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SOVIET CONSTRUCTION UNDER
DIFFICULT CLIMATIC CONDITIONS

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Soviet Construction Under
Difficult Climatic Conditions

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In the course of several exchange programs over the last few years I had the opportunity to get acquainted with numerous construction activities with special emphasis on cold regions and permafrost. As most professional visitors do, we had the opportunity, on several occasions, to visit the impressive industrial complex around the Bratsk hydroelectric station on the Angara river, but also had the rare opportunity to see the gigantic Ust' Ilimsk hydroelectric station under year-around construction including the construction of the developing town. Another older hydroelectric installation near Irkutsk was visited and also the Baikal Lake with its pollution problems and their solutions.

Access was provided to the Science City Akademgorodok and the new town project of the Agricultural Academy near Novosibirsk. Extensive visits were made to construction activities in ~~in~~ Novosibirsk itself with emphasis on recreational structures. This included al-

so hydroelectric and navigational structures on the artificial "Sea of Ob'". The Library of the Academy of Sciences in Novosibirsk (one of the best, if not the best organized, libraries in the world) provided many and valuable clues in the form of literature sources.

Construction problems on the new BAM railroad line, paralleling the China border at a respectable distance, were discussed at the Institute for Railroad Engineers in Novosibirsk which has some of the finest specialists in snow and in ice engineering.

Several visits were made to Yakutsk, a large city near the coldest inhabited place on Earth. Permafrost conditions were examined in the surroundings of Yakutsk in both directions along the Lena river and for an appreciable distance on the Aldan river. Overland trips were made in the surroundings, demonstrating permafrost effects and engineering difficulties.

Yakutsk is the home of the Permafrost Institute of the Academy of Sciences and houses also an Institute devoted to Northern studies and the solution of practical problems. The latter we were not able to visit. However, an institute for construction research stationed in Krasnojarsk sent a representative and we had access to their field activities.

After being properly cautioned that the conditions

were too severe in this part even for political prisoners we were transported by plane and overland, bypassing the famous diamond mines near Mirnyj, to the huge Černyševskij dam on the Viljuj river where we learned about techniques of year-around construction even under severe winter conditions.

The highlight of exposure to pioneering construction no doubt, was a visit to the open pit coal mines at Nerjungri in the summer of 1978. It is truly astonishing what was accomplished over a very few years. The excavation difficulties under permafrost conditions are enormous. The most advanced technology with the help of American, Canadian and Japanese know-how was failing under the challenge of permafrost: a tough proving ground for technological advances. A whole frontier town with ten thousands of people was built in a very few years without adequate transportation lines. A dirt runway available at Čul'man (frequently closed due to inclement weather) with a very difficult dirt road leading to the site on which we were almost overturned and thrown into a river due to an accident. Several hundred kilometers separated the mine from the Transiberian railroad requiring torturous overland transport over permafrost with a seasonal quagmire during the summer.

A northern extension of the BAM line was built. It

only then reached Berkakit which we had the opportunity to visit. The line was being extended to Nerjungri and it, presumably, now is in operation. Brief stopovers were made in Omsk.

Other co-workers had the opportunity to visit Magadan and surroundings, where extensive preparations are being made for the construction of hydroelectric stations on the Kolyma River (of ill repute as the past location of concentration camps.) This activity will aid in the processing of gold. Other places, given access to, were Habarovsk on the Amur near the Chinese Border, Krasnojarsk which used to be a closed city and a gigantic dam under construction near the Chinese border on the Irtyś River. Other activities visited by our co-workers are Siberian oil and gas fields and gas pipelines with cold regions problems especially in the Tjumen' region.

I was also exposed to extremely difficult foundation problems in a loess region near Taskent with the ever present danger of severe earthquakes.

A natural question arises about cold regions construction activities in the Far North. We expressed interest, in particular for Noril'sk. However, the Far North is a closed border region even since the U.S. Navy demonstrated an under ice capability with nuclear submarines. Even Soviet citizens require special clearance

to live, work or visit in these areas. However, we met many specialists working in the Far North, for example from Nori'sk, Vorkuta or even Murmansk and are reasonably familiar with construction problems in such areas.

Many institutes, specializing in cold regions problems are located in the European part of the Soviet Union. The most prominent is our counterpart, the Arctic and Antarctic Research Institute in Leningrad. Access is difficult, although I managed to visit the installation on a couple of occasions and met with their specialists in Leningrad and abroad. This Institute pioneered with an ice model tank in the sixties and did much of the initial work in ice engineering. This, of course, is now superseded by the CRREL Ice Engineering Facility, which is now the most modern in the world and previously by special ice modeling tanks in Finland and Germany, primarily for the testing of ice breaking ships. We had contacts with the Hydrotechnical Institute in Leningrad, with its Division devoted to ice technology and are enjoying a good exchange relationship with LENZNIIEP, an architectural engineering institute specializing in extreme cold regions. The exposure to an ice navigation institute was brief. The Leningrad harbor operating under winter conditions was shown and ice breaker operations in the Gulf of Finland were demonstrated. The Leningrad library facilities for senior specialists

were made available. Of course, numerous construction projects were shown in Leningrad, as well as in Moscow, Riga and Volgograd.

In Moscow we enjoy reasonably good cooperation with the Institute for Foundations and Underground Construction (formerly the Permafrost Institute) with specialists known the world over. We had access to the Lenin library and a special central construction library. Good contacts were established with the Civil Engineering Institute (excellent permafrost specialists), with the Manager of an Institute devoted to offshore structures, as well as the Moscow University and Academy of Sciences. Some exposure was provided to the Volgograd hydroelectric facility under winter conditions.

In addition numerous discussions were held with visiting Soviet specialists in the United States including officials at the highest level of GOSSTROJ, the State Construction Agency. All construction in the Soviet Union, of course, is being done by the government. Gosstroj itself a few years ago had a budget of about 115 B rubles, the whole amount of construction by all activities is now of the order of 280 B rubles or almost 300 B rubles.

As an important knowledge base we must add that the Library of USA CRREL has the best microfiche collection of relevant cold regions literature in the Western World.

Specialists in related fields are invited to have advantage of this opportunity and make use of these extensive collections. The library is continuously being updated by two annual volumes of the "Bibliography on Cold Regions Science and Engineering", monthly supplements and a computerized information retrieval system readily available to interested parties. A large portion of this information deals with construction problems in cold regions in general and is available in Russian specifically.

In preparing this presentation I was specifically asked to abstain from technical engineering discussions and to concentrate on socio-economic aspects. I am not a specialist in these fields, although I made many relevant observations, of course.

Visitors, chaperoned by intourist, normally are being shown numerous modern structures from some distance and are being guided away from charming old-time wooden structures, covered with ornaments in the old Russian style. They rarely have a chance to see how the contemporaries really live. More and more old churches are being carefully restored by real masters of the art and shown to foreign visitors, in particular the magnificent monasteries-fortresses built by monks in Zagorsk and near Vladimir and Suzdal' in the Middle Ages.

Our experience, in general, was quite different. Our professional hosts led us in and around the structures

observing construction in progress in detail and first-hand.

Any visitor to the Soviet-Union will find a curious mixture of the positive and the negative, of the good and the bad. So far as structures are concerned the first impression usually is lack of quality, poor finishing and poor durability. Soviet visitors to this country usually are impressed by high quality, good workmanship and durability. Inevitably discussions rotate around the subject, how we are able to achieve these desirable characteristics and organize our work efficiently.

Our standard answer is motivation. Everybody is motivated to make a profit, to do good work, to advance, to earn more money so that he can buy more or better types of the readily available goods. With such answers we are not getting anywhere. They answer that only the government can implement grandiose undertakings, such as the tremendous construction efforts made in the Soviet-Union. Reportedly some 16% of the Gross National Product goes towards construction versus 10% in the United States. To this one must add the military efforts which consume a considerable part of GNP, just to stay at par with the rest of the world (capitalist and China and interests in the developing third world), as well as educational efforts, health expenses, etc. and not much is

left for consumer products. There are no significant material incentives to do better work, to earn more, to organize better, to pioneer, to enterprise. Everybody draws a modest salary, lives in very inexpensive state furnished apartments, no charge for medical expenses, no charge for education, cheap books, buys clothing at a high price and does not have much money left for anything else which is not available anyhow, except very expensive automobiles with long waiting lists. Nobody can buy real estate, except summer houses (dača) in some cases, which are very popular. One wonders about incentives to come to work in extreme cold regions, but we will discuss this point later.

The lack of material incentives for the vast majority of the population is probably the main reason for the difficulties observed. Ideological appeals on huge red banners have little appeal. Our Soviet visitors, noticing the difference however, feel that there must be something special, something else to learn about American techniques, perhaps some organizational methods, computer driven scheduling, special methodologies they could adopt.

The first impression about man produced housing in the USSR is poor. All over the Soviet-Union multi-story apartment buildings are put together with prefabricated

panels, uniform rows until the spectator is fed up with it, drab exterior and interiors.

I learned, however, a lesson standing on top of one of these structures and watching the work. Under the circumstances the techniques employed are an absolute necessity for quick progress in cold regions. Work proceeds in three shifts a day, twelve months a year without interruption except for severe inclement weather (or snags in supply of materials). But what is severe weather in the middle of Siberia in the coldest part of the world? Panels are being lifted and put in place by huge cranes, hooked and welded together. Very little cement is being used in place with special warming techniques. The workers spend half an hour to 45 minutes in the biting cold, then huddle together in a warming-up cabin and rush out again to continue the assembly. All of this is being done with continuous scheduling and prodding to fulfill never ending plans. There are no strikes, grievances are being handled by middlemen, only appeals all over to work for the common good. People are giving up on quality if they are continuously prodded to complete the work. There is very little quality control in the factories mass producing the building components.

The bearing part of the buildings are the interior walls mass produced in concrete. This is quite different from our steel framework with light interior walls. I was told in Taškent that such buildings are standing up well under earthquakes. The exterior walls are light and are preferably made from foam concrete to provide better insulation. There used to be problems with handling the exterior joints, but these have been resolved. The uniform look of these apartment houses bothers the Soviet architects. They tried better and better solutions to avoid uniform expression, such as changes in color and texture or trying a variety of combinations from basic building blocks. Also varying placements of buildings are helpful. A delightful solution was found in Taškent, where traditional filigrane type exterior facades were added to provide variety. As a result the apartments are not subjected to the torching heat, but are always in shade. In Siberia triple windows are being used to handle the cold.

One aspect the Soviets are way ahead of us is district heating. Whole blocks are being heated from central locations through utilidors, thereby saving energy. The method is also highly advanced in Sweden. Our own calculations (CRREL) show that heat can be transported over long distances surprisingly efficiently using modern technology.

Waste heat from nuclear power plants, factories, electrical plants can be used efficiently for such purposes. The initial capital investment can be high and certainly requires coordinated efforts but results in enormous energy savings in the long run. The new capital in Alaska may well become the first demonstration project of this kind. Development in this direction is inevitable also in the United States.

One may wonder why high rise apartment buildings are being built in the middle of the wilderness. Again, it is a necessity under the special circumstances of cold regions. Efficient heat distribution was already mentioned, efficient transportation is another reason, the most important reason are foundations in permafrost.

Research and experience has shown that special care must be devoted to foundations. Single heated dwellings warm and thaw the ground underneath and sink over the years. Bigger buildings show severe distress due to differential settlement. The solution in most cases are expensive ventilated foundations. Since they are expensive, advantage must be taken of the foundation, therefore high rise buildings are the answer. In most cases pile foundations are being used with a free space under the building with free access to cold and wind, preserving thereby the permafrost.

So called thermal piles with convective heat transfer have been used successfully.

We cannot talk about Soviet construction without mentioning the role of women. Women are all over construction sites, not just cleaning up. They do also the most difficult jobs usually reserved for men. I have seen women carrying concrete blocks, mixing concrete, women as crane operators, women as highly qualified welders, women finishing walls and ceilings, women as construction supervisors and quality engineers. If at all, men are drifting towards the softer, physically less demanding jobs, such as machine operators or union representatives, keeping peace and harmony or negotiating with party officials or the planning departments.

I was told that this trend started during World War II, when the home front needed every woman for production. The trend just became a permanent way of life. Not all women enjoy this role but many are obviously proud to do a man's job even under the most adverse conditions.

Nevertheless, everywhere we were told about labor shortages. The contractors (government agencies, of course) are hiring qualified machine operators away from each other. As a result wages of such specialists continue to rise while professional salaries of people with university education stagnate - a common complaint.

What are the incentives for people to work under extreme and harsh conditions? Nobody likes to talk about forced labor, this is a bad memory of the past. There are dark rumors that somewhere forced labor still exists. Some officials are even willing to admit that forced labor was used initially, but these are "things of the past, not anymore, not now!" Stalin is thoroughly discredited throughout the Soviet-Union, at least officially; his name does not appear anywhere except in Georgia. (I have seen, however, leaflets with his image stuck to windshields of trucks in Siberia.)

There were, of course, mass deportations, for example, in the forties from the Baltic states. I did meet some of their descendants in Siberia, adjusted, intermarried, educated and reasonably satisfied. How about their parents? In many cases they returned to their homeland after massive reviews by military courts of sentences imposed by KGB and predecessors. In many cases there were no sentences, just deportation for internal exile.

In summary, there is no evidence that negative motivation is being used now.

How about youthful enthusiasm and spirit of adventure? Yes, very much so! It is a frontier region, just as the west used to be for the United States or Alaska is even now. In almost all cases the first pioneers in development were young people who volunteered to live in tent

cities to start the job often under most trying circumstances. It is happening now on the BAM line. Military engineering troops volunteer for the BAM line. Incentive: Civilian pay and constructive work rather than military routine.

I have seen groups of students coming from thousands of miles away to participate in the gigantic undertakings, fulfilling their obligations for practical work. They simply slept on the construction sites in half finished buildings.

How came it about that we have seen new settlements with tens of thousands of people who follow positive incentives? They can bring their families. Quarters and schools, frequently in wooden buildings, are being provided, pay is considerably higher depending upon severity of climate. They seem to be reasonably happy.

Pay is being gradually increased to sustain motivation to stay. Early retirement is offered to those who stay on with the opportunity for a second job later on. Intense efforts are being made to build the necessary infrastructure rapidly. Efforts are being made to supply better merchandise in stores. It is very limited according to American standards, but I have seen merchandise to please women in the wilderness of Siberia which is not readily available in Leningrad.

The biggest inducement are liberal vacations with opportunities to travel. Travel is inexpensive by our standards, if not by their pay scales. It is astonishing how many people from Siberia and other places with harsh conditions have travelled to resort areas in the sunny south. Intense efforts are also being made to provide recreational facilities within Siberia in beautiful locations. Places for recuperation and treatment are available. Very pleasant youth camps are being built from union funds and with voluntary labor.

The desire to own a little bit of land, to own at least a little home is common to all people, including those living in a Communist society and especially in Siberia. Miles and miles of small vegetable gardens surround big settlements with plenty of people spending their time in family efforts to build small but neat homes so that they can enjoy weekends away from the routine of work and living. How they scrounge the materials to do it is a mystery.

One of the most enjoyable Sundays we spent in a small garden home at the "cold pole" of the world with primitive greenhouses, eating self-grown potatoes and vegetables. Of course, hunting, fishing and boating are very popular in Siberia.

Despite all of these positive inducements, I under-

stand that the population in established settlements is declining. The excitement of pioneering for a new life is lost and people depart.

A few words about pollution. There are problems in industrial regions with air pollution. There are problems with the disposal of chemical wastes. There is concern, but not much is being published openly in newspapers.

The Baikal lake, for example, has some of the most unique fauna in the world. Rigorous steps had to be taken to protect the clean waters from waste products of paper-mills and related factories.

No **talk** of this nature would be complete without mentioning the planning of new towns. One must give credit, where credit belongs. Imaginative solutions are being sought and are being implemented. Traffic arteries with greenbelts are the rule, not the exception.

A remarkable example is a new science city for the Academy of Agriculture. It was planned having the harsh winter storms in mind which rush over the flatlands with blizzard-like fury and ever present snow drifts. The whole town is planned in a circle to provide aerodynamics conditions where high rise buildings surrounding the town protect the social life inside from severe inclement weather. Schools, kindergardens, parks, walks, shops, theaters, etc. are placed to provide maximum protection. The

place of work is outside this area but within easy walking distance.

Most visitors to this strange country experienced the impact of overwhelming Russian hospitality and friendliness, sometimes combined with a suspicion for foreigners, but always paired with considerable curiosity to find out about the world outside. At all levels the people consider themselves as a peaceloving nation, although surrounded by hostile nations as evidenced by past wars and present threats. We Americans also consider ourselves as a peaceloving nation, but are not so sure about others. Maybe that is where we find the real significance of recent exchanges not only with the Soviet-Union but also with China? What is the alternative?