# Mass Handling of Materials

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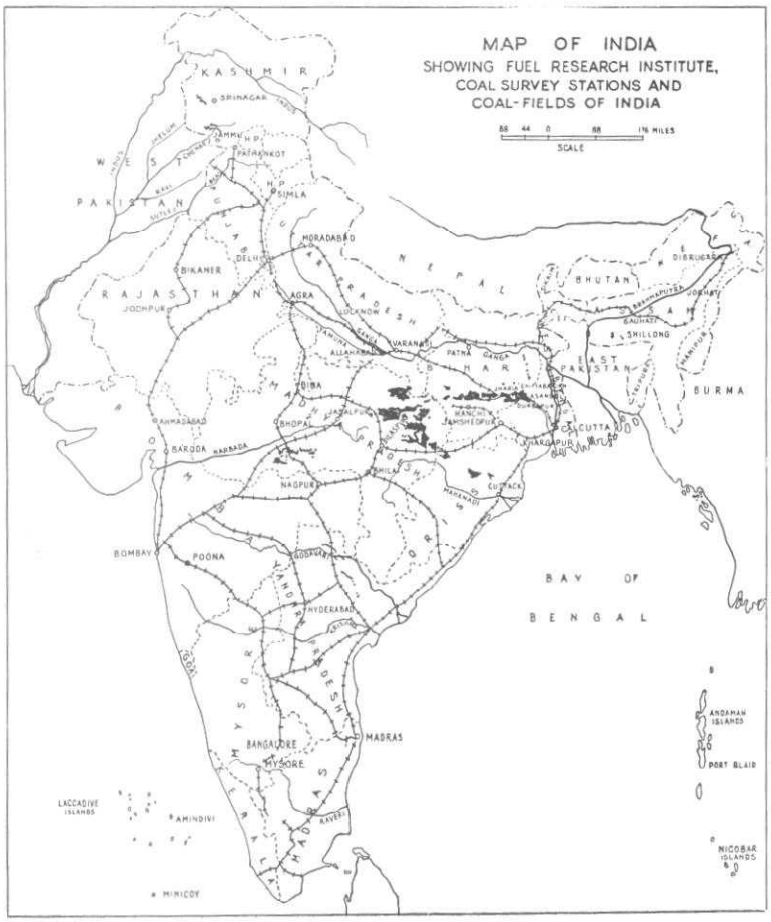
MATERIAL handling is defined as the operation of lifting and shifting. The object of all material handling is the reduction of handling cost, time, storage space, and effort. Mechanised handling permits synchronisation of operations, avoidance of bottlenecks keeping the job on the move and reduction of manual labour which may be devoted to more useful purpose requiring skill and intelligence. Mounting labour costs throughout the world have also directed attention to the expanding importance of mechanised handling in every field of industry.

It is not possible to cover comprehensively the vast subject of material handling in a short article. The present paper deals mainly with transportation, storage and handling methods generally employed in coal based industries in India with special reference to the proposed Central Washeries of India.




Over 56% of the reserves of Indian coal are concentrated in Bengal and Bihar and about 25% in M.P. Bengal and Bihar together raise more than 80% of the country's total production of coal. Nearly all the coking coal is also raised from these two regions. The outlying coalfields of Madhya Pradesh, Deccan, Orissa, etc. produce only non-coking coals and those too mostly of inferior grades. The industries are, in general, located far away from the coalfields, specially those in the west and south with the result that coal has to be transported over long distances to reach the points of consumption.

The common long distance transport in India today is the railways. Some amount is carried by road also, specially for industries located near about the production centres. About 33,000 tons is conveyed to miscellaneous industries by coastal shipping. Some amount of coal will be despatched from the Bengal coalfields by boats or barges when the navigable canal linking Calcutta with Durgapur is ready.

For far-away consumers, the price of coal is more related to transport costs than to its pit head prices. The use of higher grade coal brings them relatively higher returns as in such a case they are required to use less coal for obtaining the same amount of useful heat. Moreover, the use of superior grades permits installation of less costly plants and equipment and also requires handling machines of lower capacities. On the above grounds it is advisable to distribute coal on a zonal basis so that unless specifically required for any coal-based industry, only the consumers at relatively greater distances will be allowed to use the relatively superior grades of coal. This will also result in reducing the already heavy burden on the railway system.

The transport of coal by the railways has been subsidised to some extent. Freight charge on coal per ton mile is about Rs. 2·85 against Rs. 5·36 for grains.

The increasingly deteriorating quality of coal mined per year has called for their upgrading by washing in large central washeries. There are about 850 collieries in India. The production from most of them does not exceed 600 tons per day each. The economics of coal washing do not, therefore,

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allow installation of washery in individual collieries but require them to be grouped suitably for the purpose.

When the collieries are grouped for the purpose of installing an economically sound washery, it is desirable to locate it at a place through which the raisings of a majority or of all the collieries pass on their way to the market or industries. Coal may be brought to the washery by means of mine cars, wagons, road transports, ropeways, belt conveyors, etc. depending upon their respective convenience and other factors. The aim of all layout should be to minimise the ton mileage or, in other words, the raw coal should be hauled the shortest possible distance.

The laying out of new lines or roads on an extensive scale requires huge capital apart from other difficulties. If the coal is moved by wagons on existing tracks, it is convenient to locate the washery in the base loading stations (marshalling yards) which distribute the empties to the collieries and despatch the loaded wagons to their destinations.

The collieries in India are generally situated within ten miles of the base loading stations. On the basis of the existing rate structure, the consumers will have to pay an additional terminal charge of Rs. 1·75 per ton on account of transport of raw coal to the washery over and above the usual freight.

A network of aerial ropeways connecting the collieries with the washery can be an alternative to rail transport, but this method of transport will be equally or perhaps more costly on account of the high per cent of capital costs. It may be economical to connect a limited number of collieries if their cumulative production is sufficient to permit installation of an economical washery. The central washery at Kargali, for instance, has been planned to wash coals from two collieries, viz. Kargali and Joint Bokaro. The washery has been installed on the railway yard of the Kargali colliery. The coal from the Bokaro colliery situated at a distance of about two miles is brought to the washery by means of a bi-cable ropeway of about 250 tons per hour capacity.

The wagons generally used for the transportation of coal carry 22 tons each. The modern trend in transportation is to use bigger trucks and wagons with higher payloads in order to minimise handling costs as well as to increase the road or track capacities. Each of the wagons which will be used to transport coal to the steel plants will be designed to have a carrying capacity of 56 tons 10 cwt. The present train load of about 1,500 tons will thus be increased to 3,000 tons.

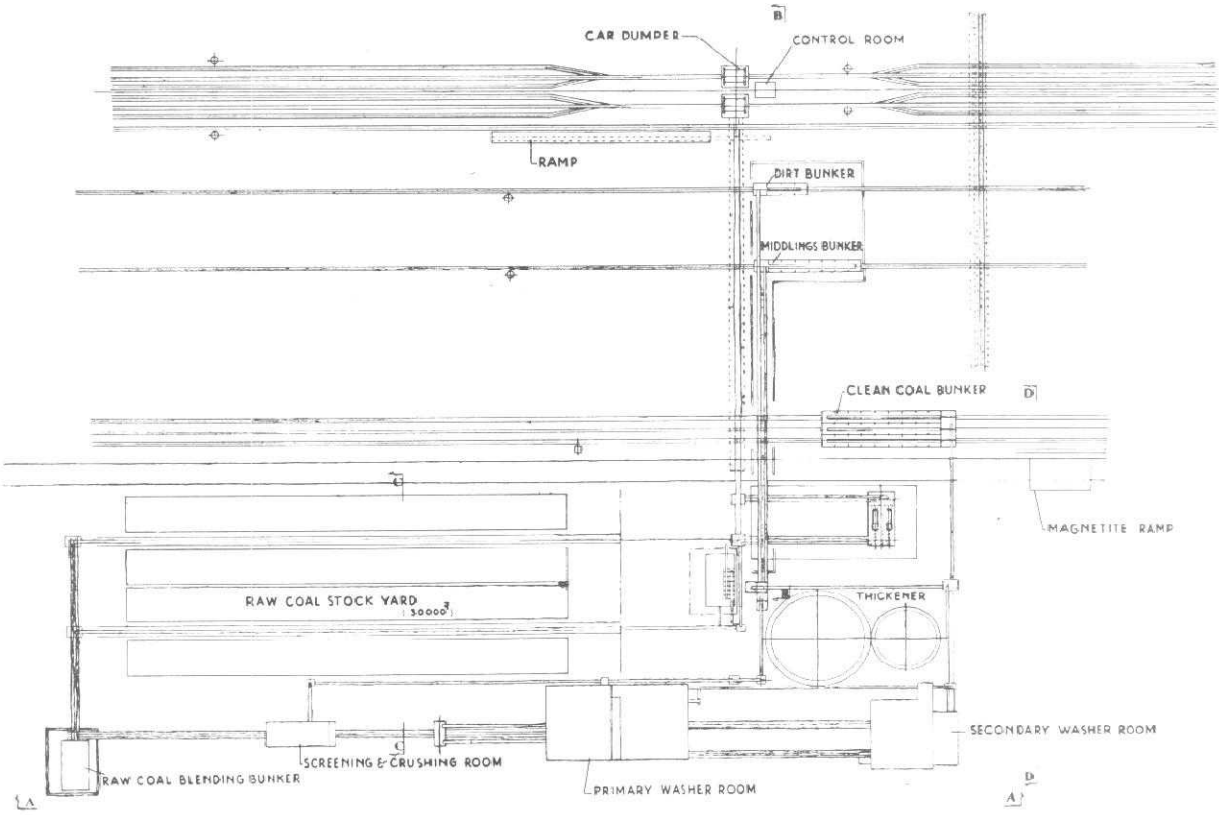
A steel plant with a yearly production capacity of one million tons requires about 5,000 tons of superior grade coking coal per day. On the basis of the quality of the coal available, this can be obtained by washing about 8,000 tons of R.O.M. coal of the type at present being raised. The existing wagons with a payload of 22 tons and the eight-wheeler bogie wagons with a payload of 56 tons will be used to transport coal from collieries to the washery and from the washery to the steel plants respectively. Correspondingly, a washery with an installed capacity of 8,000 tons per day will have to handle about 360 and 100 wagons of the two types respectively.

The receiving and despatching sections of the washery will work in all the three shifts of a day while the other sections will work mainly in two shifts or even one. The incoming loaded wagons will be pulled from their standage in sequence by car hauls on to wagon tipplers designed to unload 40 wagons per hour. The wagons will then be pushed out from the tipplers by car retarders in order to enable them to roll down to their respective standage. The non-standard and covered wagons will be unloaded manually on some adjoining inclined ramp. The unloaded coal will roll down the ramp on to a belt conveyor which will convey them to the hoppers installed underneath the wagon tipplers. The coal received by the hopper will be conveyed continuously by means of belt conveyors to the storage area or direct to the washery after being crushed to some predetermined size.

Most of the washeries in India will produce three products, viz. clean coal, middlings and rejects. The middlings will be utilised either for power generation or for the manufacture of household coke. For shorter distance of travel, specially if the power plant or the soft coke installations are located at a site adjacent to the washery ; belt conveyor is the most appropriate means of transportation, for longer distances ropeway will be more convenient. For these reasons the middlings from the Kargali washery are being transported to the Bokaro Thermal Power Station, located at a distance of about five miles, by means of a monocable ropeway.

It is desirable to instal the thermal power stations alongside the central washeries to minimise transport, storage, and blending costs. On these considerations it has been decided to instal a thermal power station of 125 mW capacity alongside the Dugda central washery to consume the middlings to be produced in the washery. Similar integration has been achieved at Kargali and will be done at Durgapur, where there will be a washery at the steel plant itself. In all these cases, the power stations are designed for high ash and powdered coal firing so that they can handle the varying and inferior quality of by-product fuels produced at the washery.

The possibility of hydraulic transportation of large quantities of coal to great distances is being considered everywhere these days. Hydraulic transportation is being used to some extent for transportation of coal from the pit bottom to the surface as well as to convey the washery rejects from the washery to the dumping grounds. Recently, the Pittsburgh Consolidation Coal Co. of the United States have built a pipe line to transport coal from the preparation plant at Cadiz to a thermal power station at East Lake, Ohio, a distance of 110 miles. The coal will be delivered at the rate of 150 (short) tons per hour through a 10″ pipe line in the form of a slurry consisting of a mixture of coal and water in the proportion of 50 : 50.




General arrangement plan of central coal washery at Dugda.

It is well known that the quality of coal being mined in India is deteriorating progressively each year. Increased mechanisation of mining methods will further increase the proportion of refuse in the coal mined. If the rejections from a washery amounts to 10% of the feed on an average, then a washery dealing in 2·5 million tons of coal per year will produce 250,000 tons of rejects. Along with middlings it may be three times the quantity. This will require not only conveying equipment for transportation but also considerable storage space to dump the rejects produced by a washery during its life time. Generally belt conveyors, ropeway and dumping cars are used for their transportation. Sometimes they are pumped to the storage ground directly as produced along with the water.

Bulldozers, scrapers, trucks ; etc. are generally employed for levelling, spreading, compacting and sealing in the storage yards. Special care is taken to compact and store them where there is a danger of spontaneous ignition.

## Coal storage

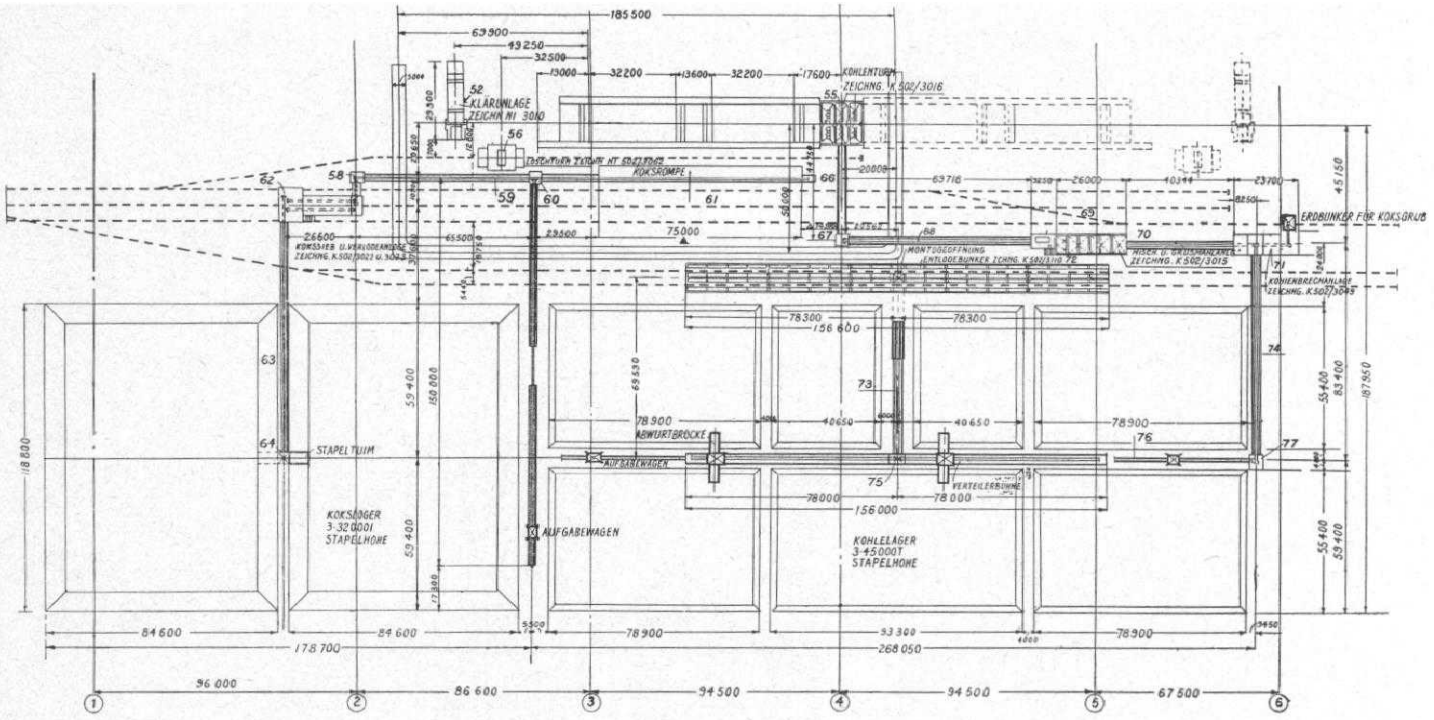
Coal-based industries require storage provisions for the following reasons :

(*i*) To even out fluctuations in the rate of flow of coal (*a*) from the mine itself (*b*) from the transportation system.

(*ii*) To provide some degree of blending of the coal feed and provide a steady fund to the procuring plant.

The central washeries using coals from a number of collieries require storage facilities for two to four days' requirement while power plants, coke ovens and steel plants require the provision for a month's requirement. Bunkers or bins are generally employed as they are free flowing. The discharging gates of large bunkers are operated by hydraulic, pneumatic or electric mechanism. In order to facilitate smooth discharge, bunkers or bins are provided with vibrating unloaders or chain conveyors. They are sometimes provided with remote controls and indicators in order to facilitate loading and unloading from a central point.

The trend today is to have large open storages on ground specially for washeries, coke ovens and power plants. Both stacking and reclamation are carried out by means of long belt conveyors mounted on gantries. Stacking belts are provided with travelling tipplers and shuttle conveyors. One end of the stacking conveyor is installed under the receiving hopper while the other end is laid out in the storage yard. The stackers are




Storage arrangement for Durgapur coke ovens.

sometimes provided with adjustable swinging booms to permit uniform distribution in the storage bin as well as to minimise degradation of the material discharged.

Dumping and reclamation on plane ground are carried out by industrial trucks, draglines, bull-dozers, power shovels, grabs mounted on crawlers, gantries, etc.

Coal can also be stacked inside V-shaped channels constructed above ground from dirt or earth heaps. The inclination of the sides are designed to have smooth gravity flow towards the bottom. Coal is discharged through a number of gates at the bottom of the channels down to a system of belt conveyors installed inside reinforced cement concrete tunnels erected underneath the storage ground. The sides of the storage channels may require pitching to prevent erosion or subsidence.

This system of stacking and reclamation has ample scope of blending, and hence it is suitable for storing coal for washeries receiving widely varying qualities of raw coal from a number of collieries. It is suitable for only relatively small storage and it is rather costly.

In storing coal for longer periods special care is taken to prevent spontaneous ignition which may lead to huge loss.

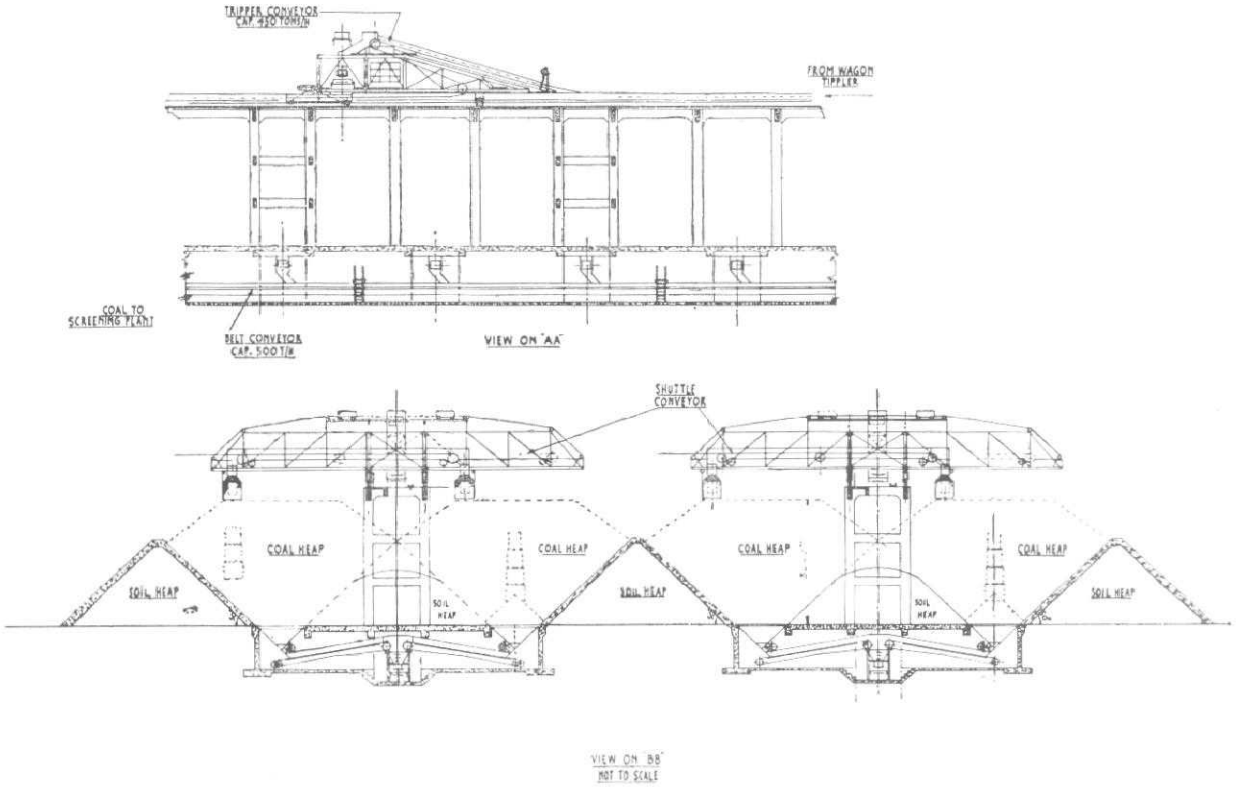
## Preparation

Crushing, screening and blending constitute some of the major items of handling and preparation plants. In a washery the raw coal may have to be crushed and screened to produce a number of size fractions which may require individual washing. Each washing unit may again produce two or more products which may have to be combined and stored in suitable bins before final disposal. All these call for considerable amount of conveying.

The present day tendency is to have the washeries designed to have gravity flows as far as practicable. In general the materials are conveyed by belt conveyors or vibrating and other types of feeders. The incoming loads are given a movement in the direction of the belt conveyors by means of suitable chutes in order to prevent degradation, spillage as well as damage to the conveyor belts. Bucket elevators and scraper conveyors are used to a limited extent, specially where the available space is limited. Sometimes the washing medium serves as carrier for the products.

When a combination of conveyors are used for the conveying of coal, it is desirable to have them coupled to a sequence operation control to prevent sudden accumulation of material in any section due to a breakdown in it.

It may be pointed out in this connection that the cost of conveying equipment of all types in a washery generally amounts to about 30% of the total cost of a washery.




Arrangement of stacking and reclaiming in the ground storage.

## Blending

For the efficient and smooth operation of washing units, the feed should be graded and blended properly so that there are no large variations in the raw material feed. Blending is also practised in coke ovens for obtaining standard metallurgical coke from non-standard coals. In either case a variety of handling equipment is necessary. For this purpose, coal is loaded by shuttle or tripping conveyors into multi-compartment bins, unloading it simultaneously on to a bunk conveyor leading to a blending machine. Variable speed feeders are most suitable for this purpose as they allow adjustment in the rates of unloading from the different bins and so adjusting the composition of the blend. Blending is generally preceded by crushing and screening, for both of which a variety of apparatus is available from which a selection can be made to suit the particular needs either of the installation or the raw material.