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Construction in Developing Countries

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BACKGROUND PAPER
ON THE
CONSTRUCTION OF THE
BALCO ALUMINIUM SMELTER AT KORBA, INDIA 1/

by

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INTRODUCTION

The first Aluminium Smelter in India was commissioned in 1943 using imported alumina and the first aluminium metal from the alumina of Indian origin was obtained from the second Smelter in 1945. Since then India has made a big stride in aluminium production - nearly a hundred fold increase in production in 1976 compared to initial start with a meagre 2500 tpa capacity. The growth of Industry after an initial set back had a big leap starting in 1958 with new Smelter set up with technical/financial collaboration of ALCAN, Aluswisse, Kaiser Aluminium, Montecatini and USSR.

With the increasing demand for Aluminium in the country, new Smelters are being planned not only to meet the internal demands but also to cater to the overseas customers. The projected demand upto 2000 AD is given in Table No.1 below :

TABLE - I

Period	Addl. cap. to be installed ('000 t)	Cumulative capacity at the end of period ('000 t)
Existing	-	270
1974-79	80	350
1979-89	450	800
1989-2000	300	1100

With vast bauxite deposits and potential hydro power resources the scope for Aluminium production in India in the future is very promising. In line with the policies of Government, the first Public Sector Company viz. Bharat Aluminium Company (BALCO) fully owned by Government of India was set up in 1965 to promote the further growth of Aluminium Industry in India. It may be mentioned that the other existing Primary Aluminium Producers in the country are in Private Sector with technical/

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financial collaboration of foreign aluminium producers. The construction of first integrated Aluminium Complex with its own captive Mines in Public Sector commenced at Korba Madhya Pradesh in 1969 in phases at an estimated cost of Rs 2750 million (316 million US $ approx). The Aluminium Complex comprises of a 0.2 million tpa alumina Plant with bauxite Mines, 0.1 million tpa aluminium smelter, Casting and semis capacities as under -

40,000 tpa	-	Aluminium pigs
10,000 tpa	-	"Properzi" rods
10,000 tpa	-	Extruded products-Sections & tubes
40,000 tpa	-	Rolled products - Sheets & plates

The Aluminium Complex together with the bauxite mines was constructed with the technical collaboration of M/s Chemokomplex of Hungary. Starting the construction work in Oct 1969, the Plant was successfully commissioned in April 1973. The Aluminium Smelter with casting and semis production facilities are now under construction with technical collaboration of M/s Tvetmetpromexport, USSR. Presently the first phase of the Smelter with a capacity of 25,000 tpa together with pig casting facilities and 10,000 tpa "Properzi" rod unit is in operation since May 1975. The second phase of Smelter with 25,000 tpa capacity is ready since April 1976 and is lying idle on account of non availibility of power. The complete Smelter construction is expected to be ready for commissioning by end of 1977 and the semis production units comprising extrusion presses and rolling mills progressively by end 1978.

2. Brief details of Korba Smelter

The Smelter consists of two cell lines with nominal current intensity of 100 KA disposed in eight cell houses. For an annual production of 0.1 million tonnes of aluminium a total of 408 electrolytic cells have been installed with 400 cells in operation and 8 cells in reserve as spare. The anode system installed is Soderberg type with vertical current conducting studs. The cells are located in the cell house in a single row and end to end disposition. The above layout of the cells has been adopted to ensure a comfortable working atmosphere with natural ventilation. Each cell line is connected to a rectifier station with six rectiformer units each of 22 KA capacity at 950 V. The operating parameters of the cells are as under :-

TABLE - II

1.	Current rating	-	100 KA
2.	Average voltage per cell	-	4.52 V
3.	Current efficiency	-	85%
4.	Anode Current density	-	0.67 amp/cm^2
5.	A.C. Distance	-	5.2 cm
6.	Cathode bus current density	-	0.384 amp/mm^2
7.	Yield of metal per KWH(DC)		62.5 g
8.	Yield of metal per cell per day		683 kg
9.	Specific consumption parameters per tonne metal -		
(i)	Electricity DC	-	16020 KWH
(ii)	Anode Paste	-	0.565 t
(iii)	Alumina	-	1.925 t
(iv)	Cryolite :-		
	(a) Regenerated and floatated	-	15.5 kg
	(b) Fresh	-	22.5 kg
	(c) For start up	-	12.9 kg
	Total	-	50.9 kg
(v)	Aluminium Fluoride	-	26 kg

For the purpose of prevention of air pollution, two numbers gas cleaning installations per cell line has been provided. Two stage cleaning viz dry cleaning of cell gases with electrostatic precipitators followed by wet scrubbing with soda solution ensures removal of 98% of HF and SO_2, 96.5% of the dust and 69% of the tar. The Fluorine concentration in the exhausted clean cell gases from the 80 metre high chimneys is less than 4 mg/NM^3. Such elaborate gas cleaning installation at Korba Plant for air pollution control is the first of its kind in India.

The scrubbed liquor from the gas cleaning installation as well as the carbon dust skimmings from the cells are processed in a cryolite regeneration and floatation unit to recover 1550 tonnes cryolite per year. For preventing water and environmental pollution, the waste products from the cryolite regeneration and gas cleaning units are dumped in special evaporation mud pond after treatment with lime.

The anode paste requirement of the Smelter is provided from a captive Anode Paste Plant having an annual capacity of 57500 tonnes of anode paste.

3. Problems in Project implementation

In project implementation specially in Public Sector certain procedures and formalities particularly applicable to India makes the total gestation period fairly long. Firstly, selection of technical collaborators and the technology to be adopted for the plant has to be made and Government approval obtained. The second step of getting detailed Project report prepared by the technical collaborators for Government approval has to be in great depth which takes anything from one year to two to prepare. One of its important function is to establish techno economic viability of the project apart from being complete in respect of all technical details. The third step is project approval and financial sanction by the Government. Then follows detailed engineering of the project and equipment finalisation and ordering. The final step is the erection and commissioning. As these procedures are cumbersome and time consuming but unavoidable with the laid down Government policies, the task with Balco for the construction of a gigantic Aluminium Complex in the shortest possible time posed a big challenge. Further the sheer magnitude of the project in terms of construction material tonnage, the urgent need for Indianisation wherever possible, lack of standard specifications for a variety of materials and equipment, cumbersome tendering and contracting procedures, import bottlenecks and the need to take decisions at the shortest possible time to ward off effects of price escalation etc. in a combined manner made the construction management of Korba Project a truly challenging task.

Some of the strategies and approach adopted by Balco which at times were not quite conventional to achieve this objective proved to be quite effective and paid handsome dividends; to cite a few -

(i) Smelter work was started on a green field area which involved a considerable jungle clearance also in early 1971. The jungle clearance & site levelling grading work was started even before Government's formal approval of the Project.

(ii) A large quantum of the plant & equipment (95%) was planned to be obtained from within the country as per the Government's mandate and also the understanding with the Soviet collaborators. While the theoretical capacity did exist within the country, quite a number of these items were to be either tailor made and needed some completing items from abroad. A very early survey was therefore conducted with the potential suppliers in the country to identify such items which might create hold due to unduly long delivery period. Anode Paste Plant & Rectiformers for the Smelter were found to be major two such items. Firm orders were released for these two items on a very special basis even before the Government's formal sanction.

(iii) During the years 1970 to 1974, India was facing acute shortages of certain construction materials, viz. particular steel sections, pipes and even cement. Without waiting for the precise bill of material based on detailed engineering a rough estimate was made of the bulk requirement of the steel sections and pipes as per the preliminary data available and also from the past experience of our Engineers and orders placed for critical sections both within and outside the country. Maintaining an adequate buffer stock for cement which varied from time to time depending on the season was also a tight rope dancing calling for effective monitoring.

3.1 ORGANISATION AND IMPLEMENTATION

Chief Project Manager is directly responsible for the entire construction activities. Besides, the Chiefs in the three engineering disciplines viz. Civil, Mechanical & Electrical, he is also assisted by a Chief of Planning & Co-ordination. The Planning & Co-ordination Cell has a key role to play in anticipating bottlenecks, constant monitoring of the conduct of construction activities through Network techniques. An independent Monitoring Cell attached to General Manager of the Project who is in over all charge of all the activities was also evaluating and reviewing the key result areas.

This helped the project in throwing up numerous constraints well in advance for timely corrective/alternative action to be taken.

For example it became evident that unless we were to import butt welded anode studs from USSR for the first 102 pots the Smelter could not be commissioned in time. A special request was made to the USSR to divert 5700 numbers of these studs from their regular production for their own requirement. Subsequent requirement of these studs were met from within the country.

3.1.1 PREMONSOON TASK

In a country like India where it rains as much as 1500 mm (in Korba) during the three months of July, August and September, construction or any outdoor activity pose special problems. The water table rises to as high as 1 M below ground level. Excavation and concreting work become extremely problematic. A schedule was therefore planned to ensure by & large completion of such civil works well before the onset of monsoon and also have the areas covered to the extent possible for the subsequent work to go more or less uninterrupted. At least raft concreting with one or two lifts was generally ensured in the area under construction before the monsoon. These measure easily saved 3 to 4 months.

3.1.2 RESOURCEFULNESS

Slippage in the initially laid down schedules became somewhat inevitable due to factors like (a) non receipt of drawings or clarifications thereof in time (b) late delivery of indigenous as well as imported items (c) inadequacy of certain type of skilled artisans locally.

These situations were met by resorting to improvisation and having contingencies plan.

A big Public Sector Undertaking was engaged for the main civil & structural construction work. Advantage was taken of this fact by persuading this agency to divert some of its resources both in terms of men & material when some crash activity became necessary to tide over critical areas.

An enormous number of welded joints were required to be done for the Aluminium bus bar installations. The numbers of such joints were around 9000 per 51 pots and these were to be done by conventional MIG method. Argon gas required for this process was just not available in time and in quantities. Soviets had done this welding in their country by carbon arc welding using graphite electrodes which does not need any inert gas shielding. Left with no choice we had a go at it and in relatively short time our artisans mastered this technique. Graphite electrodes for these threatened to be a problem since there is only one manufacturer in the country engaged mostly on large dia electrodes for Electric Arc Furnaces. Their cost too was quite understandably very exhorbitant. Discarded stubs of graphite electrodes from Electric Arc Furnaces were made to size and tried. These worked quite satisfactorily. This measure not only reduced some cost but saved us very precious time.

The Soviets recommended for providing bed drainage throughout the length and width of the cell houses. We compared notes with a sister unit in the southern part of the country, built by Alcan, Canada and operating under similar conditions of rainfall. As a result of further studies and consultations with Soviet Experts, it was decided to restrict bed drainage scheme to pot foundations only without compromising with the technological needs. This too meant substantial saving both in time and cost.

Finally, when we came quite close to the D day and the smelter was nearing completion, another skeleton in the cupboard appeared. Steam pressure reducing device was one of the few items on the import list from UK for the anode paste plant. The suppliers in UK could not maintain even the extended delivery schedule for this due to force majeure conditions although we had agreed to get this air freighted. Our engineers refused to be frustrated by this and thought of hiring an old steam locomotive for which the Railways did not have much use. This old steel horse was parked alongside the anode paste plant and within two days of its arrival was supplying steam to the plant for the manufacture of the anode paste. This enabled us to stick to the schedule.

SOME PARAMETERS AND SPECIAL FEATURES

The following figures indicate the quantum of work involved in the Korba smelter construction and erection.

(a)	Earth excavation	-	1,200,000 Cu m.
(b)	Concreting	-	150,000 Cu m.
(c)	Strl. Steel	-	20,000 tonnes
(d)	Plant and equipment	-	60,000 tonnes

While the total cost of the integrated plant as mentioned earlier is Rs. 2,750 million the cost of the semlter section along with its auxiliary units like APP, gas cleaning and cryolite regeneration facilities, electrics, etc. works out to approx. Rs. 800 million. Both the above costs are inclusive of the Township and other socio-economic facilities like hospital, schools, recreation club, extended to the employees.

It may be of some interest to note that in a developing country like ourselves and particularly if an industrial undertaking is wholly sponsored and financed by Government the cost of socio-economic obligations in form of houses and the facilities for the employees work out to as much as 5 per cent the total project cost. There is also a recurring cost in form of various subsidies pertaining to the above facilities. For example, apart from providing houses to over 70 per cent of its employees the enterprise meets the entire cost of medical facilities of all its employees and their families.

Education to employees' children is also assured on a nominal fee up to high school level. The money spent in these cases is considered to be well worth it since a worker cannot really give his best without these basic facilities particularly in a developing country like ourselves and also considering the regional deficiencies.

Another point of interest somewhat peculiar to our country again can be the fact that one of the small and private sub contractors to a big public undertaking entrusted with the job of fabrication and erection of the electrolytic pots did his share of the job at a substantially cheaper rate with little overhead and better precision, working mostly under the wide open sky even during the monsoon months. There are reasons for this.

Balco has a very good training institute both for the artisans as well as fresh engineers. The smelter at Korba is manned by at least 60 per cent of such young boys who had never seen any factory in their life let alone having worked in a smelter before. This was possible by having a core of experienced hands and a band of dedicated and enthusiastic instructors who trained these raw boys in a remarkably short time by imparting on-the-job training preceeded by intensive theoretical courses.

The maximum number of Soviet experts assisting the smelter construction, erection and commissioning at any one time was no more than ten.

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