" or negative skin friction load would be transmitted to the piles supporting the superstructure.

No precise means of evaluating this force are presently known and, in consultation with foundation experts, new methods had to be developed to evaluate these forces and deal with the problem.

This was one of the reasons which influenced the selection of a caisson type pile of adequate diameter and strength which could be founded firmly on bedrock.

It is proposed to install measuring devices in certain of these piles to measure the magnitude of this downdrag force when the sugar load is eventually applied and correlate this data with the rational design approach which was finally developed and adopted for the calculation of the downdrag force.

Wind Load

The silo structure exposes a face approximately 2 acres in extent to the wind and in view of its height and relatively thin concrete shell construction it was deemed advisable to experimentally check the maximum wind load distribution and intensities over the structure especially the negative wind loading on the leeward side which would, when added to the outward sugar pressure load, create the worst circumstance of loading on the arches.

A secondary consideration which required further experimental investigation was the possibility of dynamic resonance between the natural frequency of this structure and the frequency of oscillation of the wind load.

Wind tunnel experiments on a scale model of the silo and the surrounding structures at Maydon Wharf, were therefore carried out by the Council for Scientific and Industrial Research at their laboratories in Pretoria to provide the data required for the safe design of the structure.

Sugar Pressures

A perspex scale model of a section of the silo was constructed by the Civil Engineering Department of the University of Natal and a series of experiments were undertaken to study the loads transmitted to the structure by the sugar pile under the various conditions, which could be encountered in practice.

These experiments, together with several allied experimental investigations relating to other respects of the structural design, were of great value in the detailed design.

3. Private Railway Siding

The terminal siding will be shunted by the South African Railways direct from the adjacent Congella marshalling yards and internal staging of trucks will be carried out by shunting tractors belonging to the company.

Rail access to the siding is provided by means of two service lines laid directly from the Congella marshalling yard across Maydon Road and an alternative access route has been provided by a further two service lines to Congella via Maydon Wharf.

Six railway roads of equal capacity provide normal staging for 36 "Fulls" and 36 "Empties" and in emergencies the siding could accommodate 60 "Fulls" without unduly reducing the efficiency of offloading operations.

The whole of the siding area will be bitumen paved flush to rail level to facilitate the operations of the shunting tractor.

4. Railway Wagon Traverser

In order to provide adequate staging for the large volume of rail traffic anticipated within the small area available, a railway wagon traverser had to be incorporated into the siding layout.

Neither the usual open pit type wagon traverser nor the normal over rail type wagon traverser was deemed entirely suitable for various reasons and a special design for a unique type of wagon traverser was prepared specifically for this installation.

The electrical driving mechanism and the guide rails for the traverser will be housed underground in covered reinforced concrete troughs and the supporting steel girders for the traverser bed will pass through slots in the concrete deck thereby cutting through the siding rails. By this means a difference of only 3½" rise from siding rail level to rail level on the wagon traverser deck is achieved.

A covered inspection pit is provided for maintenance and repair to the traverser.

5. Wagon Tippler Building

This brick and concrete building will house an electrically operated "charger" for the moving of trucks, mechanical tarpaulin removal facilities and tarpaulin store, a combined side discharge wagon tippler and weighbridge, a sugar sampler and receiving hopper with 6" mesh grid.

A paved yard with loading platform will be provided at the rear of this building for vehicles transporting tarpaulins.

6. Conveyors and Conveyor Gantries

All conveyors will be of the belt type with a capacity rating of 500 tons/hour.

Conveyor gantries will be steel framed and aluminium clad supported by reinforced concrete columns.

7. Junction Tower "A"

A brick and concrete structure provides a junction for the three conveyors shown on the layout drawing.

A combined railway siding line and motor vehicle roadway pass through under this building which will also contain a combined road and rail vehicle weighbridge, overhead hoppers for outloading of sugar in bulk to road and rail vehicles and underground intake hoppers for receiving sugar in bulk from road vehicles

8. Wharfside Installations

Along Maydon Wharf at berth No. 2 two electrically powered travelling ship loaders will be erected.

These outloaders which will travel on a pair of rails laid parallel to the wharfside will be able to receive sugar at any point along the berth, as required, from the 500 ton/hour conveyor in the gantry to be constructed alongside.

The outloaders will have retractable telescopic chutes fitted with sugar throwers and these can be inserted to the required depth in the ship's holds and evenly distribute sugar therein.

As previously mentioned, remote controlled closed circuit television cameras will be fitted to these telescopic booms.

These structures are designed so as not to interfere with the normal railway operations along Maydon Wharf and the outloader rails will be supported on beams resting on piles to limit the loading on the sheetpile retaining walls forming the Wharf.

9. Servo-Balans Weigher Tower

This brick and concrete building will provide a junction between the three conveyors shown on the layout drawing and will also contain the 500 ton/hour Servo-Balans automatic weighing equipment for the weighing of sugar outloaded to ships.

This building will form the nerve centre for the operation of the terminal and the main control panel fitted with television viewing screen and miscellaneous recording equipment will be situated therein.

A passenger lift will be provided and an observation platform giving an excellent view of the whole site will be constructed on the top floor of the building.

10. Bagging Unit and Sack Store

This brick and concrete building will house the sack store and the 200 ton sugar storage hoppers which will discharge sugar to four combined sack filling and weighing machines with a combined capacity for loading 210 lb. bags at the rate of 100 tons/hour.

Four sack stitching machines fitted with slat conveyors will also be provided.

11. Garage, Workshops and Restrooms

A brick building will be constructed around the Servo-Balans weigher tower to provide garage and workshop facilities for all mobile equipment and vehicles to be used in the operation of the terminal.

Separate ablution and restroom facilities will be provided in this building for all artisans and labourers employed in the operation of the terminal.

12. Administration Building

This brick building which will house the manager of the company together with his clerical staff has been designed along modern lines which harmonize architecturally with the silo structure.

The building will be fully air-conditioned and parking will be provided under the building for staff cars whilst a paved entrance driveway with open air parking for visitors' vehicles will be provided in front of the building, off Leuchars Road.

A laboratory for testing samples of sugars consigned to the terminal from the various mills will be provided within this building.

Provision has been made in the design of the building for possible future extension by the addition of another floor above.

13. Public Relations Building

A separate building of modern design and architecturally similar to the administration building adjacent thereto will be provided specifically for the use of the Public Relations department of the South African sugar industry.

As previously mentioned, it is envisaged that the terminal will become a major tourist attraction to the City of Durban and this building has been designed primarily to provide the necessary facilities for visitors on conducted tours of the installation.

The design incorporates a reception area, an open air tea garden, a covered verandah and a cinema *cum* lecture or conference hall, tea kitchen and ablution blocks.

A feature of this building will be the floodlit 120ft. high fibreglass spire which will have a concrete spiral stairway rising round its base and leading on to a prestressed concrete pedestrian bridge spanning railway sidings and linking the Public Relations building to the observation gallery to be constructed in the end wall of the silo.

14. Garden Layout

The entire site will be enclosed by a wire mesh security fence which will be made attractive by planting flowering creepers and shrubs alongside it whilst in certain sections of the perimeter decorative brick and flower box walls will be built.

Bitumen surfaced internal service roads and bitumen paved areas will be provided where vehicles are required to operate and all remaining unused areas will be grassed for lawns and planted with shrubs and trees to enhance the general appearance of the site.

15. Conducted Tours by Visitors

Facilities for pedestrians on conducted tours of the terminal have been provided throughout the installation, along a planned route and special atten-

tion has been paid to the provision of safe pathways, pedestrian bridges over railway lines and observation galleries with safety rails in the plant installations.

CONCLUSION

On a project of this magnitude, it is likely that many unforeseen problems will be encountered during the course of construction and these will have to be tackled and solved as they arise.

The deep excavations for the piles have provided some interesting side-lights on the geological history of Durban bay and many remarkable fossils have been retrieved from the pre-historic cretaceous complex which has been penetrated by the piling equipment after lying undisturbed for many millions of years.

At the date of writing this article all contracts for the construction of the terminal have been placed and work on the foundations has now been in progress for several months.

The construction programme for this project has been so scheduled as to ensure that the terminal will have been completed and commissioned by the 1st May, 1965 in time for the commencement of the 1965 South African sugar milling season.

Mr. Perks asked if the piles were vertical or at an angle to take any wind strain.

Mr. Bosch replied that the piles were vertical and the hinges are on roller bearings, specially cast. The positioning of the bearings was calculated so that the stress component was a direct thrust on the piles. This was a reason why the arch was not tied between the pile caps but the tying was done above.

Mr. Chiazzari asked what precautions were taken for air-conditioning, and other factors which might affect the sugar.

Mr. Bosch said the S.M.R.I. was examining the possible effect of such factors but in Barbados where climatic conditions were similar to those of Durban and also in Australia, it was found unnecessary to use air-conditioning. It was felt that the sugar should not stay in one high heap very long and that was why the stirrer and conveyor were being provided. Experiments were to be carried out to determine a definite drill for the operation of the stirrer. Many safety features had to be adhered to, for instance the silo could not be loaded higher than a certain point and very strict control would be laid down. The silo was designed for ordinary export sugar and sugars with a coating of molasses might cause difficulty.

Mr. Rault said that considerable deterioration of export sugar had occurred during storage for some time near the docks during the hot and humid summer months.

Mr. Bosch said special precautions were being taken to guard against moisture and epoxy sealing was used

in the floor structure to prevent capillary rise of water or vapour through the sugar pile. Concrete was chosen also to prevent leakage of water as had been experienced elsewhere and each arch was composed of 36 shells and in the joints between these epoxy resins were used. Sugar could be expected to harden but experience elsewhere showed that it would only form a crust on the outside, so it was felt expensive air-conditioning was not necessary.

Mr. Lenferna asked why the floor of the silo was not funnel-shaped.

Mr. Bosch replied that to provide an effective hopper the angle would have to be 35 deg. which would mean the bottom would be 50 to 60 feet below sea level and it would be enormously expensive to provide for water pressure from the outside.

Mr. Buck said that at similar levels flood water stood three feet deep.

Mr. Bosch said the average ground level in the vicinity of the terminal was about ten feet above mean sea level and the floor of the silo would be a further two feet six inches above average ground level. The extracting tunnel was below the natural water table but although it had to be articulated every forty feet it was coated on the outside with Trinidad and mastic asphalt.

Mr. F. Kramer asked if the South African Railways had been approached to supply a better type of truck for transporting sugar.

Mr. Bosch replied that such an approach had been made and different types of trucks had been examined. A difficulty was, if special trucks were used, they would have to return to the factories empty and the Railways would probably require the Industry to supply them.

Dr. Douwes Dekker said that the various grades of sugar had different degrees of hygroscopicity and he knew that the question of dividing walls to prevent migration of moisture from one grade to another had been discussed. He asked if anything had been decided in this connection.

Mr. Bosch replied that the whole question was still in the air but he favoured the use of plastic sheets to separate the various grades rather than movable dividing walls.

Mr. J. B. Alexander asked what arrangements were contemplated to sample incoming and outgoing sugar.

Mr. Bosch replied that a laboratory was being provided and samplers were to be provided at the tippler and in the Servo Balans tower.

Mr. D. Renton asked how the flow of outgoing sugar was to be controlled.

Mr. Bosch said that a series of louvred hoppers was to be installed as mentioned in the paper. Such a device had been proved by Tate & Lyle to be satisfactory.