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

D03778

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.129/L
26 June 1972

ENGLISH

Interregional Seminar on the Manufacture and Utilization of Portland Cement

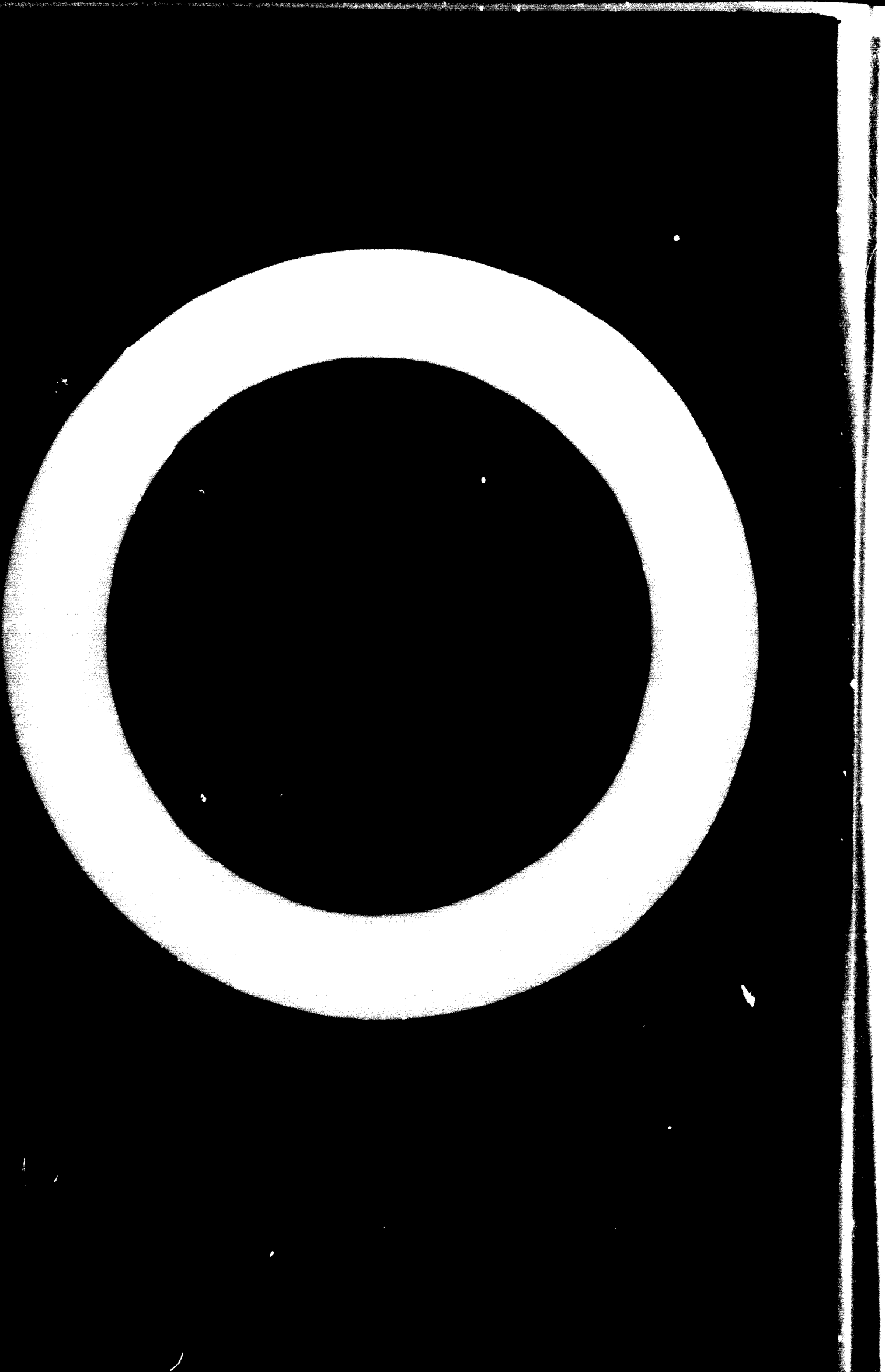
7 - 20 May 1972
Holte, Denmark

CONCRETE INDUSTRIES, BUILDING BLOCKS, BUILDING SYSTEMS, PIPES, MISCELLANEOUS PRODUCTS [1]

by

Jørgen Kaplaang,
Managing Director
A/S Nymølle Betonvarefabrik
Hedehusene, Denmark

[1] The views and opinions 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.



Introduction.

The theme for this lecture is very extensive and contains matters for hours of lecture. I'll in the following in a condensed form give you a summary over the Danish concrete industry of today, as I shall pass lightly over certain parts of it, which parts will be further discussed in other lectures or at factory-visits, and then concentrate on the parts of the industry which I myself have or have had close relation to.

The historical development of the concrete-industry.

The first Danish factory manufacturing Portland-cement was, as you no doubt learned from another lecture, established in Ringsted in 1867 and 17 years later, in 1884 the first Danish concrete-factory was established in Fåborg in Funen. The first concrete-goods produced were concrete-bricks, concrete-roofing-tiles and various garden-arts. The production was to a high degree handicraft and it is only for the latest decennia one can speak of proper industrial operation in the case of concrete-goods.
In the year 1917 some of the concrete-manufacturers were united in a branch-society - Danish Concrete-Industry, or abbreviated DBI - and this society gradually gathered the major part of the manufacturers of the country, which means that it today on a rough estimate covers about 90% of the Danish concrete-production with a number of members of app. 360.
When I in this connexion say concrete-goods, this concept first of all covers concrete-products without iron-reinforcement. Of recent years a good part of the DBI-members also manufactures reinforced building-units of various types.

As an illustration of the development of the concrete-industry fig. no. 1 shows the cement-consumption at the member-factories during the years 1947 - 1971. You'll see that the increase first really speeds up from 1958 and is having a temporary climax in 1969 with a consumption of cement of 398.000 tons.
Fig. no. 2 shows the trade of concrete-products dispersed in percentage on the various main-groups of goods. The disperse is made over the turnover, and it must be remembered that the price of the finished product - figured out per ton cement consumed - varies very much from group to group.
Later on in the lecture I'll return to the group of non-reinforced concrete-products, but first I'll tell a little about the reinforced concrete building-units.

Concrete building-units.

It is only after the end of the Second World War in 1945 that pre-fabricated concrete building-units were gaining access on a small scale in Denmark. The first proper concrete element-factory was built for money lent from the American Marshall-programme. In this factory units were manufactured for a great housing-project executed as a tower block building at Bellahøj in Copenhagen.
Since this first start there's developed a great and extensive industry for pre-fabricated concrete units for a lot of various purposes. In the beginning the new industries mostly produced units designed by architects and engineers for particular projects. But with reference to the purpose of achieving a more rational production which could make prices decrease the individual manufacturer soon was working for an introduction of his own standard-units and his own building-systems, of which you at your factory-visits will see some systems designed especially for house-building.

Prestressed concrete units.

As the concrete-technology was developing and it became possible by the correct proportioning and vibration-technique to produce concrete of a high strength, the desire for utilization of this greater strength came up. The possibility came from abroad - f. inst. the USA and France - in the form of the new technique - prestressed concrete. The steel used in ordinary reinforced concrete has, because of its rather great deformation and rather low strength, not been able to utilize the greater strength obtained in the concrete. By the introduction of a special cold-drawn steel with more than four times as high breaking-strength it was practicable to utilize the high-quality concrete.

In ordinary reinforced concrete you compensate for the rather inferior tensile strength of the concrete by placing steel-reinforcement in areas where tensile strength occurs. Hereby you obtain that the steel takes over the tension, but you do not avoid cracks in the construction with implying deformations. One might on the contrary say, that it is a condition for the function of the reinforcement that the concrete cracks.

In prestressed concrete you on the contrary by the aid of the prestressing have caused compressive stress in the concrete. When a prestressed concrete-beam later on is loaded, this compressive stress must be overcome before the concrete cracks. Normally this phase will not occur until an overload of 20 - 30%. Even if such overload should occur it won't usually mean anything to the quality of the construction as the cracks will close up completely for the reason of the prestressing when the overload ceases again.

Steel-strands of a breaking-strength of 180 kilograms per square-millimetre and concrete of a cube-strength of app. 630 kilograms per square-centimetre are used by producing prestressed concrete. In the factory the strands are spanned

in long prestressing spanbeds of a length of 100 metres. Thereafter the concrete is cast in the mould round the strands. A strand of the length of 100 metres is by the prestressing stretched app. 75 centimetres to obtain the prestressing wanted. When the concrete after some curing-time has attained sufficient strength, the strands are slackened but yet they are prevented from contraction by the concrete and now the prestressing power is conveyed as compression in the concrete by adhesion between concrete and steel. It is rather heavy energy which in that way is grafted in the concrete. In a plain roof-beam with a span of 20 metres is f. inst. a prestressing strength of 150 tons. To sustain such great energy during the prestressing of the reinforcement steel the factory must have special-built, powerful spanbeds. The principles of the elaboration are shown on fig. no. 3.

The prestressing-system described has in the course of time developed thus we today manufacture a great number of prestressed concrete standard-products all distinguished by a wide span and a small deflection with very slight concrete dimensioning and a hereby low net weight.

Beside roof-beams, beams for both house- and bridge-building are manufactured. Also slabs as double-T-slabs and hollow slabs are produced in large quantities according to the standard-systems of the contractors.

Prefabricated building-systems are worked out with application of the prestressed units for both one- and more-storeyed buildings. Fig. no. 4 shows some examples of the application of the prestressed constructions. I shall at last show you some slides with examples.

When the prestressing-technique is applied the systems usually are worked out with bearing columns, beams and slabs. As mentioned there are other building-systems with units made with non-prestressed reinforcement. In such cases wall-units are often used as bearing. These systems will be shown during your factory-visits. I therefore won't go further into that area.

In the following I'll mention various other products made of prefabricated concrete in Denmark. A rather great commodity is piles made of both common reinforced and of prestressed concrete. Also poles for street-lighting as well as for bearing of electric power cables at the railways are to some extent made of prestressed concrete. Speaking of railway traffic we must not forget, that a factory in Denmark has specialized in manufacturing concrete sleepers.

The quantity of the element-industries.

Similar to the branch-society I mentioned before - DBI - the most important factories for concrete-units have formed a branch-society, named the Danish Concrete Element Society. These factories solely manufacture reinforced concrete units.

Both societies cover each in their area app. 90% of the Danish annual turnover and on fig. no. 5 the development of the annual turnover in the DCES during the last 10 years is shown in tons. The diagram shows a gradually increasing development - except for the last two years where the Danish government has carried out a cutting-down policy which has hit the building-branch very hard. The same decline in development was seen on the diagram with the cement-consumption in DBI.

Before we leave the unit-production we on fig. no. 6 shall see how the output in 1971 has dispersed in various categories of units. There isn't here distinguished between prestressed and non-prestressed constructions. It's shown that more than one third of the total amount of concrete has been put out to hollow slabs, which in return are cheap per ton. Besides the diagram shows the great variations in price per ton and per square metre for the various groups of elements.

The total concrete industry.

The members of the two societies in 1971 have - converted into money - traded that at fig. no. 7 shown amount. While both societies each claim to cover app. 90% of the total trade in their area, we can figure out the app. total trade in Denmark in the concrete industry. The last column shows the figures in US$.

Fig. no 8 shows the number of members in the two societies, the average price per ton finished goods in D. Cr. and the average trade per factory. A remarkable difference in structure is apparent.

The concrete-unit factories, which are rather young, have immediately started as proper industry, and of the same time the units produced have very high manufacturing-costs including the expensive reinforcement. Whereas the majority of the DBI-members have old establishments started on a pure handicraft stage, and where proper industrializing has occured only of recent years.

Non-reinforced concrete products.

I shall now pass on to telling you further about the plain concrete-goods which are distinguished in three main groups, namely pipes and wells etc., flags and curbings etc. and finally building-blocks in various designs. On fig. no. 2 we previously have seen the app. dispersion in percentage of the trade between these different groups.

Concrete pipes.

Since app. 1920 there have existed standard-specifications for concrete pipes in Denmark. These specifications have included both dimensions and design, strength and test-methods etc. From time to time, however, the work with specifications couldn't keep up with development when new and

better designs of pipes were put into the market by a collaboration between the pipe manufacturers and the manufacturers of the machines on which the pipes are produced.

The majority of the pipes applied in Denmark today are assembled by the aid of tightening-rings made of rubber, which secure complete tightening of the joints without the former casting with asphalt or concrete.

Pipe-diameters are ranging from 10 centimetres (length 80 centimetres) to the greatest pipes so far produced with a diameter of 180 centimetres and a length of 150 centimetres. Such pipes weighs app. 6 tons.

In connexion with the pipes are produced various accessories as bendings and fork-pipes. Also road-wells and other wells with inward diameters of 100 and 125 centimetres are produced in plain concrete.

In 1942 new, revised specifications for concrete were published and at the same time an institution, named the Concrete Control Committee was established.

It wasn't new that the specifications from 1942 included quality claims to the concrete-goods, whereas it was completely new that the new-established Concrete Control Comittee took over to control that the finished goods met the claims. Before that the concrete-marufacturers themselves in various ways tried to control the goods, but this control solely was based on a control worked out by the individual manufacturer himself, and the various systems never gained real credence among the customers.

The Concrete Control Committee was established as a collaboration.on between the suppliers and the customers. In the committee both representatives from DTI and from the municipal technical authorities have seat. This new control-form gained the credence from the customers pretty fast - and not less important - it caused a greatly improved quality of the finished goods.

Just now in 1972 the specifications for concrete-products

again are being revised, and the Concrete Control Committee is reviding its control-system too, seeing that they are based on the newest of statistical quality-control.
The claims for strength and watertightness of the pipes are of late years greatly increased. The pipes are laid still deeper into the earth and must therefore have a greater strength than earlier, and the claim for watertightness is partly due to the desire of avoiding pollution of the ground water and partly to secure that a planned-tight pipeline won't really act as a drainline for the ground water which would cause overload of the expensive purifying plants which are to secure, that our lakes, streams and surrounding waters are not polluted.

Flags, curbings etc.

The group flags, curbings etc. has in the recent ten years shown an essentially greater increase than what was present for the pipe-group. This heavy increase must be imputed to several factors:

> Partly the increasing prosperity of the late years has caused that private house-owners have spent still more money on flag-covering in their gardens, and partly the Danish architects to a higher degree than earlier at the planning of new, great house-building have worked for creating architecturally and aesthetically attractive environments for the house-blocks. Add to this that the growing car-traffic has increased road-building and with that the application of curbings and pavement-flags.

For covering pavements we in Denmark during a lot of years have applied a flag of the size 62.5 x 80 centimetres whereas the garden-flag most used 5 or 6 years ago was 50 x 50 centimetres, gradually supplemented with a flag of 25 x 50 centimetres.

In the building-sector it, however, is still more common to plan over a module of 30 centimetres as recommended by the Danish Ministry of Housing which has made the size 15 x 30 centimetres a highly preferred size. Later on there has been worked further on this system, and sizes like 30 x 30, 30 x 60 and 45 x 90 centimetres are yet used to a great extent - often intercombined - which give the possibility of making a lively and varied flag-covering.

The flags are made with a dense and smooth surface from some manufacturers whereas others manufacture them with a more open and coarse surface. In excess of the normal, grey flags both black and white flags are produced, and in some factories coloured flags too. Lately also flags with a surface of free-laid pebbles are gaining access in Denmark. By the aid of some chemicals the curing of the outer 5 millimetres of the cement-paste is retarded. When this paste the day after the casting is washed away, the pebbles mixed into the concrete will appear. By mixing various types of pebbles a lot of fine surfaces can be created.

Building-blocks.

The third main group of the plain concrete-goods is building-blocks of which I'd especially mention foundation-blocks. They are meant for building foundations and basement-walls in smaller houses. These blocks are made with vertical ducts, which on the site are cast with concrete, thus the blocks are making coherent concrete-walls.

An example of a concrete factory.

I won't here spend more time describing the long rank of various concrete-products produced for the Danish market.

We'll instead have a look at an example of how a concrete-factory might be constructed.

Fig. no. 9 shows the principles in a modern factory. At the left we have the silo-plant for aggregates, gravel and pebbles in various grades. These silos are here placed under-ground, but also elevated-silos placed in a tower-building are to be seen.
From the silos the aggregates are conveyed in precise apportions to the concrete-mixer where they together with just as precise appertions of cement and water are mixed to just that homogeneous and correct composed concrete which is necessary to produce concrete-goods of high quality. The batching and mixing processes are normally automatically controlled.
From the mixer the concrete is brought to the production-machines by means of an electrically driven overhead travelling bucket. On the figure we'll see various machines placed under the conveyor-plant. Here is a machine for building-blocks, a large vibration-table for rings for wells and great pipes, a smaller machine for flags and another machine for pipes. This factory is, as you'll see, equipped for producing many various products, and this is presumably the most common in Denmark even if there's a few proper factories specializing in the production of flags or building-blocks.
The production-hall ought to have a width of at least 20 metres to secure efficient curing-place alongside of the walls of the hall. A width of the hall of 30 metres will mostly be right. With halls so wide it is economically most defencible to put one or two rows of columns in the central-line of the hall. These columns then can be used for suspension of the conveyor-plant and prospective overhead travelling cranes.
The length of the production-hall isn't stated here, but it is important that it won't be any longer than what enables the overhead travelling bucket to reach the production-spot farthest out and to return in time conveying the next mixture finished for transportation. In the

system here shown the price of belt-length will be 50 - 60 metres.

The production-machines.

The working out of the single production-machine I won't go further into but only say, that all of them are based on that, that the concrete by a combination of vibration and pressure is compacted so hard that it is possible to move the product immediately from the mould and bring it to the curing-place.
There are many firms - both in Denmark and abroad - manufacturing concrete-machines in various elaborations. It's mostly pipe-machines which are manufactured in Denmark, and I have brought leaflets from two firms which - besides providing the Danish market with machines - are exporting machines to a long range of other countries. At your visit in Brønderslev you'll see still another factory producing machines for at great many countries all over the world.

Concerning machines for flags, curbings and building-blocks Western Germany presumably is where you find the largest selection of advanced, automatic machines of great capacity. I'll later on show you some fotos of such machines.

The economy of the production.

You could ask, "How much does a concrete-factory cost"? But I really am unable to answer that question. It depends on so many things, f. inst. how far an assortment of concrete-goods the factory must be able to manufacture, and to be more exact - which. Besides it is vital in selecting machines how great you want your production to be per day and which degree of automation the machinery must have.

Instead we could look at the dispersion of the price in aggregates, wages and other expenses. This too depends - of course - to a certain extent on the automation of the particular factory. Therefore you must only take the figures as an example. On fig. no. 46 you see the dispersion

per cent of the price.

Marketing and distribution.

Since there in the manufacturing is applied Portland-cement of the rapid hardening quality you can already efter app. 18 hours of indoor curing transfer the articlec to outdoor-stock. After a certain hardening-period depending on the time of the year the articles are ready for distribution.
It is great quantities of concrete the factories are keeping in stock. Partly because most of the goods are standard-goods which the costumers expect they can fetch without reservation and partly because most of the factories are producing steady all the year around, though the delivery is conducted more seasonal.
Even if concrete-products - both reinforced building-units and plain concrete-goods - traditionally hold a strong position on the Danish market compared with other products there must, however, still be made an energetic sales-work. Against the finished building-systems of concrete-units stand partly in-situ-cast concrete-constructions and partly constructions of both steel and wood. The latter materials first of all compete in the field of one-storeyed industry-halls. Concrete-wallunits are today up against a long range of light wallunits built in wood and asbestos-cement, aluminium or plastic.
Concerning concrete-pipes they are meeting an increasing competition from plastic-pipes. This competition though manifests itself mostly in the field of pipes of the smaller dimensions.
The great, non-reinforced, concrete-pipes have, as the claims to the strength of the pipes increase, met a strong competition from centrifugal-cast, reinforced concrete-pipes which, because of their thin walls, can be produced

in nature for [illegible] To neutralize this [illegible] concrete-factories in Denmark [illegible] have developed a method of reinforcing their concrete-pipes to meet the large loads which the still deeper-placed lines are exposed to.

Conclusion.

Let me end this lecture by saying that prefabricated concrete-products - the great reinforced units as well as the smaller plain products - have found their position on the Danish market to stay. It will, however, be necessary to prove equal to the development and to renew the products when new materials appear, like f. inst. Epoxy used as cementing material or artificial-fibres mixed in the concrete as reinforcement.
At last I'll show you some slides which can illustrate some of the things mentioned.

FIG 1

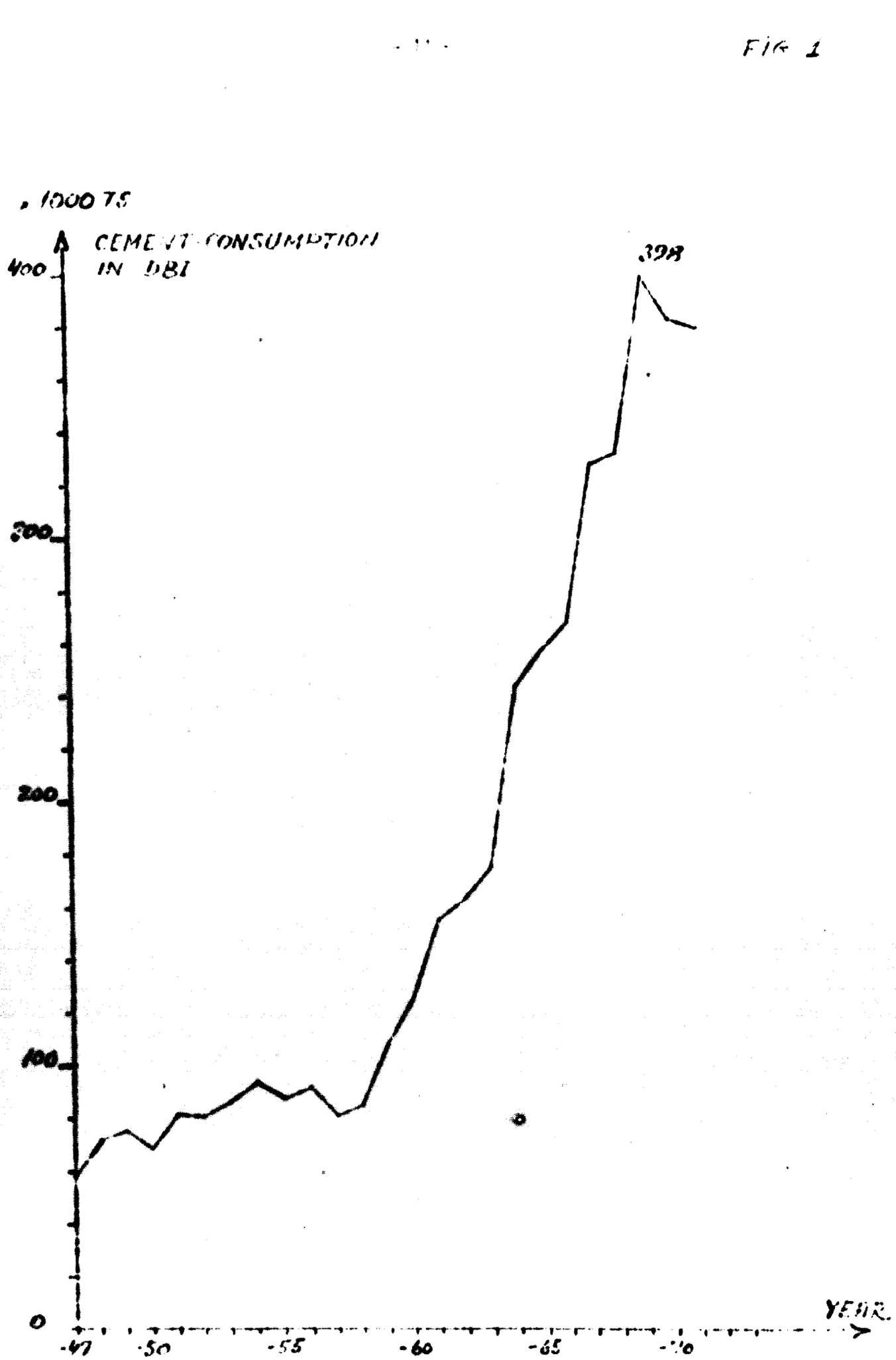
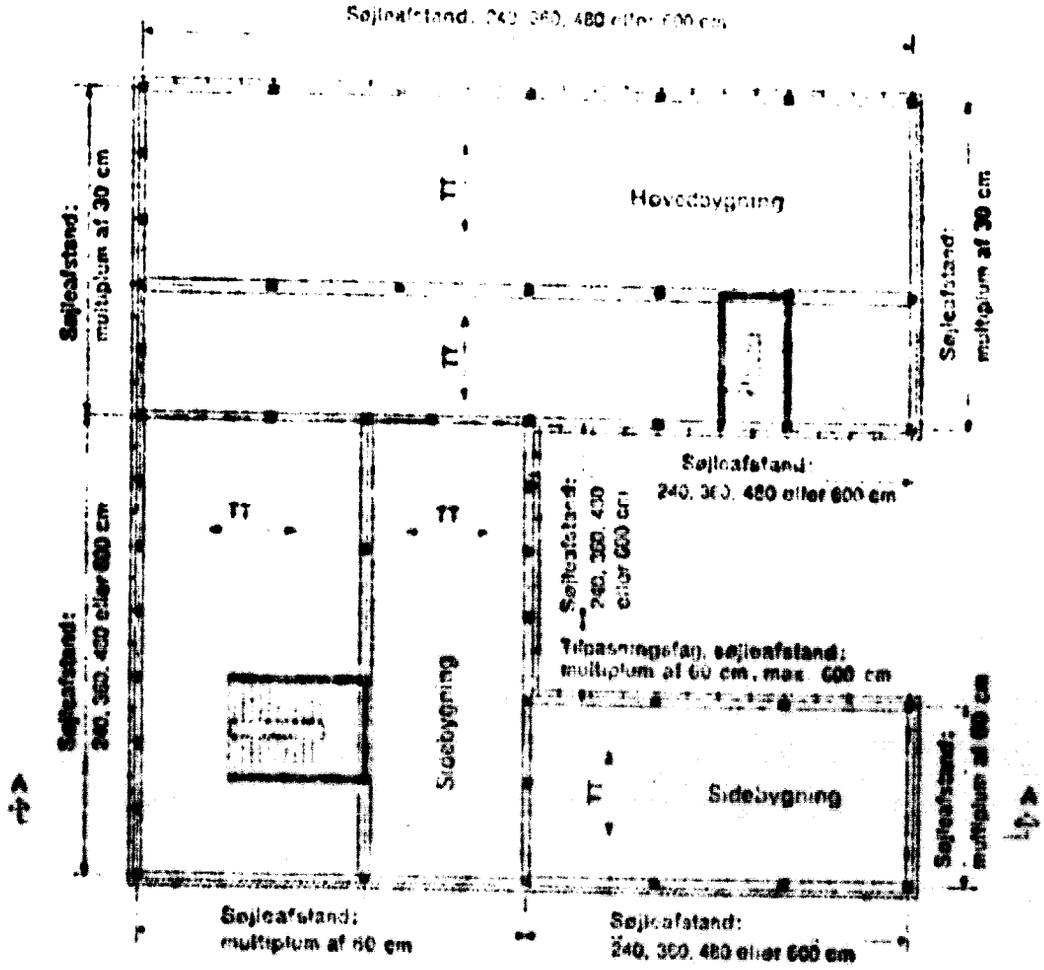
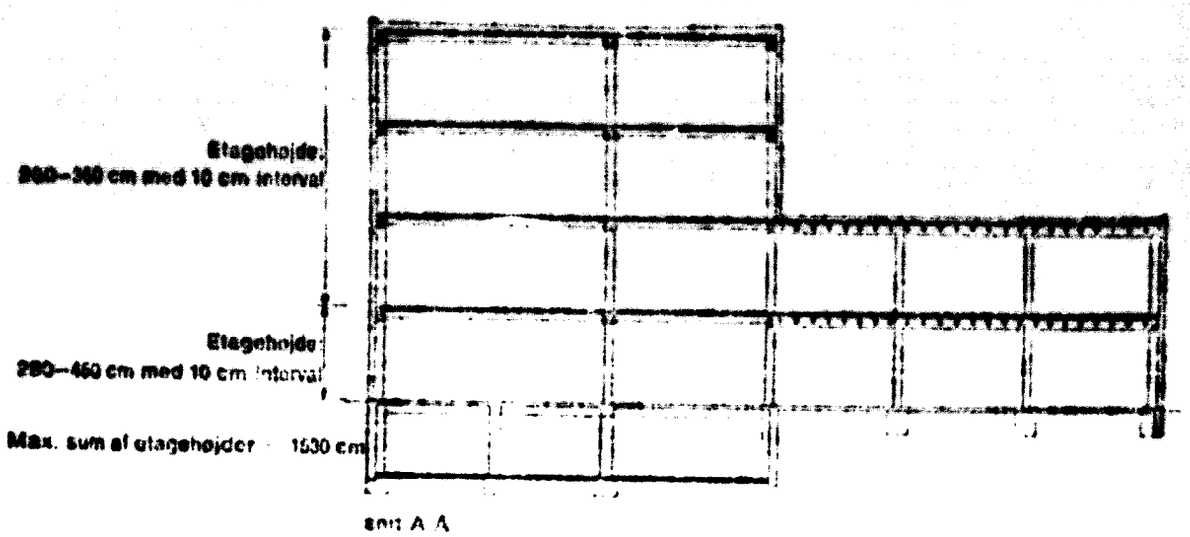

, 1000 TS
CEMENT CONSUMPTION
IN DBI
398
400
300
200
100
0
YEAR
47
50
55
60
65
70

Fig 4


Søjleafstand: 240, 360, 480 eller 600 cm
Hovedbygning
Søjleafstand:
multiplum af 30 cm
Søjleafstand:
240, 360, 480 eller 600 cm
Søjleafstand:
240, 360, 480 eller 600 cm
Tilpasningsfag, søjleafstand:
multiplum af 60 cm, max. 600 cm
Sidebygning
Søjleafstand:
multiplum af 60 cm
Søjleafstand:
240, 360, 480 eller 600 cm
A
A


Etagehøjde:
260–360 cm med 10 cm interval
Etagehøjde
260–460 cm med 10 cm interval
Max. sum af etagehøjder 1530 cm

snit A A

FIG 5

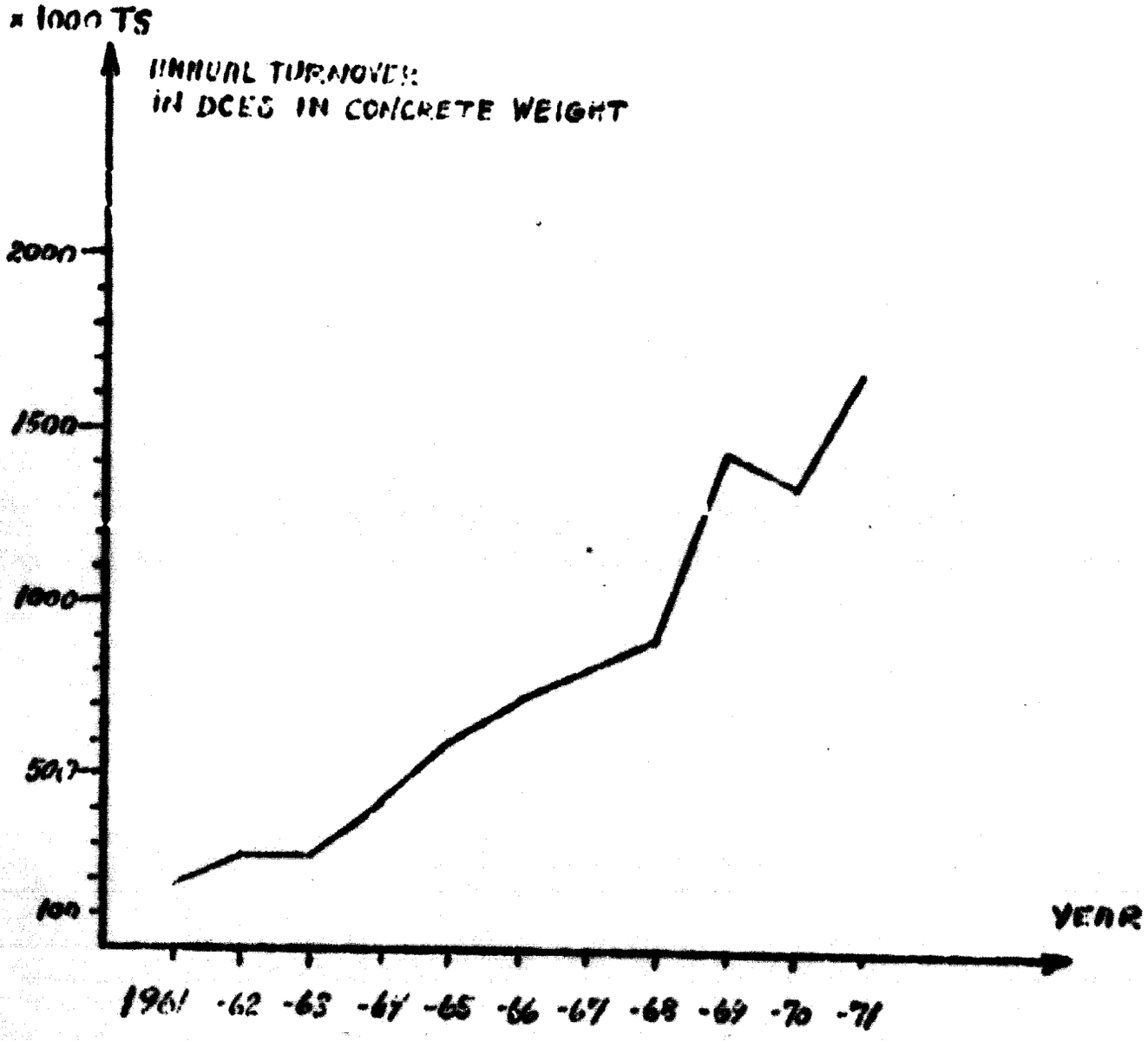

x 1000 TS
ANNUAL TURNOVER
IN DOES IN CONCRETE WEIGHT
2000
1500
1000
500
100
YEAR
1961 -62 -63 -64 -65 -66 -67 -68 -69 -70 -71

Fig. 3

CATEGORY	1000 M²	1000 TS.	MILL. D. KR.	KR./M²	KR./T.
FLOOR- S. ABS	1855	601	131	71	214
EXTERIOR WALL-UNITS	814	303	123	151	405
ROOF SLABS	319	53	17	85	320
INTERIOR WALL-UNITS	1169	368	76	65	196
COLUMNS AND BEAMS	-	212	97	-	457
STAIRCASE-UNITS	-	24	14	-	583
OTHER UNITS	-	90	31	-	344
TOTAL	4037	1671	489	-	293

THE PRODUKTION IN DCES 1971 DISPERSED IN UNIT-CATEGORIES

FIG. 7

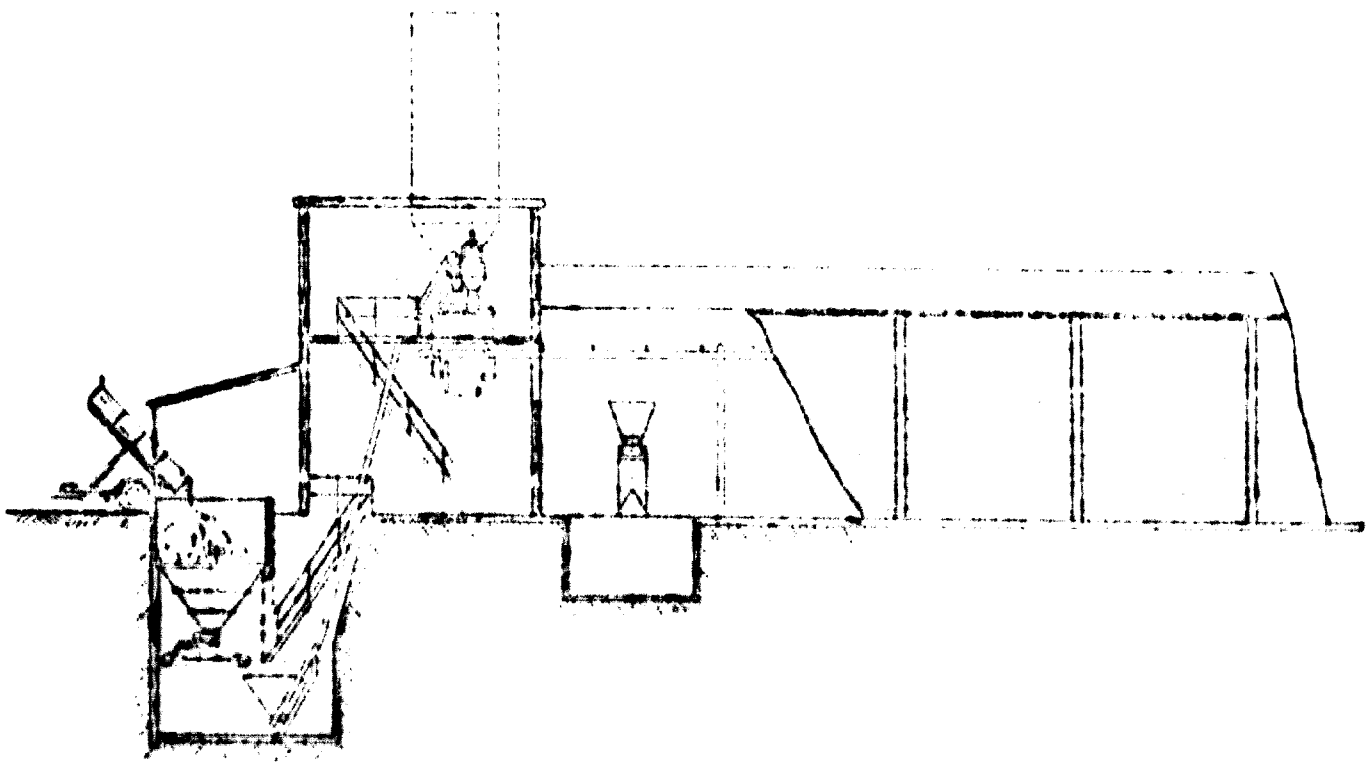
	MEMBERS TRADE D.KR.	TOTAL TRADE IN DENMARK	
		D.KR	US-DOLLAR
DBI	485 MILL.	APP. 540 MILL	APP. 77 MILL
DCES	489 MILL.	APP. 540 MILL.	APP. 77 MILL
		APP. 1080 MILL.	APP. 154 MILL

THE TOTAL TRADE IN DENMARK IN THE CONCRETE-INDUSTRIES.

FIG. 8

1971.	NUMBER OF MEMBERS (FACTORIES)	AVER. PRICE/TON FINISHED GOODS D.KR	AVERAGE TRADE PER FACTORY, D.KR
DBI	358	140	APP. 1,35 MILL.
DCES	27	293	APP. 18,1 MILL.

A REMARKABLE DIFFERENCE IN STRUKTURE.



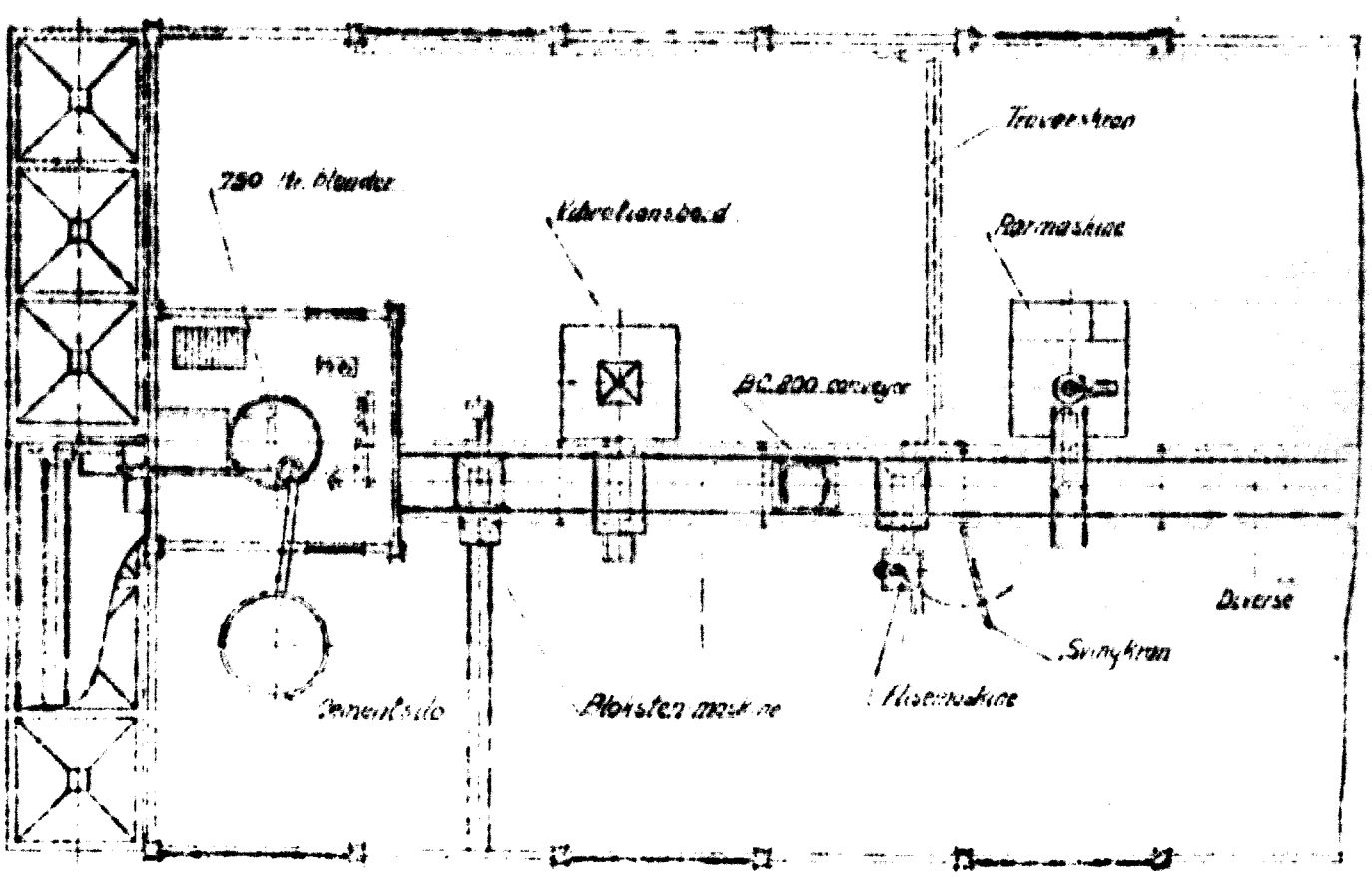
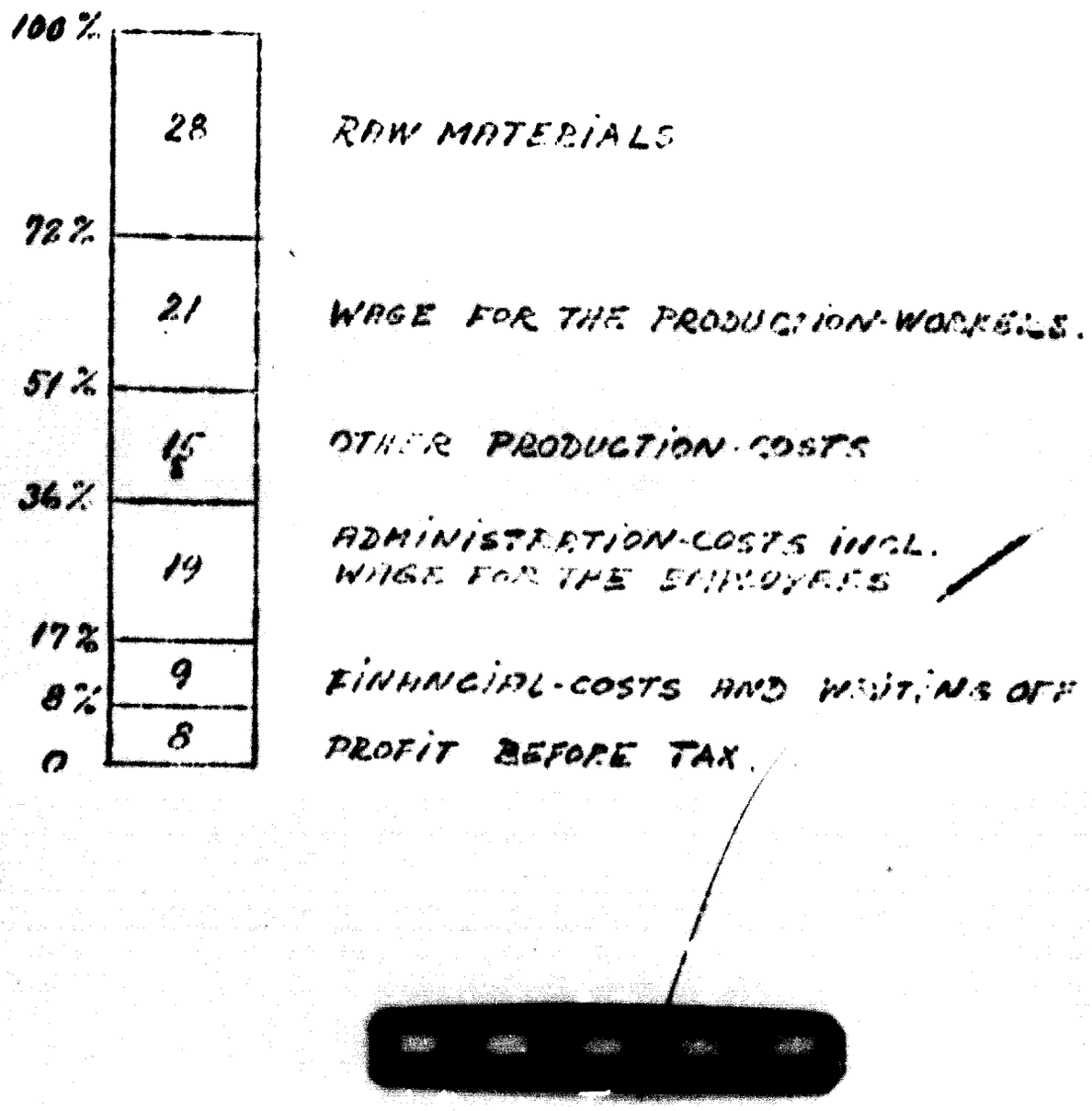
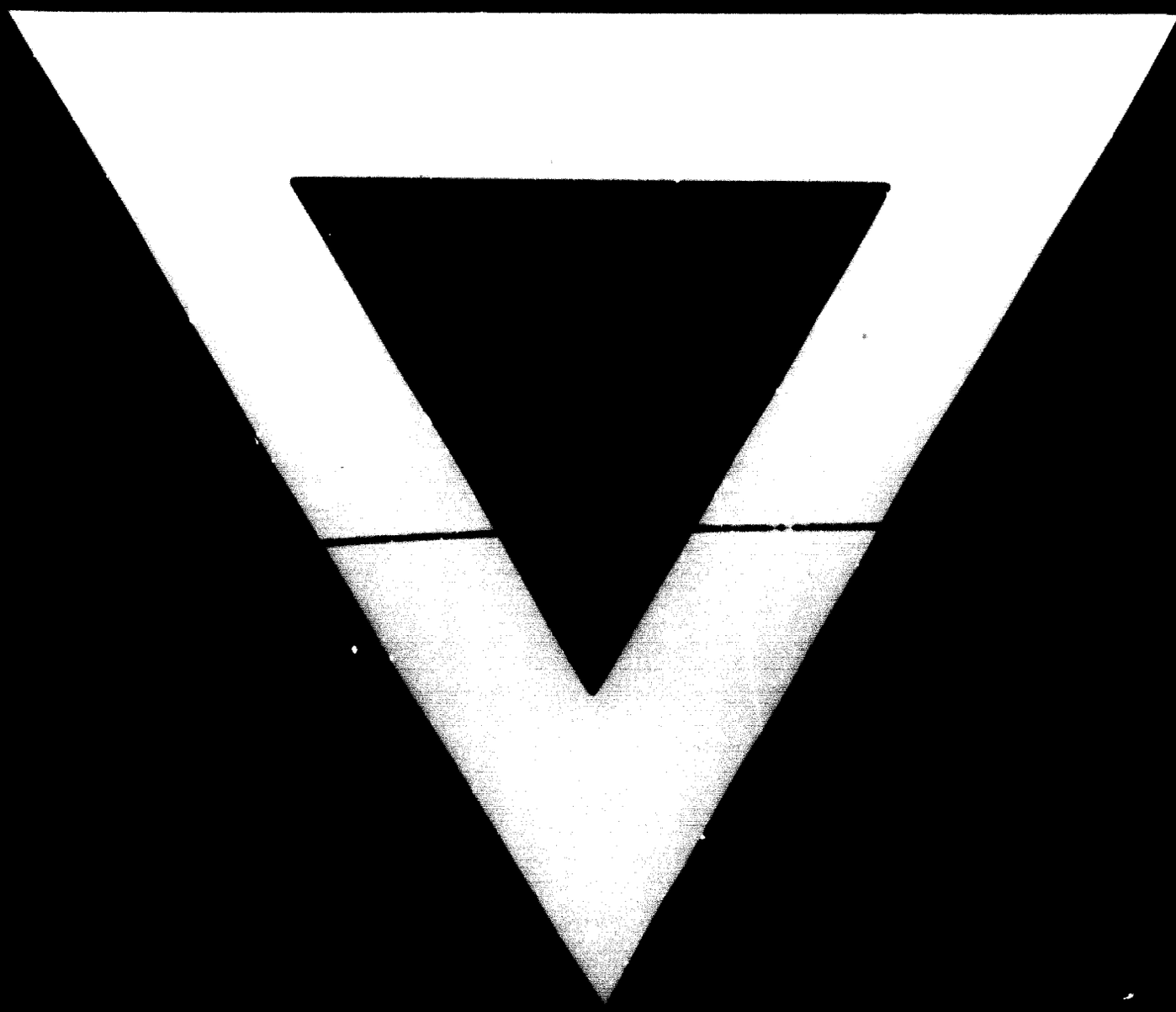

Traverskran
750 kr. blander
Rørmaskine
BC 200 conveyor
Diverse
Svingkran
Rørmaskine

Fig. 10


100 %
28
RAW MATERIALS
72 %
21
WAGE FOR THE PRODUCTION-WORKERS.
51 %
15
OTHER PRODUCTION-COSTS
36 %
19
ADMINISTRATION-COSTS INCL. WAGE FOR THE EMPLOYEES
17 %
9
FINANCIAL-COSTS AND WRITING OFF
8 %
8
PROFIT BEFORE TAX.
0



10.7.74