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(R) PROVISION OF ADVISORY ASSISTANCE IN THE DEVELOPMENT OF THE BUILDING INDUSTRY .

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MONGOLIAN PEOPLE'S REPUBLIC .

Terminal Report

Prepared for the Government of the Mongolian People's Republic by the United Nations Industrial Development Organization, the executing agency of the United Nations Development Programme

Based on the work of V. Merunovich, expert in industrial construction

United Nations Industrial Development Organization
Vienna

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Explanatory Remarks

The following abbreviations have been used in this report:

BPRI	Building Production and Research Institute
CMEA	Council for Mutual Economic Assistance
HCC	Housing Construction Combine
MPR	Mongolian People's Republic

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Contents

I. Familiarization with construction in Mongolia

The expert was on assignment in Mongolia from 20 July 1977 to 21 March 1978 as a UNIDO consultant and worked at the Building Production and Research Institute (BPRI).

During his stay in the country, the expert travelled to the aimaks (regions) of Öbör Hangay, Ara Hangay, Selenge and Doronod, where he acquainted himself with local building conditions and the construction industry.

Principally, the expert familiarized himself with construction activities in Ulan Bator. He visited the following:

(a) A housing construction combine employing Soviet specialists. (The combine's production capacity of 70,000 m^3/year is the approximate equivalent of 46 houses/year; one house weighs 7,000 tonnes.) This combine has already been in operation for 16 years. It manufactures prefabricated large-panel houses of reinforced concrete.

(b) A light-weight concrete plant which is at this time being modernized with the assistance of Polish specialists. (Following renovation, the combine's current capacity of 27,000 m^3 of concrete articles a year will be increased to 36,000 m^3 a year.) Sixty per cent of the output is used for the heating of walls made of other materials, with the remaining 40 per cent used for the production of self-supporting walls.

(c) An electrical and sanitation plant which produces sanitary ware and electrical articles for houses in addition to metal trusses 12, 18 and 24 meters in length. (Output is 900 tonnes of metal structures a year, with all the steel imported from the USSR, as there are no local iron and steel plants.)

(d) A wood-processing combine which manufactures furniture, windows (39,000 m^2/year), doors (26,000 m^2/year) and floor boards (10,000 m^3/year). In the MPR, all woodworking enterprises come under the Ministry of the Timber Industry.

(e) A brick-works with a production capacity of 60 million bricks a year.

In addition, the expert visited installations being built by the Technical Assistance Trust for Large-Panel Housing Construction. The structural elements are obtained from the housing construction combines.

The trust puts up six to seven good-quality houses a year. (It employs Soviet specialists in a ratio of approximately one specialist to every ten local workers.)

The following kinds of building standards are in effect in Mongolia:

- Building material standards;
- Planning and design standards (Soviet Building Standards and Regulations are used for this purpose);
- Standard procedures for building operations and acceptance approval;
- Estimate standards.

(Design standards specify a minimum thickness for brick walls of 64 cm, i.e. 2.5 bricks.)

The expert also visited a number of aimak and somon (district) centres.

Located in every aimak centre are construction offices, each of which is in charge of several teams of construction workers and the related auxiliary construction facilities. Each aimak construction team employs from 30 to 50 persons.

In each case, the auxiliary facilities include the following production units:

- A concrete-mixing unit;
- A joinery shop;
- A lime preparation shop.

There are also tuff-concrete plants (for example in Tsetselig, producing 300,000 units/year).

The aimaks are supplied with reinforced concrete elements from Ulan Bator. A plant for the production of reinforced concrete is, however, currently under construction at Arvaykher; the cement is to be obtained either from Darkhan or Ulan Bator. Not far (40 km) from Arvaykher there is a brick-works which operates only from 15 April to 15 September and turns out 2 million bricks. These bricks are produced from red clay, an excellent raw material.

As a rule, each somon centre has one construction team, consisting of 15-20 persons.

There are exceptions, however. In the Khudzhirt somon centre, for example, there is a construction office which manages three teams with a total strength of 120 workers.

As a further part of his assignment, the expert inspected the woodworking combine at Sukhebator, where 630 persons are employed. At present, this combine is turning out 56,000 m^3 of sawn timber a year. When it originally went into operation (in 1959), the monetary value of this combine's output was 3 million tugriks a year; following renovation, this figure has risen to 20 million tugriks a year. Once renovation has been completed (in 1980), the monetary value of the goods produced by this enterprise is expected to total 70 million tugriks.

Technical Assistance Trust No. 2 in Darkhan employs 750 persons, including 94 Soviet specialists. The trust builds agricultural installations, schools, houses and hospitals. The expert also visited the cement plant at Darkhan.

In the town of Choybalsan, the expert visited branch enterprise SOT-3, which is managed from Ulan Bator. A total of 1,800 persons are employed at this site.

Not all construction organizations come under the Ministry of Construction and the Building Materials Industry. There are, for example, a number of organizations which come under the Ministry of Agriculture. The woodworking combines (a number of which, such as those at Tosotsengel and Sukhebator, manufacture wooden houses) are under the jurisdiction of the Ministry of the Timber Industry. There are, in addition, certain Soviet trusts which are engaged in general construction work.

According to the statistical yearbook of the member countries of the Council for Mutual Economic Assistance for 1976, capital investment in the Mongolian construction sector for 1976 totalled 79.4 million tugriks. This volume of investment is rising much faster in Mongolia than in the other CMEA countries (in 1972 investments amounted to only 24.5 million tugriks).

II. Conclusions

Building materials

Mongolia has a shortage of building materials, and this fact has seriously affected living conditions in the country. Some 77.5 per cent of the population currently live in yurts.

What must be done to increase the production of building materials?

In the first place, there is a need to construct new plants for the production of building materials. But what kind, and how should they be built? Where should the major emphasis be focused and in what areas should investments be concentrated? The following approaches are possible:

1. Establish a large number of housing construction combines throughout the country. At present, one such combine is in operation in the MPR, and two others are under construction, each to have a production capacity of 70,000 m^2 of living space a year.

2. Build more brick-works.

3. Step up the programme to build cellular-concrete plants.

4. Build wood-processing combines (for wooden houses).

5. Increase the number of tuff-concrete plants.

6. Improve the design of yurts.

The approach calling for the construction of a large number of housing construction combines equipped with the modern technology to produce high-quality housing is inadvisable in the light of existing conditions in Mongolia.

There are three reasons for this:

(a) The establishment of housing construction combines is too expensive an undertaking for the MPR to be able to afford an extensive programme to erect these plants throughout the entire country.

(b) The long-distance transportation of the heavy components produced by the HCCs over Mongolian steppe roads is not economically feasible.

(c) The erection of these houses requires the use of heavy cranes which are not produced in the country.

All these factors add to the cost of the houses.

As a result, what opportunities do exist for improving the building-materials supply situation must necessarily involve increasing the construction of brick-works and houses fabricated from light-weight concrete (light-weight concrete blocks are similar to bricks), as these houses are cheaper, require no heavy equipment for their construction and assembly, and are easier to transport. To manufacture the necessary roofing, it would be advisable to begin production, at the auxiliary facilities attached to each aimak centre construction office, of light-weight hollow reinforced-concrete panels of up to 6 m in length, since it is economically unsound to bring in these components by truck from Darkhan or Ulan Bator.

Short-term regional housing requirements could be met by building wooden houses, but on a longer-range basis this is not an advisable approach, as it would result in damage to the environment (through the depletion of forests). The construction of a number of wood-processing enterprises can, however, be recommended at this juncture since, once current building requirements have been satisfied, these facilities can be used to manufacture furniture, which, for a long time to come, will continue to be produced from wood.

Concomitantly, more tuff-concrete plants should also be built.

It is impossible to heat a yurt without modifying its design and forfeiting all the advantages of this type of structure. Yurts have no windows; they "breathe" mainly through their walls, and it is only through this "breathing" that good, healthy and hygienic conditions can be regenerated within them. If a yurt is heated, its interior is cut off from the outside atmosphere and this "breathing" process no longer operates. This results in a need for windows that can be opened (thereby changing the design of the yurt), or else it becomes necessary to open the door more often (which means changing the habits of the people, something that is virtually impossible).

Consequently, all that can be done in order to heat a yurt is to raise its average temperature slightly. Mongolian scientific research institutes are currently working on this problem.

One way to supply the rural population rapidly with housing and public buildings would be to build inter-aimak plants to manufacture standard transportable light-weight structural units; however, this approach is not promising at this time since the country does not produce its own steel, which is the basic material used in the manufacture of all standard transportable light-weight structures.

It is evident from the introductory analysis given above that bricks and cellular concrete are the most suitable materials for building in Mongolia. They have similar physical and mechanical properties, and the only factor used to determine the thickness of walls made from these materials in low-rise buildings is the heat transfer coefficient.

In order to ascertain which of these two materials is more suitable, a more detailed analysis, including cost estimates, is required.

Three factors affect the cost of construction in the MPR:

1. The heat-transfer coefficient of the building materials (because of the low temperatures this may drop to as low as -60°C in some areas);

2. The large distances over which the materials must be transported (mainly by truck) in a country where normal, asphalt-surfaced roads are the exception;

3. The great depth of the foundations, which in some areas may reach 5 m in the case of taller buildings (5-8 stories).

Each of these three factors is discussed individually below.

1. The heat-transfer factor for brick: 0.5-0.6 kcal/m^2/hour; average value: 0.55 kcal/m^2/hour.

Heat-transfer coefficient of cellular concrete:

Concrete weighing 500 kg/m^3: 0.11 kcal/m^2/hour;
Concrete weighing 700 kg/m^3: 0.15 kcal/m^2/hour;
Average value: 0.13 kcal/m^2/hour.

$$\frac{0.55}{0.13} = 4.23$$

Consequently, on the basis of physical considerations (heat transfer), a cellular-concrete wall can be 4.23 times thinner and yet still provide the same thermal characteristics.

On the other hand, brick is cheaper than cellular concrete. According to standard estimates:

1 m^3 of brick costs:	166 tugriks
1 m^3 of 500-kg cellular concrete costs:	193 tugriks
1 m^3 of 700-kg cellular concrete costs:	238 tugriks

The average cost of one m^3 of cellular concrete is:

$$(193 + 238)/2 = 215.5 \text{ tugriks.}$$

Thus, cellular concrete is 1.3 (215.5/166) times more expensive than brick. One may therefore summarize by saying that a brick wall is 3.254 (4.23/1.30) less expensive than a wall constructed of cellular concrete.

2. The cost of transporting building materials, in the case of structural elements of nearly the same design, depends on the weight of the load:

Specific weight of brick:	1,800 kg/m^3
Average specific weight of cellular concrete:	600 kg/m^3

At the same time, 4.23 times more brick must be transported than cellular concrete (see point 1).

Thus, it will cost 12.69 ((1,800/600) x 4.23) times more to transport brick than it does to transport cellular concrete.

3. If a cellular-concrete wall weighs 4.23 times less than a brick wall, then it is also true that less concrete will be used in the foundations. A foundation wall constructed of cellular concrete may be thinner than a brick wall for the same permissible ground pressures.

Taking all these factors into account, it is clear that, as a wall-building material, cellular concrete offers overwhelming advantages over brick.

To this should be added the fact that cellular concrete is a good heating agent for reinforced-concrete roofing in a wide variety of buildings. The production of this material should, therefore, be actively promoted.

Structure of construction organizations

The question of the structure of construction organizations is of secondary importance in the actual performance of building and installation operations.

The major factor is industrial experience. The technical organization is modelled basically on the Technical Assistance Trust in which Mongolian specialists, working together with specialists from industrially more developed countries, learn the techniques and methods of production and study new skills.

Attention therefore must be focused on those trusts in which there is a 1:7 ratio between foreign specialists and local workers. After he has worked for three years in a trust of this kind, a Mongolian worker can transfer to a trust in which this ratio is only 1:15, and after three years of experience there, to one with a ratio of 1:50.

Only after the workers have completed this kind of 9-year apprenticeship training period, can trusts consisting entirely of Mongolian personnel be organized.

This is the only way to avoid serious problems in construction and installation work as the result of a lack of industrially experienced local workers.

The figures cited above may be modified somewhat once the programme just described has been set in motion.

In this way, the emphasis is switched from the problem of creating the best possible organizational structure to one of providing planned and systematic training for local personnel.

III. Recommendations

1. Advisory assistance should be given with a view to improving the production of a number of building materials from locally available raw materials, primarily in such areas as the manufacture of refractory materials, the processing of natural stone, the production of natural dyes, etc., and also the increased output of cellular concrete, which under Mongolian conditions is the best material to use for building walls.

2. A programme should be prepared to assist the Building Production and Research Institute, focusing on:

- The introduction of new building research programmes in such areas as structural physics, standards, heating and ventilation, water supply and sewerage systems, the testing of structural elements and parts, and soil mechanics, especially permafrost and seismic research;
- The establishment, at the Institute, of a permanent system of advanced training courses for construction engineers and technicians, accompanied by the organization of the necessary infrastructure and the formulation of the required programmes;
- The establishment, at the Institute, of a school for advanced production methods designed to train qualified personnel, instructors in construction-related subjects, team foremen and site supervisors;

  Existing advanced training schools and courses should be methodology centres engaged in administering an extensive personnel-training programme which will, in the main, be organized at the technical assistance trusts. In order to place basic construction work on an industrial footing, the training of mechanics should be concentrated at the mechanization trusts, under the methodological supervision of the school and advanced training courses;
- Assistance in the establishment, at the Institute, of a programming group able to prepare suitable programmes for the development of the Mongolian construction sector on the basis of instructions from the Ministry of Construction and the Building Materials Industry, followed by the use of these programmes for cost-accounting purposes;
- Assistance in the establishment, at the Centre, of an integrated information centre on construction, to include a technical and patent library and reproduction/copying unit, plus an editorial group to publish periodic building information bulletins.

3. Consideration should be given in the future to expanding assistance to the Ministry of Construction and the Building Materials Industry in setting up industrial construction bases in the administrative regions of the country and in conducting detailed studies of the problems involved in the use of locally available raw materials for construction purposes, the rational siting of construction organizations and construction industry enterprises, and the formulation of rational schedules for the transportation of the raw materials and building materials needed for their production.

4. In order to meet the requirements of the building-materials industry, two or three repair centres staffed by highly qualified journeymen-mechanics should be set up in the country. (Since different CMEA countries have built plants in Mongolia, a breakdown, given the lack of spare parts, may mean a serious disruption of production for about one year.)

5. Using existing planning institutes and organizations as a basis, a programme for improving construction planning geared to industrial development targets should be prepared in co-operation with the Ministry of Construction and the Building Materials Industry.

6. Assistance should be given in organizing the production of heat-insulation materials for which raw materials are available locally, so as to reduce imports of these items.

7. In the light of the severe manpower shortage in the construction sector, a major effort should be made to increase substantially the industrialization of construction operations and reduce labour costs through the mechanization and automation of the most important processes, both at building sites and at enterprises of the building-materials industry.

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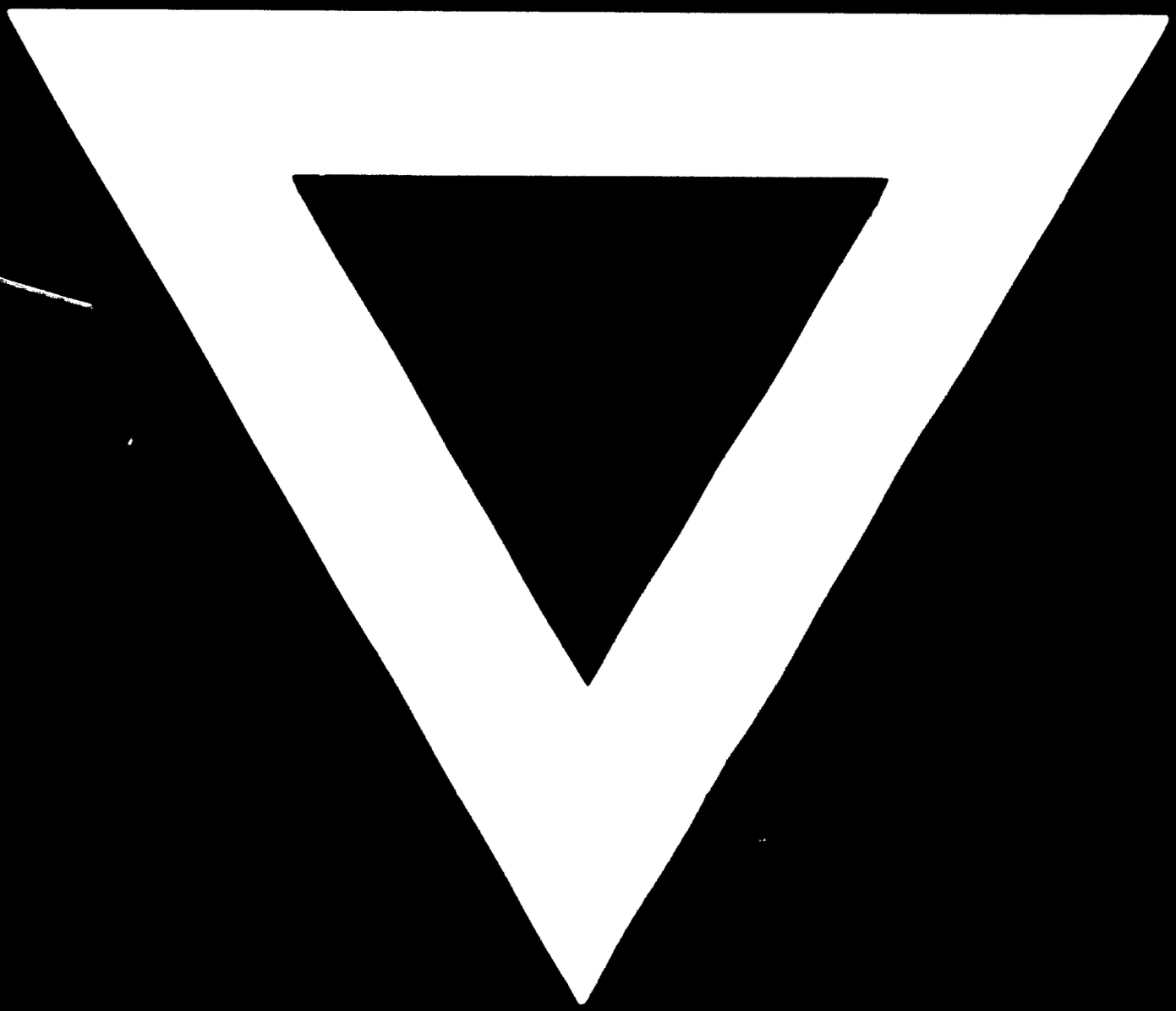

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