HOT CONCRETE IN THE U.S.S.R., DENMARK AND FRANCE

DEPARTMENT OF INDUSTRY,
TRADE AND COMMERCE


Leningrad
Moscow
Kiev
Irkutsk
Novosibirsk
Tashkent

DEPARTMENT OF INDUSTRY, TRADE AND COMMERCE

OTTAWA

"HOT CONCRETE" IN THE U.S.S.R., DENMARK AND FRANCE

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Prepared by
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Materials Branch
Canada. Department of Industry, Trade and Commerce

CONTENTS

INTRODUCTION

The Canadian Section of the National Precast Concrete Association organized a three-week study tour to the Union of Soviet Socialist Republics, Denmark and France to investigate the rapid production and casting of concrete with particular reference to the use of "hot concrete". The tour was arranged on the basis of information contained in the following papers:

> "Hot Concrete Mixtures for the Manufacture of Prefabricated Parts for House Building", by Ju. Kljusnik and D. Michanovskij, published in the Soviet journal Ziliscnoe Stroitel'stvo (Housebuilding), 1968, No. 8, pp. 19-21.

> "Loss of Strength on the Heat-Curing of Concrete Can Be Avoided", by G.E. Hummelshoej, published as an information bulletin by Thomas Schmidt A/S, Copenhagen, June 1967.

Arrangements for the portion of the tour in the Soviet Union (two weeks) were made by the Commercial Division of the Canadian Embassy in Moscow in co-operation with the Materials Branch of the Department of Industry, Trade and Commerce while the stops in Denmark and France were arranged by the National Precast Concrete Association. All members of the group, whose names appear in Appendix 2, were responsible for their expenses.

The party visited six factories, six construction sites and attended seven technical meetings in the Soviet Union - and visited six factories and two construction sites in Denmark and France. Scheduled visits to sites in Eastern Siberia were cancelled because of weather conditions.

While it may seem that the group saw very little "hot moulded" concrete during the limited time available, this was because its use has not received general acceptance as yet. Excellent use of hot concrete was observed in the plant of Hojgaard & Schultz A/S in Denmark. Officials in the U.S.S.R. are definite in their determination to use hot concrete moulding to increase plant efficiency and productivity and there is a trend towards its use in France.

In keeping with the aims of the Department of Industry, Trade and Commerce, this report has been prepared to acquaint Canadian industry with new technology to increase production efficiency. No attempt has been made to describe the factories visited in detail since it is extremely doubtful that factories of the scale seen in the U.S.S.R. would be viable in Canada due to the lack of an assured market for a plant in this country. However, the study tour members were told about, and shown, methods of concrete production that could be extremely useful in Canada. These are described in this report with the expectation that they will be of value and given some indication of possible future trends in the development of the Canadian concrete industry, including certain areas where profitable research and development might be undertaken.

Sincere thanks are expressed to The State Committee on Civil Construction and Architecture, Gosstroy, which hosted the group in the U.S.S.R., and to all representatives of the organizations visited for the very friendly reception and co-operation extended by them and for the excellent relationship which was established.

CONCLUSIONS AND RECOMMENDATIONS

The group did not see extensive use of hot moulded concrete. However, a strong indication was found that extensive use will come with continued usage and greater general acceptance. Excellent use of hot concrete was observed in the plant of Hojgaard & Schultz A/S in Denmark. This firm has a second plant in operation and another under construction. Both will be using hot concrete for production. A highly automated plant using hot concrete to advantage is Home Construction Combine No. 3 (DSK No. 3) in Moscow which produces exterior wall panel at a rate of 18 metres (59 feet) per hour and interior wall panel at 30 metres (98 feet) from one production line.

Officials in the U.S.S.R. are definite in their determination to use hot concrete moulding to increase plant efficiency. They plan to use both steam injection and the electrical discharge method with the choice being dependent upon economic considerations since the technology for both has now been fairly well developed on an experimental basis. Additional impetus to use hot concrete in the U.S.S.R. arises from the coarse grind and quality of cement which causes the concrete produced using this cement to have a relatively low early strength. Within the next few years, construction of large-panel blocks of flats using lightweight concrete, not only in enclosing structures but also in all load-bearing units of the superstructure of buildings, will find extensive application.

In France, some plants are heating aggregates and water to increase productivity and make it possible to obtain increased form usage.

It was found that there are thousands of engineers, scientists and technologists engaged in concrete research in the U.S.S.R. To date, much of the technology developed by this tremendous research and development effort has not been put into practice in production facilities. It is suggested that it would be wise for Canadian industry to evaluate Soviet technology every few years.

The methods of concrete production that could be extremely useful to the Canadian industry are:

1. Arben'yev's 380-volt electrical discharge hopper (Novosibirsk).

2. 380-volt electrical heating and expansion of reinforcing steel for prestressing (Kiev).

3. 380-volt electrical heating of concrete after pouring, using ¼-inch (0.6 cm) steel electrodes (Tashkent and Leningrad).

4. Electro-magnetization of mixing water which is claimed to be a substitution for water reducing dispersing agents (Tashkent).

5. 380-volt electrical heating hopper for batch plants (Tashkent).

6. The use of potassium carbonate as an additive to lower the freezing temperature of concrete and promote cement hydration at lower temperatures.

7. The use of a rubber belt to hermetically seal the surface of panels during curing to improve surface finish (Moscow).

It is considered that Arben'yev's hopper could be of great benefit for winter construction in Canada, but further research should be carried out to determine optimum temperatures for Canadian cements and to draw up operational and safety regulations. The use of electrical heating after pouring and the use of potassium carbonate also warrant further investigation, in relation to their application for winter construction.

It was observed that construction work on site did not proceed when temperatures dropped below -25°C (-13°F) in some areas. The group did not find extensive work under way in extreme cold weather.

Items that could be of particular interest to the precast concrete industry are the electrical heating and expansion of reinforcing steel for prestressing; the electro-magnetization of mixing water as a replacement for water reducing agents, and the electrical discharge method of producing hot concrete. These merit intensive investigation and evaluation including the establishment of safety regulations for the electrical heating devices.

It should also be pointed out that there is wide-spread controversy in the Soviet Union regarding the claims made for the electro-magnetization of mixing water and some scientists state that the procedure is of absolutely no value.

Some of the battery moulding systems seen could also be of interest to Canadian producers. These are the small parallelogram-shaped moulds and the battery moulding system having a moving bottom which were observed in Tashkent. The method of pumping concrete into the bottom of battery moulds at Les Entreprises Balency & Schuhl in France is worthy of a detailed examination.

The production of single family homes and townhouses at the Les Entreprises Balency & Schuhl plant in France was interesting from the point of the use of heating forms and the use of precast panel construction for one-and two-storey houses.

The construction systems in the U.S.S.R., Denmark and France varied in aesthetic appeal, yet it was noted that the structures could have a very long life expectancy. The use of hot or heated concrete, heated forms, heated water or heated aggregates was the means by which economical form usage became possible. A four-hour turnaround can and is being used.

As a general conclusion, it is considered that although several plants in Canada are now using hot concrete for their production, and curing cycles of three hours are not unknown in this country, the precast concrete industry in general has not fully exploited this technology. It is recommended that the industry thoroughly investigate its possibilities as a method of increasing production efficiency.

The object of observing rapid production of apartment structures was achieved. The production facilities of the U.S.S.R. are the largest in the world and the Danish facilities could number among the world's finest. In the opinion of many people, it would be difficult to successfully gain a market in Canada for these industrialized systems. Some of the reasons given are that Canadians will not accept the quality of workmanship and that sufficient volume cannot be obtained. It was observed during this tour that industrialized systems could produce low-cost housing and that in addition to low-cost, good quality can be obtained using careful design. The question of volume remains one of need - if good, low-cost, long-life housing is required in volume, some of these systems provide one way of achieving such a goal.

A final recommendation is that companies planning to embark on research and development projects make themselves aware of the Department of Industry, Trade and Commerce programs to assist research, development and innovation to determine the kind and amount of assistance that can be provided.

DESIGN COMMITTEE OF THE INSTITUTE OF HOUSING CONSTRUCTION - MOSCOW

(TSNIIEP chilishch)

This committee is responsible for the design of house-building plants throughout the U.S.S.R. where almost all housing (apartments) is of prefabricated, reinforced concrete construction. The committee employs 1,000 designers and 758 research and development workers. It has four laboratories which study the following subjects:

a. Factories to produce prefabricated units for dwellings.

b. Curing processes including the use of electrical power in prefabricated concrete factories.

c. Finishing (in plant).

d. Economics.

In recent years, 45 per cent of the total volume of residential buildings were erected using fully-prefabricated concrete and reinforced concrete units. There are 330 large panel home building factories in operation in the Soviet Union having an overall annual capacity in excess of 33 million square metres (350 million square feet) of useful floor space. In 1969, the share of large panel construction in the overall volume of housing amounted to 35.8 per cent. By 1975, it is expected that this figure will reach 50 per cent. Lightweight concrete is used for 60 per cent of large panel production.

The following points were brought out in a discussion on hot concrete production:

The electrical discharge system can raise the temperature of the concrete to 98°C (208°F) in five minutes using 50 to 60 kwh per cubic metre (1.3 cubic yards) for regular concrete and 30 to 40 kwh per cubic metre for lightweight concrete.

The recently designed Soviet steam injection system has a large number of orifices around the base of a stationary pan mixer.

NOVOSIBIRSK

Novosibirsk is situated on the Ob River in Western Siberia. This city had a phenomenal growth rate from a population of 200 in 1900 to the present 1.2 million. According to the chief architect of Novosibirsk, the city contains 7.5 million square metres (80 million square feet) of living space or 6.6 square metres (71 square feet) per person. It is hoped that by 1990, the living space per person will be 20 square metres (214 square feet).

Most housing in Novosibirsk consists of five-storey apartment blocks. Private wooden houses account for 18 per cent of the city's living accommodation.

An attempt is being made to limit the size of Novosibirsk to 1.3 million people. It is planned that 50 per cent of new housing will consist of five-storey apartment blocks, and 40 per cent of nine-storey apartment blocks.

The city has two housebuilding plants, having a total capacity of 500,000 square metres (5,350,000 square feet) of living space per year. Seventy per cent of all new housing is prefabricated.

ELECTRICAL DISCHARGE HEATING HOPPER - NOVOSIBIRSK

Mr. Arben'yev of the Academy of Sciences, Akademgorodok, described his electrical discharge heating hopper and these were examined on a construction job site.

In the U.S.S.R., concrete is either site-batched or centrally-batched and delivered to the site in open bodied dump trucks. In winter, its normal arrival temperature is only a few degrees above freezing. Placing of this material is only possible if it is heated, and a solution in use was provided by Mr. Arben'yev. This system consists of a resistive electrical heating system in which the plastic concrete itself serves as a resistance to current supplied by three electrodes installed in the concrete bucket shown in Figures 1, 2 and 3.

Normally the concrete, having a slump of 6 to 8 cm (2 to 3 inches), arrives upon the site at a temperature of 5-10°C (41-50°F). This is unloaded into the bucket which is then connected to a 380-volt power source. The mix warms up to 50-70°C (122-158°F) in 10 to 12 minutes, after which the electrodes are disconnected and the hopper taken by crane to the location of placement. For a smooth operation, at least six buckets are required.

The placement takes place not later than 15 minutes after the electric heating is finished, in order to avoid setting. The structure is protected depending on the coefficient of exposure, temperature variations and wind force. Concrete temperature is taken twice per shift. After three to four days, the forms are removed. The attained strength is 60 to 80 per cent of design strength.

Power consumption varies from 20 to 47 kwh per cubic metre (1.3 cubic yards) of concrete and is dependent upon initial and final temperature, concrete composition and the volume heated in one batch.

In order to protect the workers, a ground wire is attached to the bucket fixed to a ground rod when the concrete is being heated. In addition, in the photographs in Mr. Arben'yev's paper and in a model of the system seen in Moscow, the hopper was protected by a fence with warning lights which flash when the power is on. However, there was no evidence of this fence on the construction site visited in Siberia and the immediate concern of the Canadian group was for the safety of the operating crew. The local officials considered that proper grounding was adequate and reported that no accidents had occurred.

It was claimed that the advantages of this procedure over the insitu method of heating (described later in this report) were that the structure of the concrete was not disturbed; increase in early strength, and easier form removal due to the formation of a condensate on the form walls.

It would appear that this system could be of great benefit for winter construction in Canada. Further research will be required to convince building authorities of its feasibility and to draw up operational and safety regulations.

A full set of instructions and papers dealing with this subject were given to the group. A copy of these may be obtained by writing to Industrial Minerals Division, Materials Branch, Department of Industry, Trade and Commerce, Ottawa, Ontario, K1A OH5.

Figure 1 - Overall view of hopper with electrodes connected

Figure 2 - Close-up view showing electrodes

Figure 3 - View showing vibrator attached to hopper

TASHKENT BUILDING CONSTRUCTION
RESEARCH INSTITUTE - TASHKENT

(Tash ZNIIEP)

Discussion of Hot Concrete Production

The following points were brought out in this discussion:

The power required to heat 1.5 cubic metres (2 cubic yards) of concrete to 85°C (185°F) in five minutes using electrically heated hoppers is 50 to 55 kwh per cubic metre (1.3 cubic yards). The power required to heat 0.8 cubic metres (1 cubic yard) of concrete to 85°C in five minutes is 40 kwh per cubic metre (1.3 cubic yards).

Without heating, the normal mix contains 320 kg of cement per cubic metre (540 lbs. per cubic yard). With heating, the mix contains 270 kg of cement per cubic metre (455 lbs. per cubic yard). No pozzolans are used. The water cement ratio is 0.5 to 0.6. Some evaporation of water takes place during heating. The hydrolysis of water which takes place entrains some air in the concrete. The highest temperature used is 90°C (194°F). In one batch, the temperature of the concrete will vary from 65°C (149°F) to 90°C (194°F) depending on the distance from the electrodes.

All installations are grounded and protected by fences with gates, which automatically lock when the power is on, and flashing lights.

Discussion of Electro-Magnetization of Mixing Water

This is claimed to be a substitution for water reducing agents through a reduction in the viscosity of the water. It is also claimed that the reduced surface tension produces higher degree of hydration of the cement. An electromagnet operating on 380 volts and drawing three amps is placed on a section of the water line going to a mixer or storage tank.

The effect is less pronounced if the aggregate is wet and this method is not used if the moisture content of the aggregate exceeds 30 per cent of the total water content of the mix. The effect was said to be more pronounced in light-weight concrete.

It is thought that the water will retain its properties for 2½ hours. However, this has not been fully determined and further work on this is being conducted.

It should be pointed out that there is a great deal of controversy in the Soviet Union regarding this procedure. Some scientists stated that this procedure was of no value whatsoever since the water only retains its properties for 2½ seconds.

Laboratories and Pilot Plant

The pilot plant has three types of mixers available for experimentation - pan, paddle and drum. There is a scale model of the electric discharge hopper and a battery moulding system that is said to eliminate the segregation that occurs during the pouring operation. This latter piece of equipment is designed with a pouring device fixed to the top of the mould and a frame that is progressively lowered between fixed mould plates as the frame is filled.

The pilot plant also contains a model (1/3 scale) of an extruder which produces the floor and walls of an apartment block in one pass. This equipment is being developed to provide an economical way of producing a large volume of box units. The designers indicated that they expect box units to replace large panels as the basic construction element.

PREFABRICATED REINFORCED CONCRETE PLANT - TASHKENT

This plant produces a wide variety of precast concrete components for industrial construction and also manufactures concrete pipe. It also contains an experimental electrical discharge hopper.

Another item of note at this plant is the type of battery form used for making flat slabs. The forms are in the shape of a parallelogram on a steel base. In removing the forms, the parallelogram is simply brought into a rectangular shape and the concrete slabs are lifted vertically out of the forms. This is an excellent method of producing a standard panel that does not have cut-outs or inserts. However, because of the articulated nature of the form, aligning of faces is difficult and the surface finish is poor.

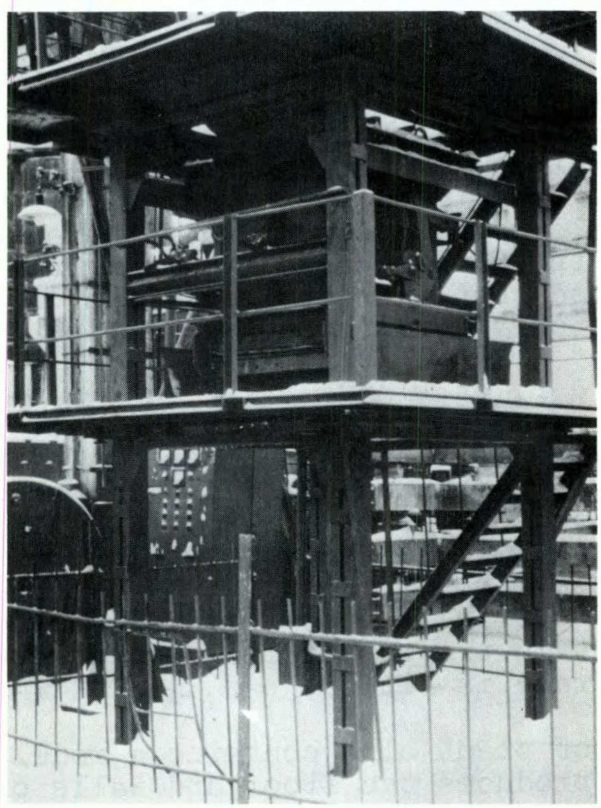

Figure 4 - Overall view of experimental electrical discharge hopper

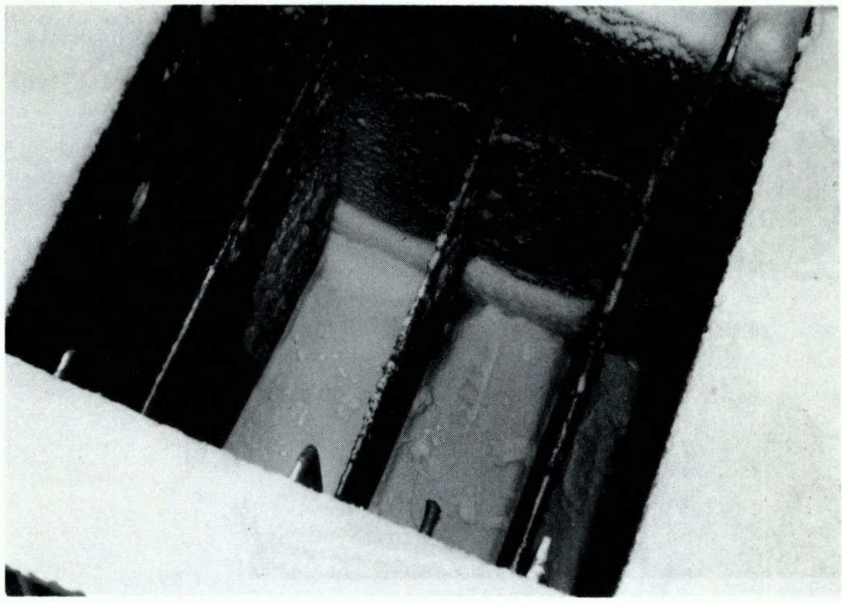

Figure 5 - View of top of experimental electrical discharge hopper showing electrodes

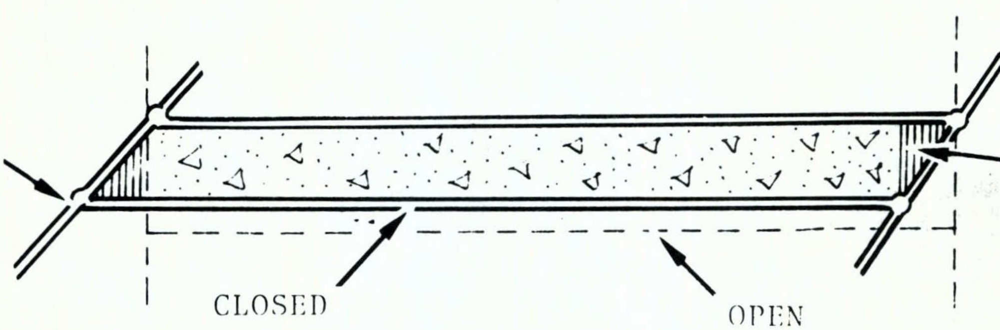

Figure 6 - Articulated Form

Figure 7 - Top view of battery form

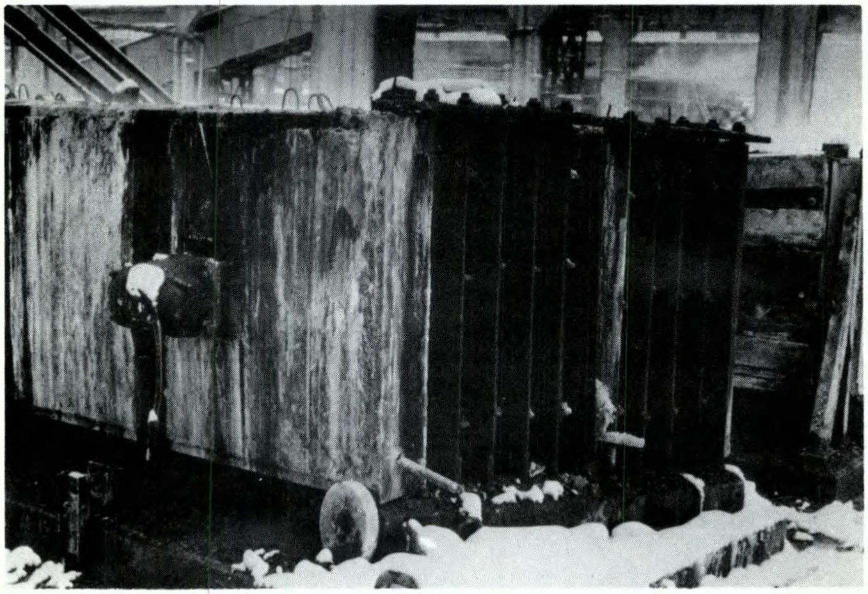

Figure 8 - End view of battery form - vibrator on side

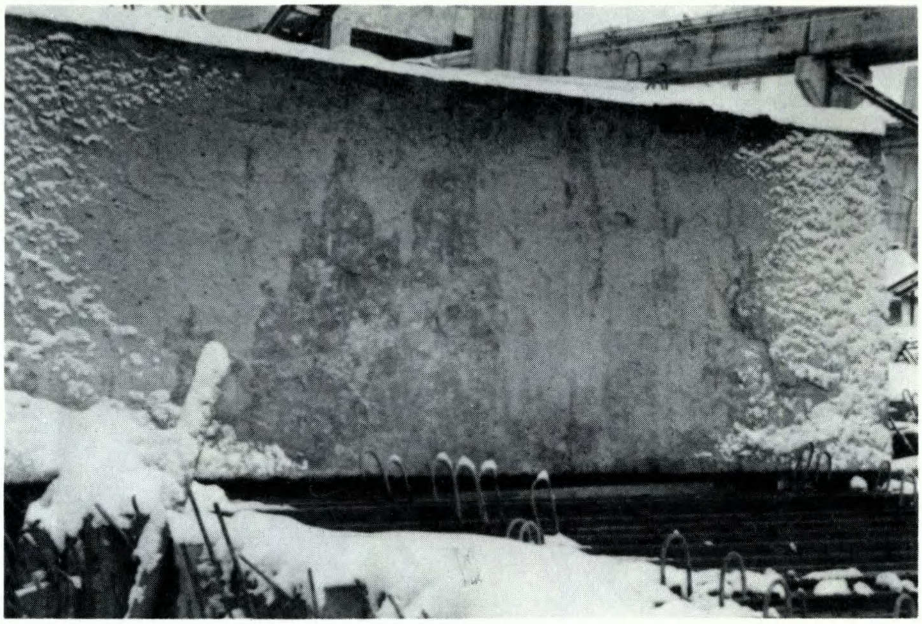

Figure 9 - Surface finish of slabs produced in battery form

HOUSEBUILDING PLANT - TASHKENT

This plant is based on the Camus system and was built by Société Raymond Camus & Cie. of France. The Camus system is described in the Department of Industry, Trade and Commerce publication "Prefabricated Concrete Components in Industrialized Building in Europe". This plant produces 100,000 square metres (1,076,000 square feet) of living area per year.

The most notable points of interest at this plant were the electromagnetic device on the water supply line; the air-driven finishing wheels, and the production of wall panels having murals made of mosaic tile as an exterior surface. In this latter process, mosaic tile is glued to paper according to the designs of murals prepared by artists. This is then placed, paper side down, into the mould and the concrete is poured on top. After curing, the paper is removed, leaving the mural.

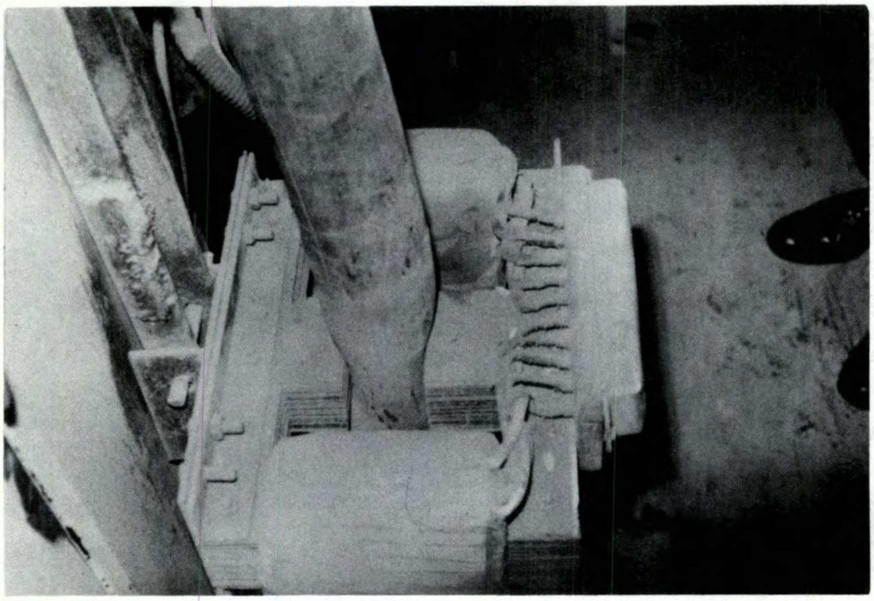

Figure 10 - Electromagnetic device on water supply line

CONSTRUCTION SITES - TASHKENT

Two construction sites - circus building and a hospital - were visited. Both of these buildings were of cast in place concrete construction. On both jobs, 380-volt electrical heating of the concrete after placing was used. The method of heating was through ¼-inch (0.6 cm) steel electrodes and aluminum wire connections. On the hospital job, fine wire mesh had been used as a forming material for the basement. This will not be removed.

UKRAINIAN CONSTRUCTION COMMITTEE - KIEV

The Ukraine has a population of 45 million of which 1.7 million live in Kiev. Since the end of World War II, new dwellings have been constructed for 9 million people. There are 1.5 million building workers in the Ukraine. In 1970, the average living space per person amounted to 14.5 cubic metres (510 cubic feet).

Prefabrication accounts for 53 per cent of all construction in the Ukraine and 2.5 million cubic metres (3.3 million cubic yards) of prefabricated concrete is produced each year. For industrial buildings, normal practice is to construct with prefabricated concrete up to spans of 36 metres (117 feet). Steel is used for more than 36 metres (117 feet). However, a new circular bus station having a span of 126 metres (410 feet) is under construction with prefabricated concrete.

In the Ukraine, the housebuilding plants are responsible for erection as well as the manufacture of components. Approximately 30 per cent of total construction is of large reinforced concrete panels. The capacity of Ukrainian housebuilding plants is 3.5 million square metres (37.8 million square feet) of living area per year. This capacity is to be doubled by 1975. Also during the next five years, more use will be made of lightweight concrete.

The Ukrainian Construction Committee employs 250 people and is responsible for technical research and development, architecture, building codes, technical policy and design. It also participates in the formulation of five-year plans. In the U.S.S.R., the central Ministry of Construction is responsible for all industrial design while the regional committees are responsible for all civil and housing construction design.

REINFORCED CONCRETE FACTORY FOR PRODUCTION OF INDUSTRIAL BUILDINGS - KIEV

One feature of this plant is the production of bow string trusses with prestressed wire in the bottom chords. The plant also uses electro-thermal prestressing of reinforcement for some members and mechanical pouring and finishing of slabs. Hot concrete was not used for moulding.

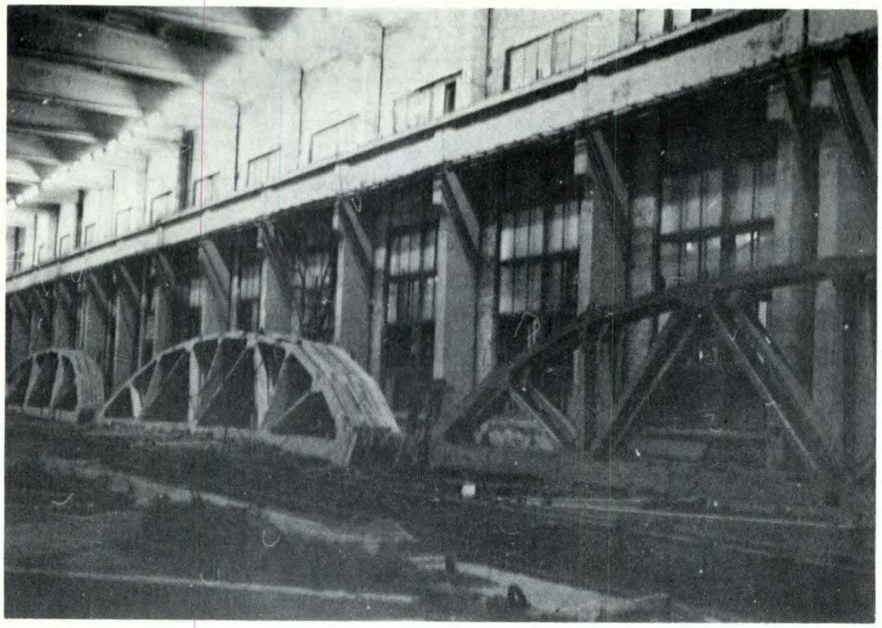

Figure 11 - Prefabricated bow string trusses

Figure 12 - Prefabricated bow string trusses

HOME BUILDING COMBINE - KIEV

This factory produces 10,000 apartments per year. The most notable feature was a computer-operated automatic control system used to control inventories and for dispatch and assembly purposes.

At this plant, concrete is produced at atmospheric temperature, poured into the mould and then virtually cooked at near 100°C (212°F). The factory manager stated that equipment for steam injection concrete heating would be installed in the near future. As is the case in all plants visited in the Soviet Union, no insulation material is incorporated in exterior panels but the thickness of these panels is adjusted for different temperature zones.

LENINGRAD CONSTRUCTION INSTITUTE (GLAVLENENGRADSTROY) - LENINGRAD

This institute deals with construction in the North Western U.S.S.R. It employs 1,000 people in its design department and 450 people in its research department. Research operations are divided into six sections: mechanical testing, physical testing, plastics, concrete, reinforced concrete and radio electronics in construction.

CONSTRUCTION SITES - LENINGRAD

Two construction sites - a bus depot and the Leningrad airport - were visited. The bus depot was being constructed from precast concrete arch shells and prestressed and post tensioned concrete members. It has a 98-metre (321 feet) clear span and the bays are 18 metres (59 feet) in width. At the Leningrad airport, ready-mixed concrete was being delivered by dump trucks and 380-volt electrical heating of the concrete after pouring was used. As in Tashkent, the heating was through ¼-inch (0.6 cm) steel electrodes and eluminum connecting wires.

Figure 13 - Electrical heating of concrete after pouring - Leningrad airport

HOME CONSTRUCTION COMBINE (DSK No. 2) - Leningrad

This combine produces 15,500 apartment units a year and employs 5,000 people, 48 per cent women. They work three shifts a day, five days a week. The combine consists of two factories and one assembly crew. It has its own computer which has reduced construction time for a nine-storey building, containing 200 apartment units, to 20 days from 28. The combine has also developed a galvanized metal joint system which, according to the chief engineer, reduced erection time by 35 per cent. Elements can be delivered to the site once they have achieved 50 per cent of their design strength.

The factory produces 700,000 square metres (7,560,000 square feet) of panels annually which are used in the construction of five and nine-storey apartment buildings. The factory produces exterior panels on a horizontal conveyor system with a heating chamber for fast setting. Lightweight aggregate (450 kg per cubic metre (760 lbs. per cubic yard) of concrete) is used for insulation purposes on these panels. This aggregate is produced at the factory from clay excavated from the Leningrad subway extensions. The production cycle is 5½ hours.

Bathroom units are produced in special moulding machines similar to concrete pipe machines. Inner partition panels are produced in battery moulds. For these, the concrete is poured at atmospheric temperature and subsequently "cooked" in the forms.

The chief engineer stated that, during the next five years, new standards will be introduced with more emphasis on quality. Apartment buildings will be up to 24 storeys and care will be taken to avoid repetition or "sameness". New finishing methods will be introduced and productivity is expected to increase by 80 per cent. Plans are to use steam injection at the mixer for heating regular concrete and the electrical discharge method for heating lightweight concrete.

At the combine's other factory, which was not visited, exterior panels are manufactured with cellular concrete cured in autoclaves. These panels are used in apartment buildings up to 16 storeys. Buildings above 16 storeys are constructed using a concrete frame and curtain walls.

Figure 14 - Finished apartment building

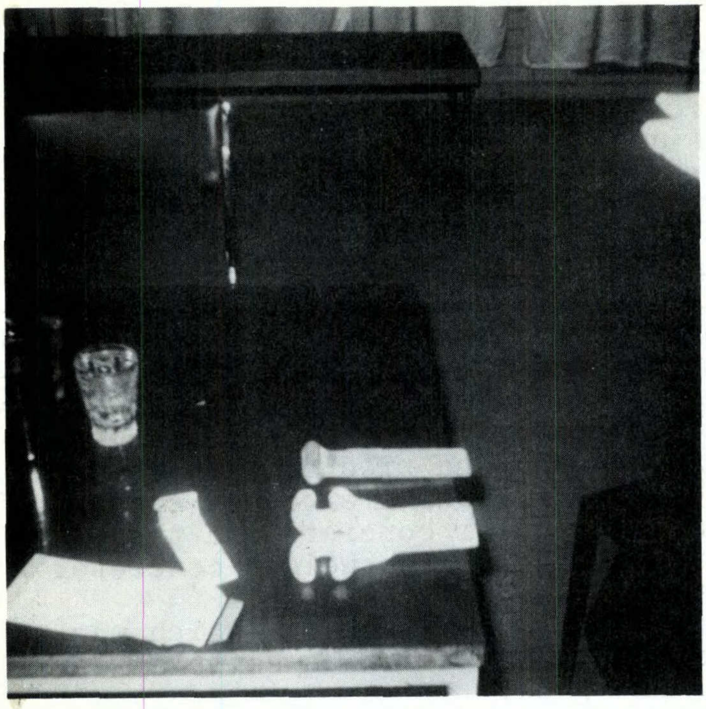

Figure 15 - Panel joining device

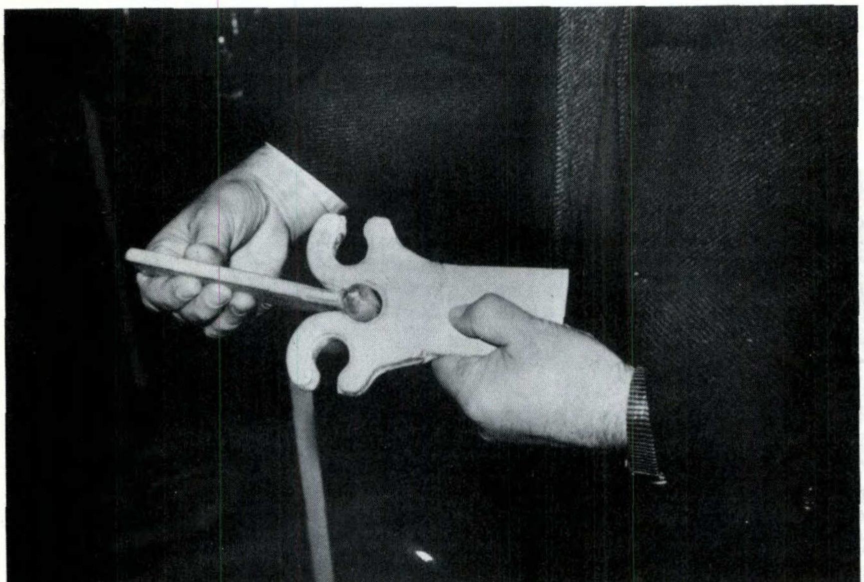

Figure 16 - Panel joining device

HOME CONSTRUCTION COMBINE (DSK NO. 3) - MOSCOW

This plant produces 370,000 square metres (4 million square feet) of living space per year. Exterior and interior panels are manufactured on a horizontal conveyor line system. A very dry mix is produced in a central batching plant from which the concrete is transported by conveyor belt to the various production lines. Steam is injected at the pouring points. The conveyor system, which is one storey wide, consists of steel plates 15 to 16 inches (38 to 41 cm) by one storey in height with attached ends equal to the slab width. Where the conveyor is flat, it forms the mould. The conveyor operates at 18 metres (59 feet) per hour when exterior panels are being produced and at 30 metres (98 feet) when interior panels are made. Reinforcing, provisions for door and window openings and panel spacers are placed on the conveyor at one end. The concrete is poured as the conveyor passes under the pouring point after which the exposed surface of the panel is finished. The conveyor with the panels then enters a low pressure steam curing chamber where a rubber belt comes in contact with the exposed surface. This hermetically seals the panel while it is in the curing chamber. The curing time is 3½ hours for exterior panels and 2 hours for interior panels. At the end of the line, the panels pass onto a tilting table from which they are removed by a crane. It is planned to extend these conveyors so that all finishing operations including window glazing are performed on a production line basis.

This plant employs 2,100 of which 200 are technical and administrative employees.

Figure 17 - Concrete Finishing

REINFORCED CONCRETE INSTITUTE - MOSCOW

It was stated that precast concrete heating will be mainly by steam discharge and that open transportation on conveyor belts from the mixer will not be a problem since some loss of moisture would be an advantage insofar as the water-cement ratio is concerned.

There is a new experimental installation at Minsk that produces panels under a combination of vibration, pressure and vacuum. In this procedure, casting is done in the vertical position.

Potassium carbonate has been used as an additive in order to lower the freezing point of concrete and to induce hydration of cement at lower temperature.

HOJGAARD & SCHULTZ A/S - COPENHAGEN

Hojgaard & Schultz A/S is a contracting firm with three precast concrete factories. The company employs 1,200 people and about 350 are factory workers. The factory visited produces precast concrete floor and wall slabs while the others turn out special products including long span, prestressed floor panels.

The factory visited employs 62 people and produces 110,000 to 125,000 metric tons (121,000 to 138,000 short tons) of concrete products per year. The factory building covers 1,400 square metres (15,100 square feet) and productivity is 1/3 man-hour per cubic metre (1.3 cubic yards) of precast concrete. Made-up reinforcing is purchased from another company.

The factory has two Schmidt Turbine mixers fitted with steam injection equipment. Each mixer has a capacity of ½ cubic metre (0.65 cubic yards). In these mixers, low-pressure steam (100°C) (212°F) is injected through the mixer arms after the other ingredients have been added. Four types of concrete are produced: 1) floor slab concrete with zero slump and water-cement ratio of 0.55; 2) low strength (240 kg per square cm) (3380 psi); 3) high strength (360 kg per square cm) (5070 psi); 4) wall slab concrete having a slump of 2 to 5 cm (0.8 to 2 inches) and water-cement ratio of 0.65 to 0.70 - strengths as above. The concrete is 55°C (131°F) after mixing.

Hollow core floor slabs are produced horizontally using travelling pans, a mechanical concrete distribution and finishing machine, and steel cores that are retracted after surface finishing. The slabs are then moved into the curing chamber, which is at 70°C (158°F), for four hours before cycling and stripping.

The floor slabs are 1 metre (3.28 feet) wide and are produced in two thicknesses. Six unskilled workers produce 100 elements per shift in this section which operates two shifts per day.

The other section of the factory produces interior wall panels in an automized travelling battery of 26 moulds. Hot concrete is poured into the moulds from the open top and no further heat is added. The curing time is four to five hours The slabs have a temperature of 55°C (131°F) when the forms are stripped. Only a minimum of reinforcement was used in the panels but quality appeared to be excellent.

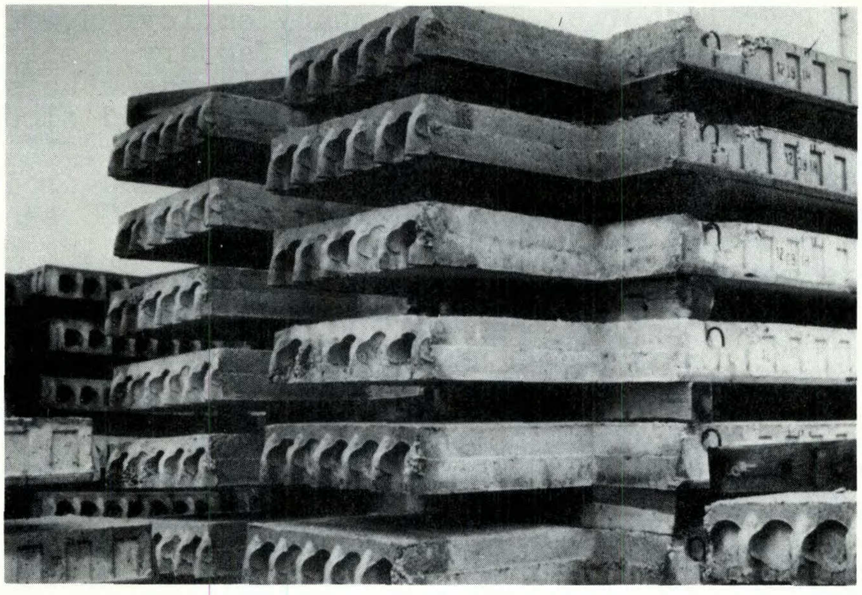

Figure 18 - Hollow core floor slabs

BETONVAREFABRIKEN SJAELLAND A/S - COPENHAGEN

This plant, which has 200 employees, manufactures a number of precast products including piles, exterior panels, apartment stairs, pipe and paving slabs. Exposed aggregate was used for many exterior panels and some apartment stairs. Hot concrete was not used.

One of the most notable features of this plant was a computerized over head crane set-up that automatically picked up apartment stairs after curing and delivered them to the stripping bay for form removal. Most apartment stairs had a smooth ground terrazzo finish.

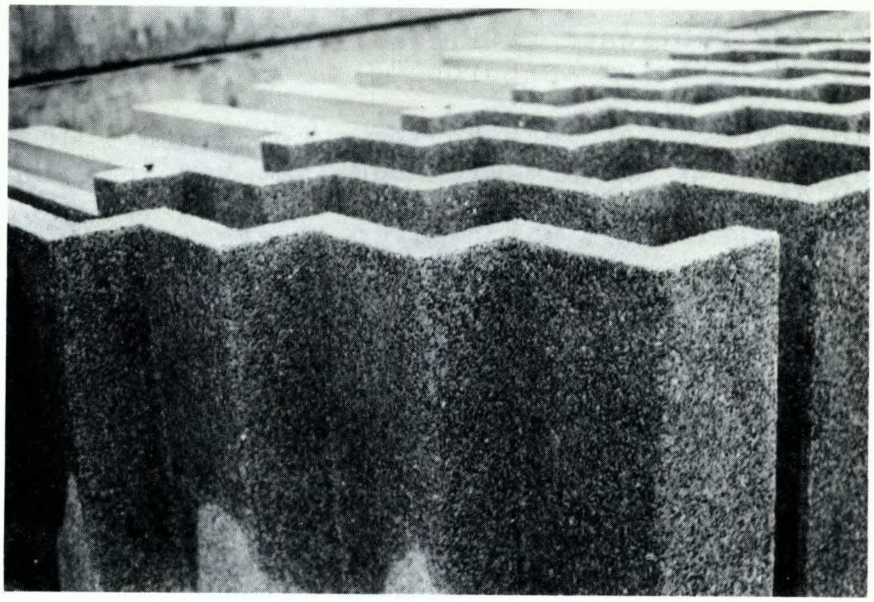

Figure 19 - Apartment Stairs

A/S DANSK SPAENDBETON - COPENHAGEN

This is a large prestressing plant which produces 25,000 metric tons (27,500 short tons) per year of girders, 75,000 metric tons (82,600 short tons) per year of standard prestressed slabs and tees, 15,000 metric tons (16,500 short tons) of reinforced concrete and 200,000 square metres (2,160,000 square feet) of prestressed planks. The firm employs 150 workmen and has a staff of 75.

Concrete is produced at 20°C (68°F) to 30°C (86°F). The mixer is fitted for steam injection but it was not being used. The reason given was that a high cement content is used in the mix and thus there was concern regarding flash setting if steam was used. Twenty-eight day strengths of the concrete were in the order of 6,000 to 8,000 psi (425 to 562 kg per square cm).

All production is on a 24-hour cycle with forms being heated to 70°C (158°F).

CONSTRUCTION EDMOND COIGENT, AULNAI-SOUS-BOIS, FRANCE

This plant is described in the Department of Industry, Trade and Commerce publication "Prefabricated Concrete Components in Industrialized Building in Europe".

Moderately hot concrete having a temperature of 40°C (104°F) is produced by using aggregates that have been heated by steam. Moulds are designed to heat the concrete to approximately 80°C (176°F), which gives an average curing cycle of three hours.

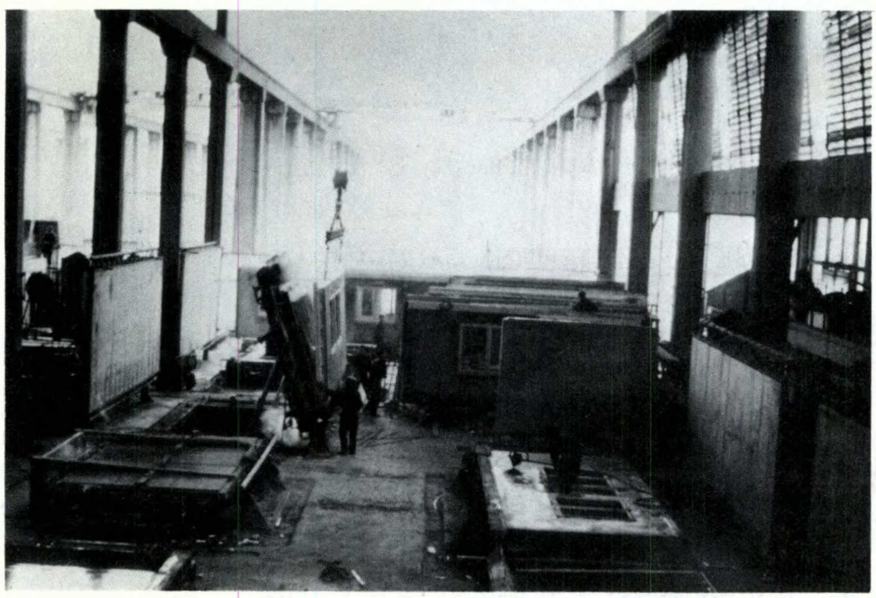

Figure 20 - Factory Bay

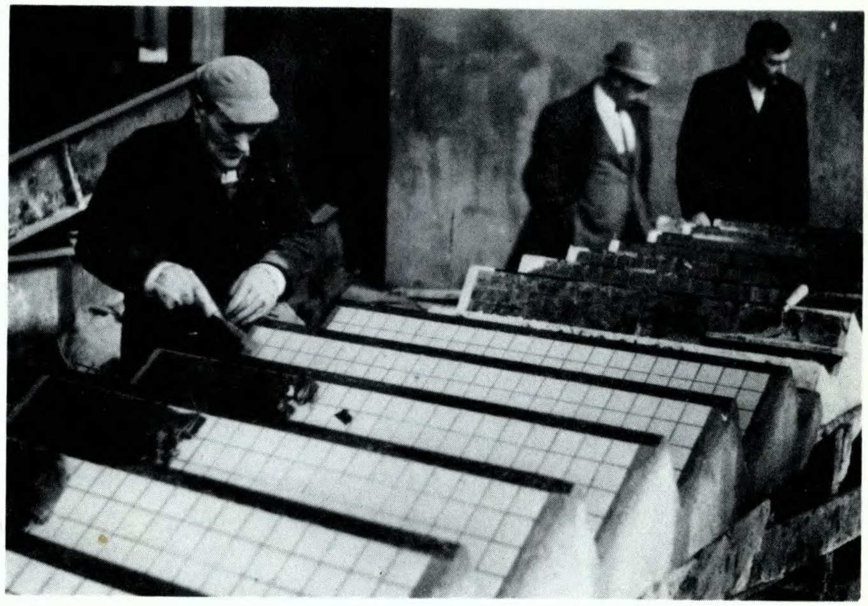

Figure 21 - Apartment Stairs

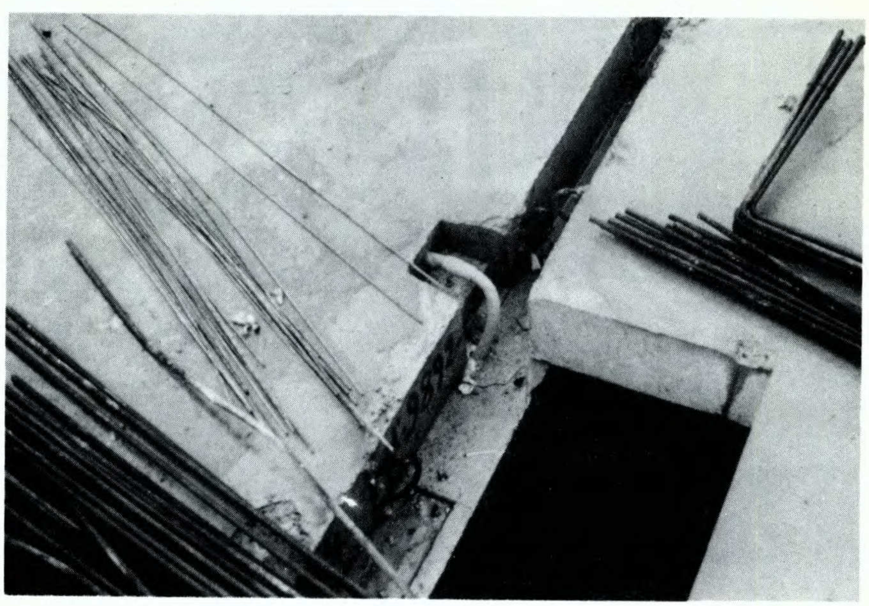

Figure 22 - Panel Installation

LES ENTREPRISES BALENCY & SCHUHL, VILLENEUVE DE ROI, FRANCE

This plant is described in the Department of Industry, Trade and Commerce publication "Prefabricated Concrete Components in Industrialized Building in Europe".

The moulds are heated by hot water to 40°C (104°F) and the aggregates are also heated. One notable feature is the system of battery forming which involves the pumping of concrete into the moulds from their base.

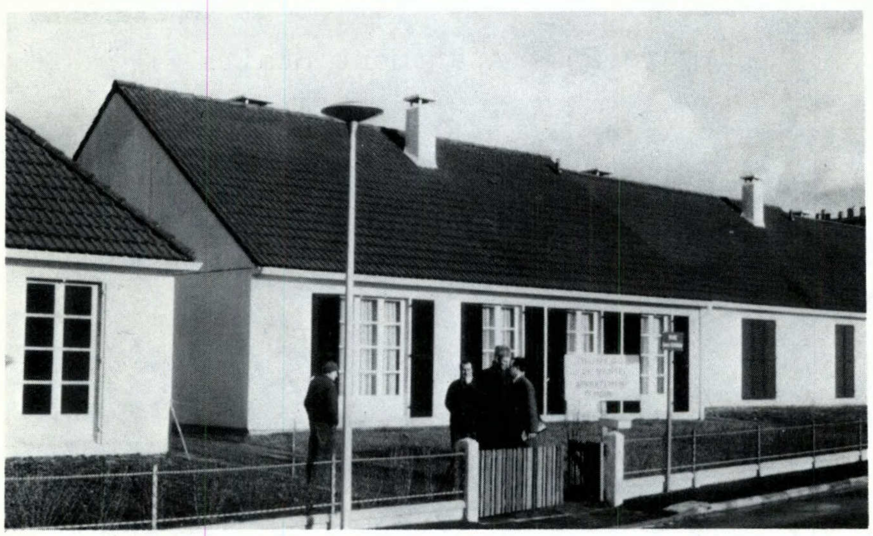

Figure 23 - Concrete Housing

SOCIETE RAYMOND CAMUS & CIE., MONTESSON, FRANCE

This plant is described in the Department of Industry, Trade and Commerce publication "Prefabricated Concrete Components in Industrialized Building in Europe".

Concrete is produced at a maximum temperature of 25°C (77°F) and moulds are heated to 50°C (122°F). Moulds can be used from three to seven cycles per day.

This plant has a number of battery moulds but most were in the process of being discarded because their construction had been too light.

Tile facings were placed and rolled into the upper face of the slab instead of being placed in the bottom of the mould as in other plants.

APPENDIX 1

conversion tables

1 centimetre	= 0.3937 inches
1 cubic metre	= 35.3144 cubic feet
	= 1.3079 cubic yards
1 kilogram	= 2.2046 pounds
1 kilogram/sq. centimetre	= 14.223 pounds per sq. inch
1 kilogram/cu. metre	= 1.685 pounds per cu. yard
1 metre	= 3.2808 feet
1 square metre	= 10.7638 square feet
1 metric ton	= 1.1023 short tons
degrees Fahrenheit	= 9/5 (degrees Centigrade) + 32

APPENDIX 2

STUDY TOUR MEMBERS

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APPENDIX 3

ITINERARY

January 9 - Moscow

Technical meeting with Design Committee of the Institute of Housing Construction.

January 11 - Novosibirsk

Technical meeting with chief architect of Novosibirsk.
Technical meeting with designer of electrical discharge heating hopper.
Visit to construction site.

NOTE: The original itinerary called for factory site visits in Irkutsk and Bratsk on January 12 and 13. However, this portion of the tour was missed due to weather conditions (a 48-hour blizzard which left the group stranded at Novosibirsk airport).

January 14 - Tashkent

Technical meeting with Tashkent Building Construction Research Institute including visits to laboratory and pilot plant.

January 15 - Tashkent

Visit to large prefabricated reinforced concrete factory.
Visit to housebuilding factory.
Visit to two construction sites.

January 18 - Kiev

Technical meeting with Ukrainian Construction Committee.
Visit to reinforced concrete factory for production of industrial buildings.

January 19 - Kiev

Visit to home building combine.

January 19 - Leningrad

Technical meeting with Leningrad Construction Institute.

January 20 - Leningrad

Visit to two construction sites.

January 21 - Leningrad

Visit to home construction combine (DSK No. 2)
Visit to construction site.

January 22 - Moscow

Visit to home construction combine (DSK No. 3)
Technical meeting with Reinforced Concrete Institute.

January 25 - Copenhagen

Visit to: Hojgaard & Schultz A/S.
Betonvarefabriken Sjaelland A/S.
A/S Dansk Spaendbeton.

January 26 - Paris

Visit to Construction Edmond Coignet.
Visit to construction site.

January 27 - Paris

Visit to Les Entreprises Balency & Schuhl.
Visit to construction site.
Visit to Société Raymond Camus & Cie.