Computer-controlled production in the precast works 2000

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Introduction

In 1986 we started operating our first CAD/CAM-controlled element floor slab works, the works of Messrs Lösch at Bad Dürkheim.

The latest stage of our development is demonstrated by the multi-functional plant which was recently put into operation. In this plant element floor slabs as well as walls are produced. It is also possible to install the requirements for the production of sandwich elements.

Due to the steady progress of technology there are meanwhile 12 computer-controlled precast works which are very successful in production. And 5 other works have been planned which will be able to produce precast elements in January 1992.

At the same time this technology is used to construct a facility for industrial elements weighing up to 50 to each.

What are the tasks of a precast concrete works in the year 2000?

The aim is, through co-ordinated introduction of all economically available technologies, to produce elements which in the year 2000, in a changing society, make building construction still at all possible.

The production facilities should be planned sensibly around complementary families of elements in order to utilise synergistic effects. This leads to the following task definition:

- The design scope of the planning and creativ architectmust not be reduced; on the contrary, we must ensure that the scope is widened naturally with improved product quality.
- In order to survive permanently in the market place, the trans port and the methods of assembly of elements must be improved without neglecting the statical requirements.
- You will most probably not disagree with me when I claim that in a future modern precast concrete works, there will be employed less than half of the present personnel. For some of our plants this is already reality. The reduced level of technical personnel, which is the most important capitalof a factory, will demand working conditions which will be able to compete with those of other industries.
- For economic reasons the central inrfastructure such as batching plant with recycling, heating, production facilities, storage and social area must be used to capacity by several production facilities or in combination with a transport-distribution. The synergistic effects are confirmed by existing plants.
- The rising consciousness of the environment requires the optimi zed use of energy and resources through computers.

In the precast concrete works 2000 the following tasks have to be co-ordinated:

1. Products and technical processing
2. Buildings and outdoor installations
3. Concrete technology
4. Transport and storage technology
5. Shuttering technique
6. Reinforcement technique
7. Control engineering
8. Last but not least: Service

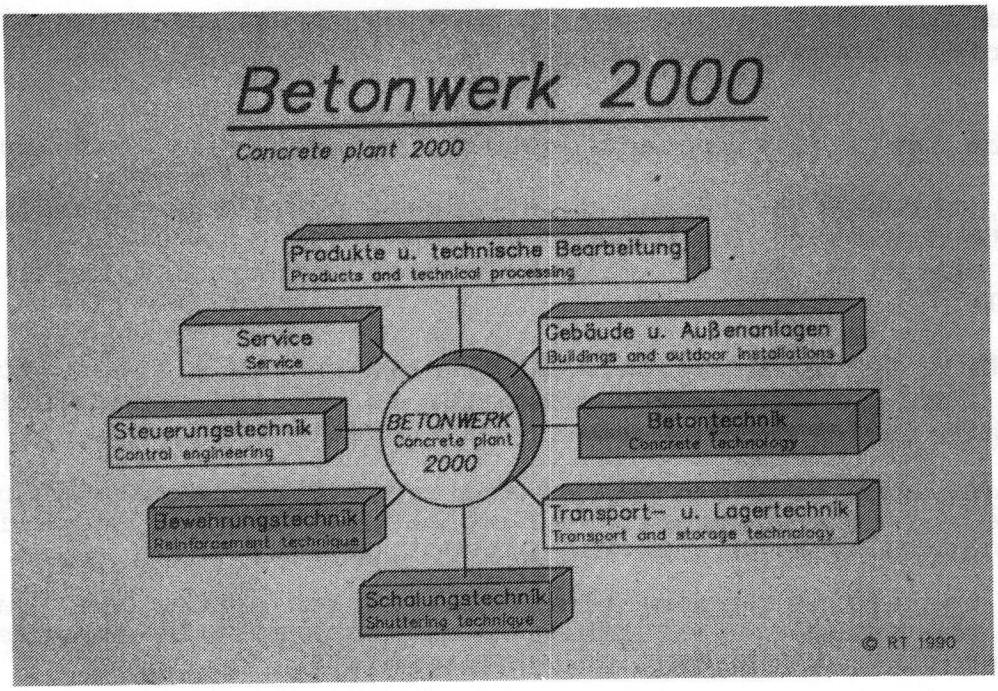

Fig. 1 Precast concrete works 2000

The precast concrete works 2000 specialises in one product or one product family and satisfies with these products all requirements of the market. The degree of prefabrication will be maximised because the production process can only be automated in the works.

The distribution staff provided with mobile PCs will carry out exact calculations in the client's place and register his wishes.

By means of diskettes the geometrical data will be received by the engineer.

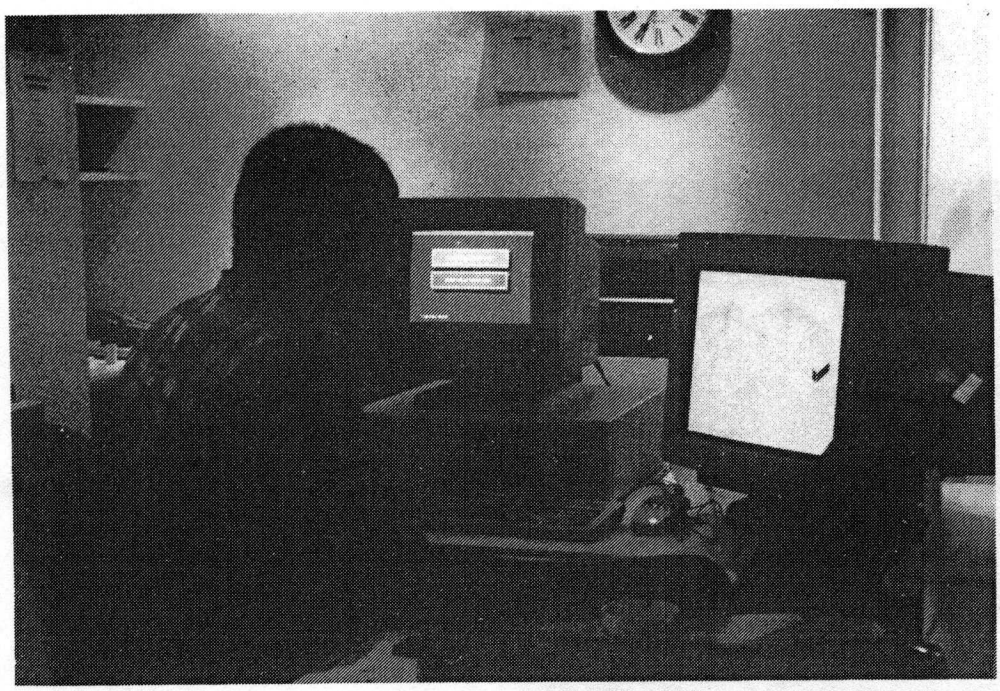

Fig. 2 Receit of data

These data defined by the CAD system of the architect is the basis for all further processes. The technical department of the precast works only works out the precast units according to the works' specific requirements. Thereby, all data required for production and calculation of quantities is immediately available. From this time onwards the end product is technically and economically completely defined. The check of the specified details against the actual details after completion is carried out automatically.

As the means of communication will no longer be paper but data channels or diskettes the entire treatment of a contract will be considerably rationalized, the client will be informed more direct, the decision-making processes in production will be reduced and the possibility of errors will be largely eliminated.

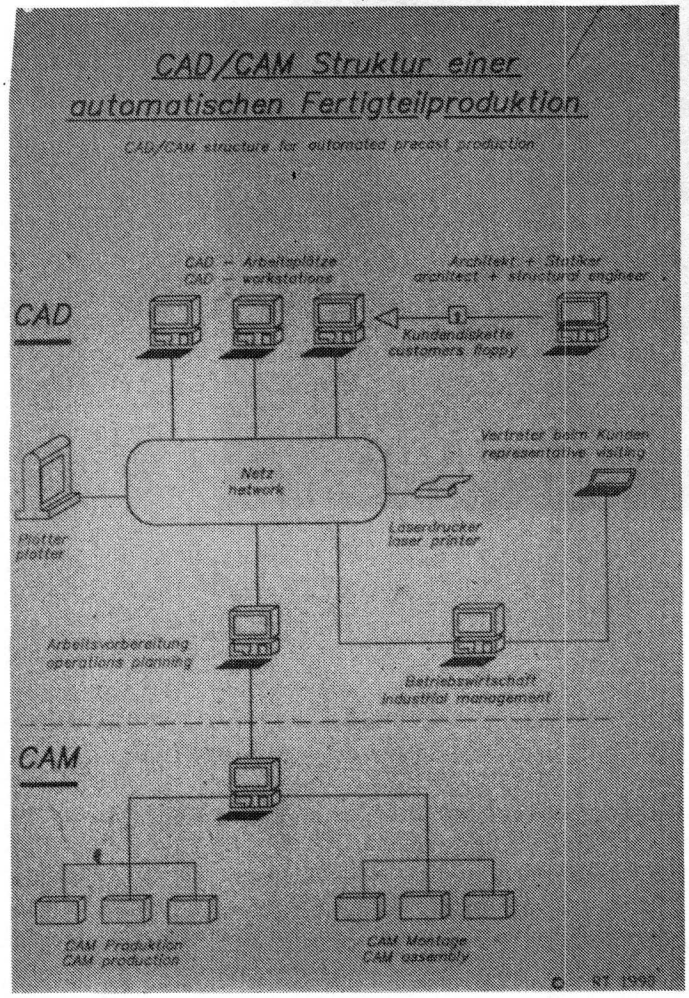

Fig. 3 CAD/CAM structure

Production facilities are considered as an established industrial real estate with a potential use not limited to 10 years only.

The production facilities are arranged according to material flow and movement pattern of operatives which does not necessarily stand in contradiction to the outward design. With the help of an expert two of our clients have surrounded their works with plants and biotopes.

Fig. 4 The Schlagmann works

A future precast concrete works will no longer be recognisable as such by its buildings and open air facilities. The modern production hall is insulated against noise and heat so that an all-year round two or three shift production is possible.

The storage yard will not have the same importance as in earlier times. Here, "just in time" is the slogan. The entire production is planned in accordance with the principle of least stock carrying, small capital tie up and for min. transloading operations.

Wether a crane, gantry or stacker loading is adopted depends on the product and the spatial conditions.

Concrete technology comprises production, transportation, distribution, compaction, surface finishing, curing and recycling of residual materials.
After its preparation the concrete is introduced into the moulds als quickly as possible by the shortest possible way.

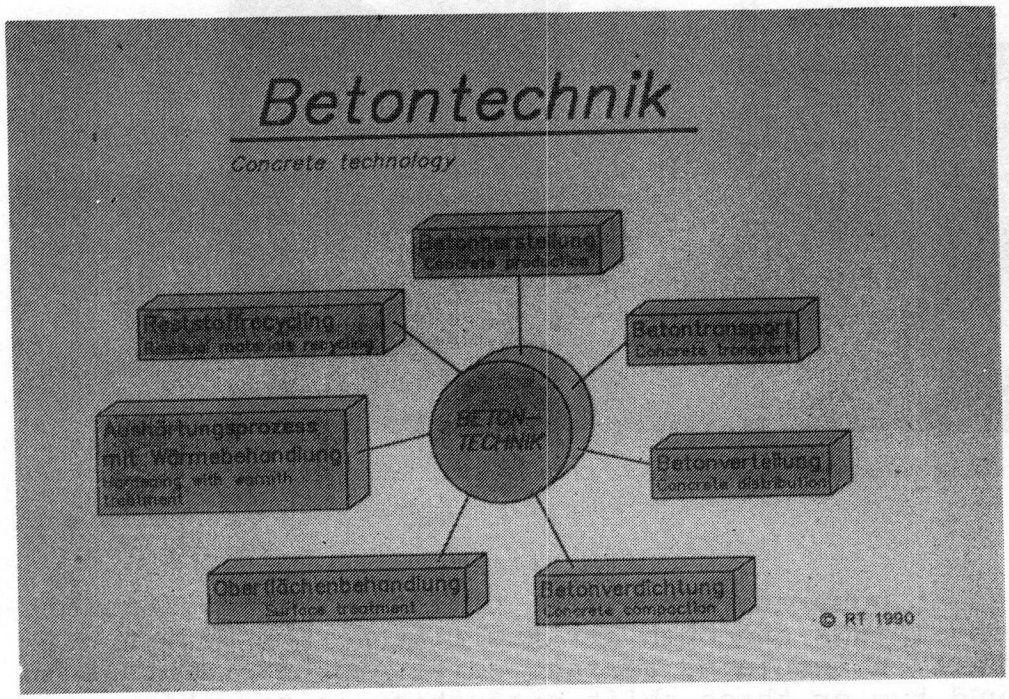

Fig. 5

The concrete demand is carried out computer-controlled and according to the exactly required quantities. The batching plant operates automatically.Constructional detail solutions such as large servicing and cleaning openings, rounded off containers, convenient access to servicing areas reduce the servicing and cleaning work to a minimum.

Casting and compaction takes place in a noise-insulated chamber.

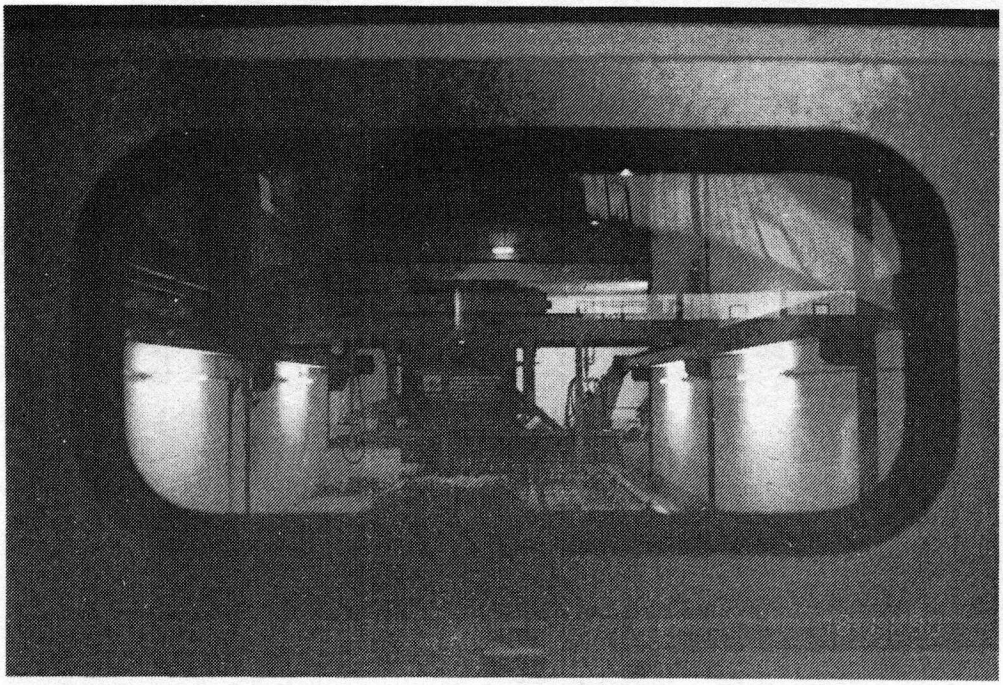

Fig. 6 Noise-insulated chamber

The vibrators are controlled in accordance with the CAD data and according to production mix. In the same way the precast units are roughened and fine finished.

As to the production of wall units the demands on casting are particularly high:

In particular, if two separate units with no air-space between them are joined to produce a massive wall unit.
The narrow strips which are caused by the gaps for doors and windows also require an exactly geometrical casting.
Last not least the automatically introduced steel must not be displaced by the casting process.

The adjacent recycling plant utilises the washing water and rejected solid matter in the production of concrete.

The curing process is controlled depending on the available time, the concrete mix proportions and the heat input.

In the transport and storage techniques the following areas have to be co-ordinated:

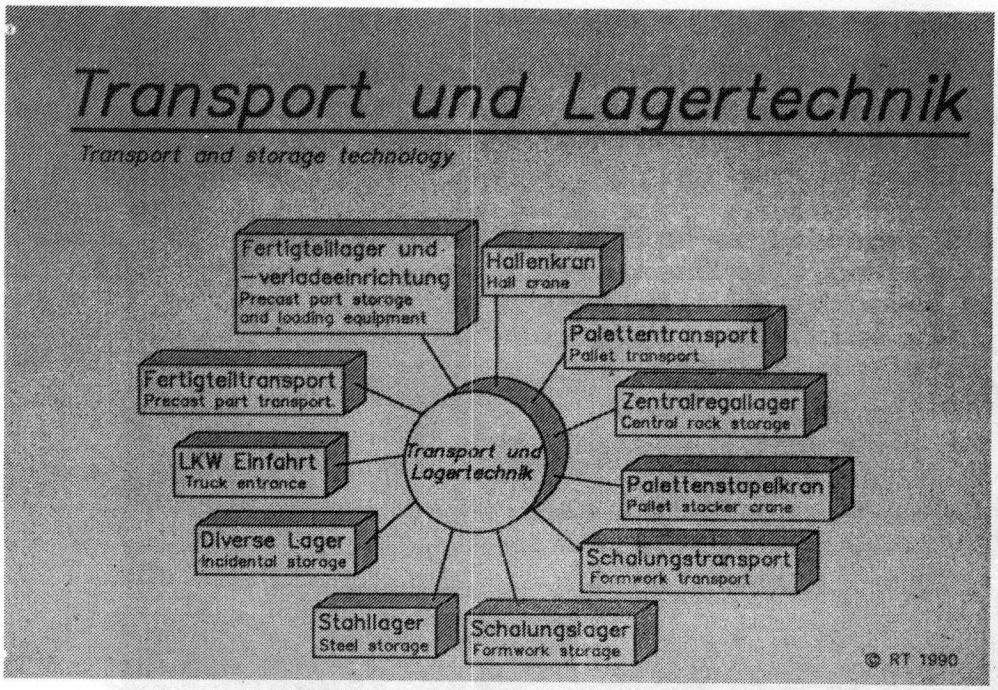

Fig. 7 Transport and storage technology

1. Hall crane
2. Pallet transport
3. Central rack storage
4. Pallet stacker crane
5. Formwork transport
6. Formwork storage
7. Steel storage
8. Incidental storage
9. Truck entrance
10. Precast part transport
11. Precast part storage and loading equipment

The core of a production plant is a pallet circulation logistic which brings the task to the operator.

This is true for the floor slab, the multi-functional plant and also for the production of supporting parts etc. In the curing area the floor pallets are stacked which is the most favourable way. For a superior multi-functional production, however, it is preferable to use a shelves system which permits the individual access.

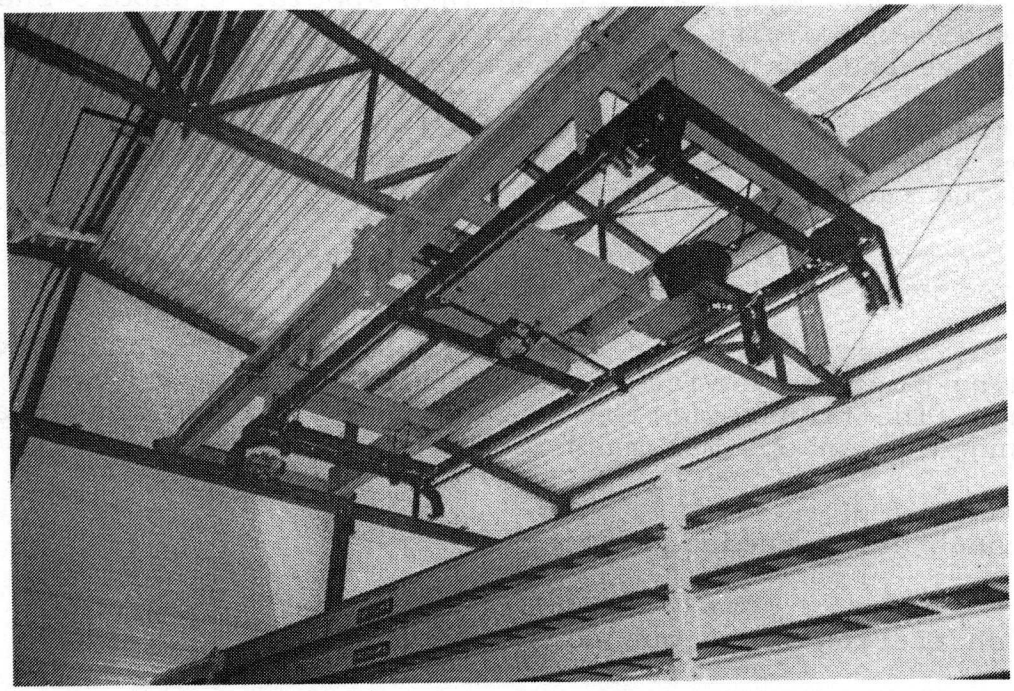

Fig. 8 Pallet stacker crane

In the multi-functional plant a CAD/CAM adjustable vacuum turning device for the prefabricated elements for the cavity wall is planned.

For safety or timing reasons the longitudinal transport is controlled by a sequence switch which deflects the pallets one after the other synchronously.

All materials required in producton are stored in the production hall close to the points where they are used. The production hall gantry makes it possible to off-load the trucks supplying the materials unter the roof and with the gates close. This applies also to the loading of 14 metre long lattice girders.

A special lifting device serves the purposes of ease of demoulding. Such a device can be applied in the demoulding operation of 25 tonne units and formation of transport stacks, all controlled by one operator. After completion of the wall the hall crane which is equipped with two lifting devices takes care of this task. The walls are lifted into special tranport-shelves for their direct loading on transportation trucks. This avoids time intensive and quality reducing handling of the units.

The transportation packs are formed on ramps in the hall. The ramps serve as an intermediate buffer and facilitate an underrun with the radio controlled lift truck.

The precast storage space as well as the material stores are administered by the lead computer.

For the purposes of loading of transportation trucks conventional loading plant is envisaged with a lifting capacity of 15 - 25 tonnes. The transportation roads through the storage area are arranged in an optimal manner.

The shuttering technique

The shuttering technique consists of:

1. Shuttering system
2. Formwork transport
3. Automatic shuttering-station
4. Automatic formwork cleaning
5. Work station system
6. Formwork storage
7. Embeds storage

The most important components of the shuttering for the wall and floor production are the pallets. They permit to fix transversal shutters at an increment of 5 mm and the raising of the edge shutters as well as the fixing of special built-in parts. The transverse shutters making possible a grid independent reinforcement of the units and its joint action with the automatic concrete distributor reduces the concrete spillage to a minimum.

Due to a longitudinal shuttering the use of Styropor is limited to the absolutely necessary extent and will be increasingly further reduced. The system is arranged in such a way that at most 25 cm of Styropor (expanded polystyrene) profiled blocks are used as matching units. For reasons of a clean environment and for cost reasons the minimized residual concrete and Styropor is wasted separately.

The above-mentioned longitudinal and transverse shutters are taken off the pallet by means of a special shuttering machine, are cleaned, stored and administered and then used again in accordance with new CAD controlled data.

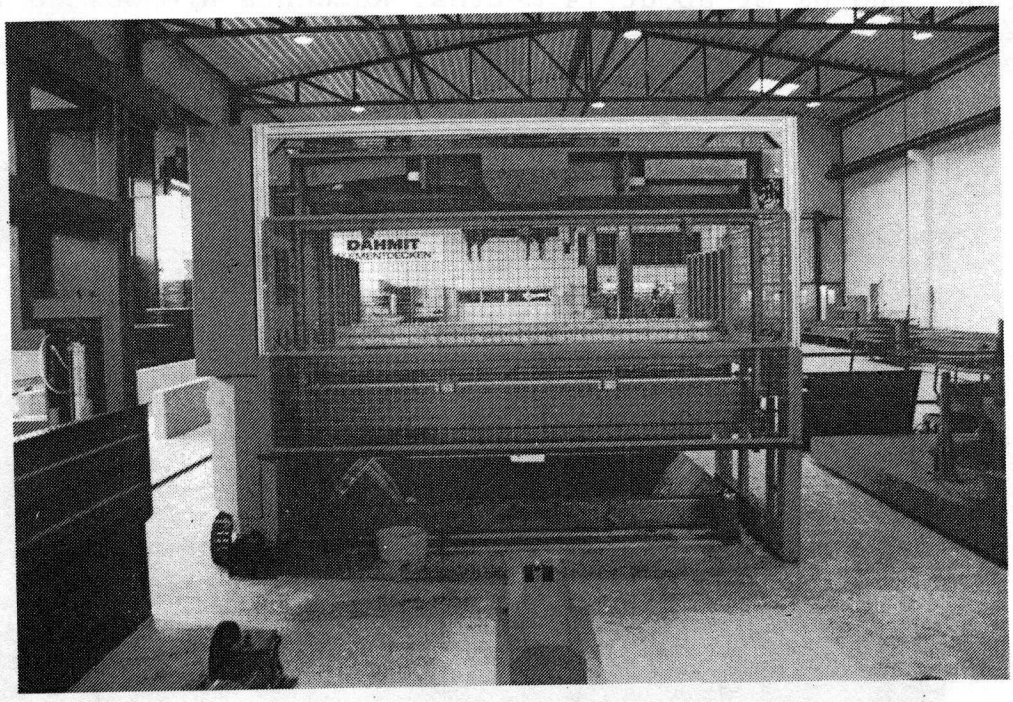

Fig. 9 MRP

For the purposes of control and for hand adjustment purposes, the entire unit geometry is plotted onto the pallet in a scale of 1 : 1.

Shuttering parts which are not taken over by this machine are brought to the next station by a means of transport.

The manual shuttering operations are supported by an ergonometrically arranged work place where all the parts needed for the shuttering and installation are stored.

The reinforcement technique

The reinforcement technique consists of:

1. Storage for steel

2. Robot for transverse bars with spacers

3. Robot for lattice girders and production of longitudinal bars with bending and

4. Special reinforcement

In principle only off-cut reducing round steel reinforcement is taken from a dispenser. The latticed girders are produced in storage lengths of about 14 metres. Remnants are welded together. In 2 out of 12 works we have integrated into our production process our own latticed girder production.

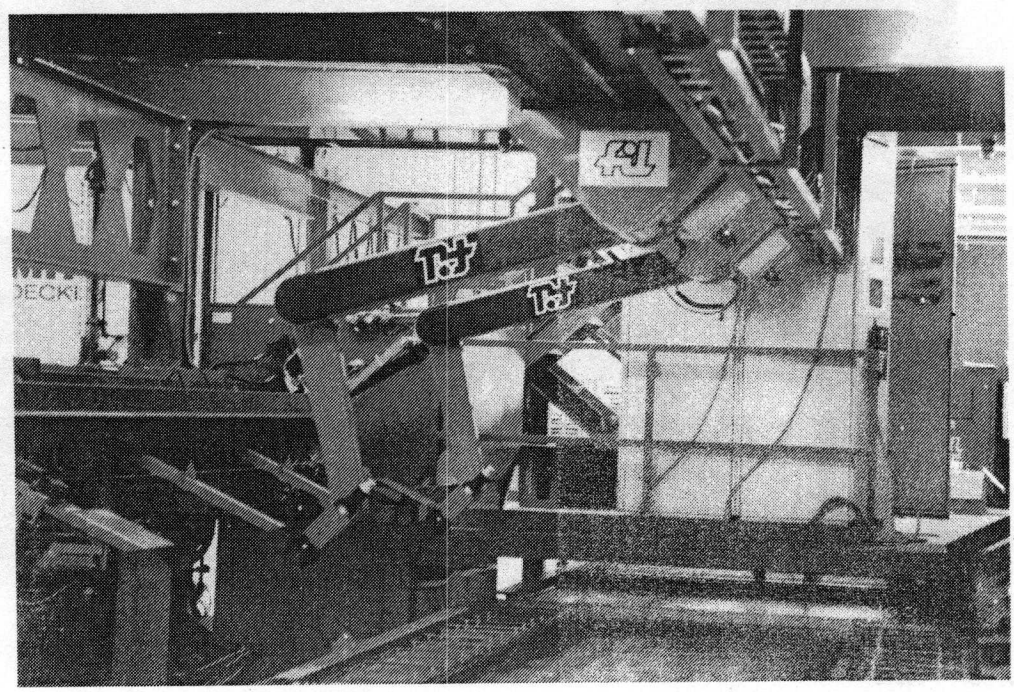

Fig. 10 Robot of the first generation

Latticed girders as well as steel coils in diameters of 6 to 14 mm are stored in the production hall. The steel preparation and placement takes place basically in two circuit stations. The placement of the reinforcement steel is carried out by one or two robots. This technology has meanwhile proved because it takes some of the load off the employees and guarantees the statical provisions.

Fig.10 shows the robot of the first generation. In the course of development the so-colled "crooked arm robot" was replaced by a

linear robot with double grab (Fig. 11). This type of robot works faster and more exactly. The output of the entire installation was again increased by this machine.

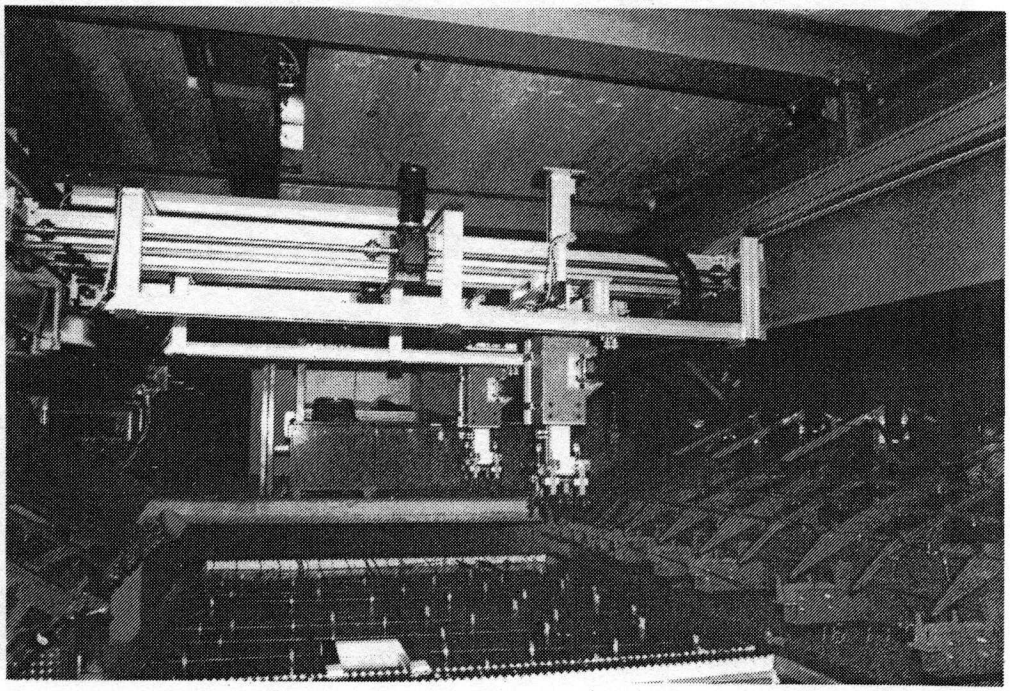

Fig. 11 Linear robot

The first reinforcement layer is provided with reiforcement spacers. All the machines in the steel operation are looked after by one operater who controls the processes.

Special shutterings can be taken out and brought in from the storage tables which are placed next to the work place.

The control

The entire control consists basically of 3 important components:

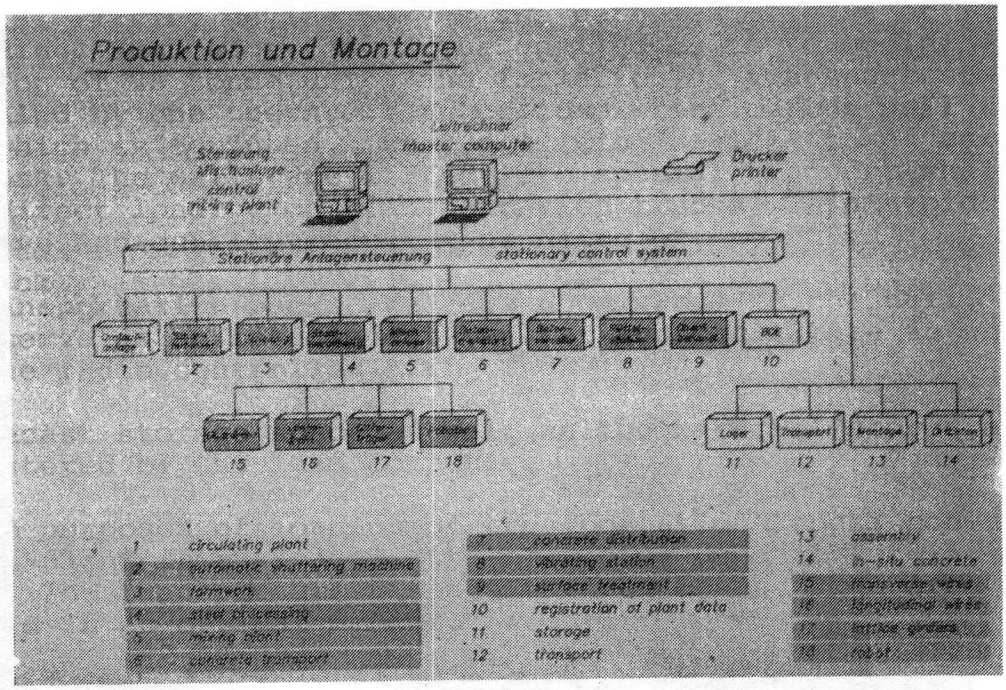

Fig. 12

- the lead computer
- freely programmed machine controls
- stationary output monitors

The lead computer acts as a link between CAD and machine controls.

The data of the machines is processed within the computer into production reports, down-time statistics, stock inventories and to a summary report to management.

The lead computer communicates with the following machines:

Circuit plant, curing chamber control, shuttering automation, shutter store, steel reinforcement processing devices, batching plant, concrete transport, concrete distribution, vibrator station, surface finish treatment and timing devices.

Externally to the production hall the computer administers the precast unit store, carries out tasks relating to availability of transport, supports the assembly with geometrical data which makes possible the application of a mobile robot in the assembly of units and in the casting of concrete.

The above-mentioned machine types are controlled and supervised locally by freely programmable controls which form the link between the lead computer and the production switches. These controls are partly crosslinked. Virtually every movement and every disturbance is picked up and is chronologically conveyed to the computer. The production process is, thereby transparent in every detail and is capable of correction.

Service

The service will play a more and more decisive role for the precast works in future. The following points have to be stressed:

The complex technology requires for its continuous maintenance and warranty of safety an enterprise structure which is not presently available in medium-sized companies. It is, therefore, appropriate to offer this structure as a joint example for a number of different works. The task of this service is to achieve synergy effects in production, product development and marketing through exchange of experience. A further task of a service department is to conduct continuously motivating staff training sessions, to provide for operator bottlenecks in all areas of activity and to ensure a co-ordinated supply of spare parts.

This is already successfully practised by the 11 working concrete plants planned by our company.
The exchange of experience within regularly meeting teams motivates the staff to increase the output by more availability of the entire technique of the plant.

A jointly organised promotion carries these effects in an appropriate form to the world outside and ensures success.

CAD/CAM technology

CAD/DAM technology combined with a consequent planning of the working conditions and surroundings offer our industry a lot of new and important changes.

8 of the 11 owners of an automatic concrete works belong to the medium-sized companies. The financing of these plants has always been possible through solid preparatory work.

The most important part of this work is a project study from which the scale, the costs, the possibilities of development and the expected returns can be determined.

Today, we must already have the courage to plan the works 2000 in accordance with all the aspects man, environment and future to carry it out step by step in the future.

The aim is to produce environmentally and to sell successfully first class quality with a few competent employees.