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Technical Article

Speeding up Wagon Unloading – C-Frame type Tandem Rotary Tippler and Transfer Platform for high capacity Wagon Unloading in India

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Railway transport is one of the most important means of transport for huge amounts of dry bulk solids. Often, train unloading is a bottle neck of such systems. A solution to this problem is presented in the article below.

Fig. 1: Tandem tippler working at the Ust Luga coal export terminal, Russia. (Picture ©: ThyssenKrupp India Ltd.)

Countries with high rate of economic growth like China, Brazil, Russia are constantly upgrading their port infrastructure to meet increasing demand for import and export of various bulk materials. Tandem wagon tipplers have been employed extensively to achieve higher unloading rates and improve the

utilisation of existing railway infrastructure.

In China at the Huanghua coal export terminal six tandem rotary tipplers supplied by ThyssenKrupp have been installed to achieve export figures of 80 million tons of coal per year. Each tippler at this port simultaneously unloads two rail freight box type wagons, with a payload of 60 to 70 tons each, at a rate of up to 33 cycles per hour, thus unloading an average 4000 tons of coal per hour with a maximum capacity of 4500 tons per hour.

At the port of Tubarao in Brazil, five tandem tipplers supplied by ThyssenKrupp are in operation - each having a handling capacity of two 120 ton (gross weight) wagons with rotary coupler at 45 dumping tips per hour of iron ore.

Fig. 2: Tandem tippler working at Vale’s Tubarao Terminal, Brazil.

Similarly at Ust Luga, one of the largest ports in Russia, two tandem tipplers are installed to unload coal at the rate of 3500 tons/hour each for export of Russian coal.

1. Indian Scenario

In India, as per old railway guidelines (RDSO - Research Design and Standards Organisation), the dumping capacity of tipplers was limited to not more than 20 tips/hour. Hence side discharge tipplers having a maximum of 20 tips per hour were popularly used to unload material from railway wagons of 110 tons gross weight in ports, power, steel and cement plants. Rotary tipplers have been less popular in India in the past, as it calls for four to five meters deeper underground civil construction than side discharge tipplers. Especially for small scale projects, civil construction costs grew to a considerable percentage of total project cost.

The energy requirements of side discharge tipplers are much higher due to the lift and shift type operation while unloading the box wagon. They require heavy counterweights to even out the mechanical effort. In contrast, rotary tipplers are energy efficient as they rotate the wagon about its center of gravity. No

counterweights are necessary in this case.

Side discharge tippler design is not suitable for more than 27 to 28 tips per hour and also is not amenable to tipple more than one wagon at a time.

As per the new RDSO guidelines effective from December 1, 2010, the number of tips has been increased to more than 25 tips per hour for both side discharge and rotary tipplers to achieve higher unloading capacity and more turnarounds of rakes per year. These new guidelines now also permit the use of single as well as tandem wagon tipplers.

Indian economy is growing at a rapid pace creating a high demand for raw materials by steel, cement and power plants. It is necessary, therefore, to improve the utilization of the available railstock and railway network as it is the main source of transport for bulk materials. Thus necessity is felt to introduce high capacity tandem tipplers in India.

Today new steel, power and cement plants are being set up in India and the capacity of existing plants is being expanded. In a steel plant we need to unload approx. 3 tons of raw materials like coal, iron ore, dolomite, limestone etc. for producing one ton of steel. Since all the above raw materials are transported by railway wagons, the tandem tippler is an ideal solution to unload rakes at the high rate of more than 3500 tons per hour making effective use of limited railstock, smaller rail yard area and limited rail lines connecting to the main railway network.

This is a special constraint for landlocked steel plants which want to expand the steel production. For their new three million ton steel plant project at Kalinganagar, Odisha, Tata Steel have incorporated two tandem and two single C-type rotary tipplers in the scheme to unload about nine million tons of the above mentioned raw materials. This will be the first installation of tandem tipplers in India.

Fig. 3: Two tandem tipplers under erection at Tata steels Kalinganagar site, Odisha, India.

The new tandem tipplers will unload two 140 ton (gross weight) wagons at a time at the rate of 25 tips per hour. The supplied tipplers are designed as per the latest RDSO guidelines and can tipple all types of existing box type wagons as well as the proposed DFC and feeder route wagons, to be introduced in the near future for coal and iron ore transportation.

For a bulk export terminal, where we have to load ships in the minimum possible time, tandem tipplers can play a pivotal role for unloading trains carrying coal, iron ore etc. at higher rates and make effective use of limited railstock, smaller rail yard area and limited rail lines connecting to main railway network.

Recent trend of installing mega and ultra mega power plants, has increased daily coal requirement of power plants substantially. For a 4000 MW power plant, the typical coal requirement may be up to 40 000 or 45 000 tons per day. To cater for such high requirements, again rotary tandem tipplers will satisfy this requirement by unloading at rates of approx. 3500 to 5000 tons per hour in eight to twelve hours. One can achieve a capacity between 10 and 15 million tons per year with a single rotary C-frame type tandem tippler.

2. Tandem Tippler Installation and Operation

There are two types of tandem rotary tipplers: ”O”-type and “C”-type tipplers.

The C-type tandem tipplers are more popular nowadays due to its C-shaped frame - open at one side which allows side arm charger to travel through the tippler and place loaded wagons on the tippler platform while pushing empty wagons out of the platform where they help to form the empty rake on outhaul side.

O-type tipplers are more popular in the countries where railstock is provided with rotary coupling – here it is not necessary to decouple the wagons during tippling. These tipplers can achieve very high tippling cycles of up to 45 tips per hour. Wagon placement on O-type tipplers is done using rope driven side arm chargers.

As rotary couplings on wagons do not require de-coupling higher tip rates are feasible. This advantage can be derived only in rotary tipplers. Wagons with rotary couplers, however, are not actually not utilized in India. Hence the O-type tippler is not popular.

The tippler is controlled by PLC system in either manual or fully automatic mode. The drives for tippler are either variable speed controlled electro-mechanical drives or hydraulic drives.

In case of a hydraulic drive, the hydraulic power pack can be kept away from the dusty environment in a separate closed pressurized room. Electric panels of VVFD drives are protected from dusty environment by placing them in a separate airconditioned room.

Variable speed controlled electric drives are advanced and effectively used with regenerative braking for both tippler and side arm charger - with consequent reduced demand on the power network. This regenerative feature is not available with hydraulic drives.

In a mobile machine like side arm charger, indexer and puller cum pusher of transfer platform, it is recommended to provide electro-mechanical drives with VVVF control. We can place the VVVF panel in a separate closed pressurized dustfree room inside the control tower, and the power is supplied to the drive motors through flexible cables using an energy drag chain or a festooning arrangement. Such an arrangement is not possible with hydraulic drives.

Fig. 4: Side arm charger with electro-mechanical drive and festoon arrangement for power supply.

In case hydraulic drives are applied for side arm pusher, indexer or puller cum pusher for tandem tipplers, the size of the power pack will be much bigger and it becomes difficult to accommodate the power pack on the machine platform. This increases size and weight of the moving machine and makes it unstable. Furthermore, during frequent starts and stops and forward and return movements of the machine, the power pack experiences jerks, and is additionally exposed to environmental hazards like dust, heat and rain – which is not desirable.

A typical installation of a tandem tippler consists of tippler, wagon positioner, side arm charger, wheel grippers, hopper and apron feeders:

1. A positioner (or indexer) which pulls the loaded rake over a distance of two wagon lengths towards the tippler platform on the inhaul side. The two wagons are decoupled and pulled further towards the tippler platform.
2. Wheel grippers installed on the inhaul side engages with the front wheels of the first loaded wagon standing on the inhaul side, ensuring the fixed position of the leading wagon of the loaded rake. Wheel grippers are hydraulically actuated and horizontally arranged.Another set of wheel grippers installed just before the platform on the inhaul side ensures that two wagons are maintained in fixed position, when indexer arm decouples and the side arm charger (SAC) arm couples with the two loaded wagons.
3. An SAC which pulls the two wagons on the tippler platform. Simultaneously, the SAC pushes the empty wagons standing on the platform (from the previous unloading cycle) to the outhaul side.
4. Another set of wheel grippers installed on the outhaul side engages with the rear wheels of the last (tailing) empty wagon standing on the outhaul side, ensuring the fixed position of this last wagon of empty rake.
5. The SAC continues pushing the empty wagons out of platform with controlled speed until they couple with the last empty wagon of empty rake standing on outhaul side. The wheel gripper is now disengaged so that SAC can continue pushing the empty rake through a distance of two wagons and thus continue to form the empty rake on a level track (or max stipulated gradient of 1:1200 as per RDSO guidelines). The last wagon is then gripped and SAC decouples its arm and returns to original position to take charge of the next two loaded wagons placed by the positioner – and the cycle starts again.

The tandem tippler with wheel gripper at inhaul and outhaul side with wagon positioner plus SAC, forms a completely automated system for unloading bulk material from wagons and also reinstalls the empty train at outhaul side.

The tippler unloads the material into the hopper. Two Apron feeders arranged beneath the hopper extract the material at a controlled rate and load the same onto the downstream conveyor system. Apron feeders are provided with variable speed hydraulic or electro-mechanical drive.

Quite often, coal received from mines contains a greater number of oversize lumps. If the percentage of over size material is high, these larger lumps will also be allowed to pass through bigger size grid opening and will be crushed to a desired size by the primary crusher located at the discharge end of the apron

feeder. This enables the system to be operated without interuption for clearing the grid. It also allows to reduce the lumps to an acceptable size suitable for loading onto downstream conveyor system.

Fig. 5 shows the drawing of a tandem tippler with apron feeder and primary crusher to crush oversize size lumps coming along with the feed material.

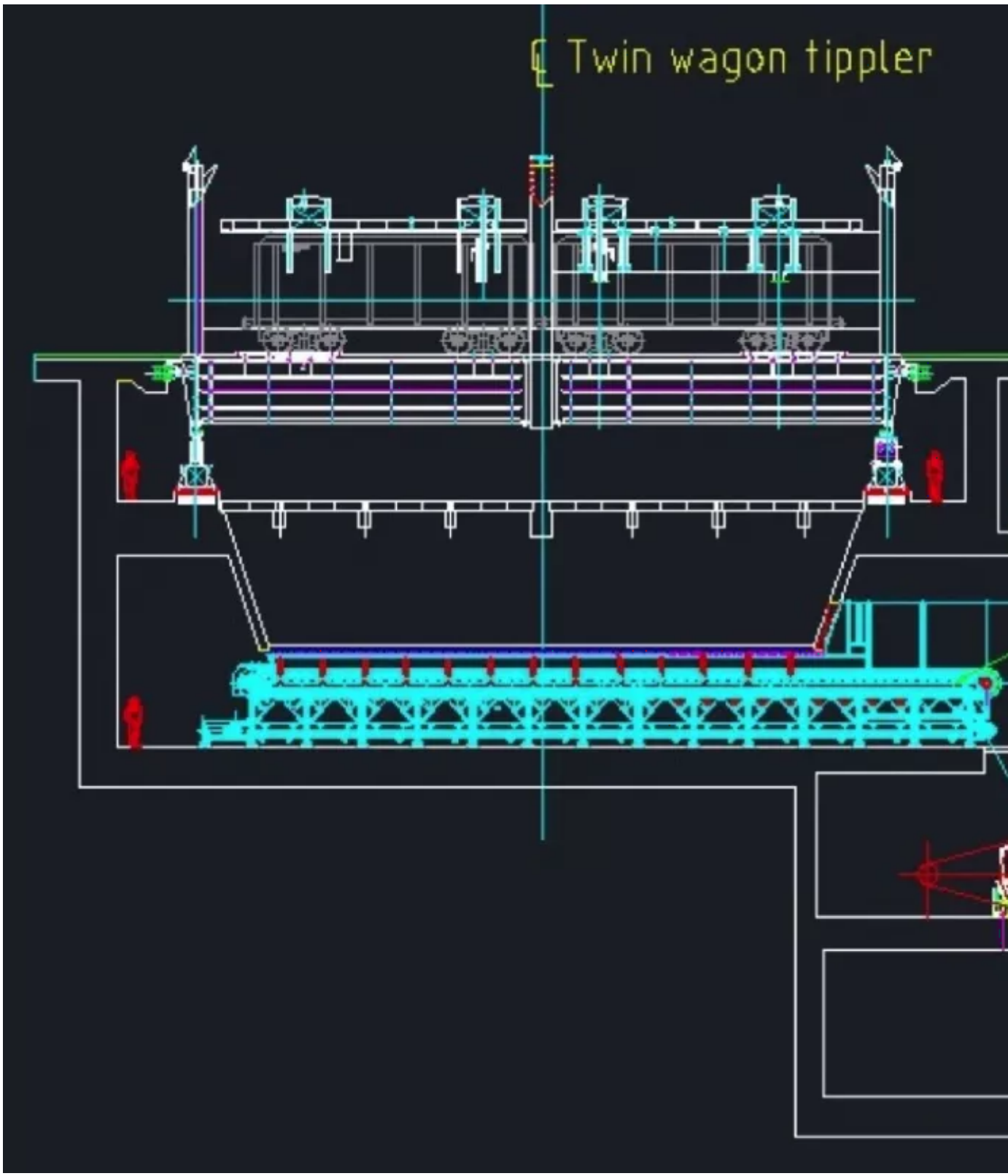

Fig. 5: Tandem tippler with apron feeder and primary crusher to crush bigger size lum

3. Compact Railway Yard Layout by Transfer Platform

To form an empty rake at outhaul side, we need around 700 m free rail tracks at outhaul. This space at times puts severe constraints in plant layout. Today space

is at a premium in plant or at the port and is many times an issue because of shortage of land availability due to cost and environmental issues.

Transfer platform installed after tippler at out haul side is an effective solution to this problem. With the help of Transfer platform and built in puller / pusher - we can transfer empty wagons on a track which is parallel to inhaul track and form the empty train. Thus around 700 m length of track is not required at out haul side. This also avoids circular track in the plant area simplifying the plant layout, eliminating constraints on inplant logistics.

Refering to Fig. 7 the reader will find a large plant area occupied by the circular outhaul rail track.

In Fig. 8, it can be seen that the complete out haul circular rail track is eliminated with the help of a transfer platform installed at the out haul side of the tandem tippler making plant layout and internal road and drainage layout much simpler.

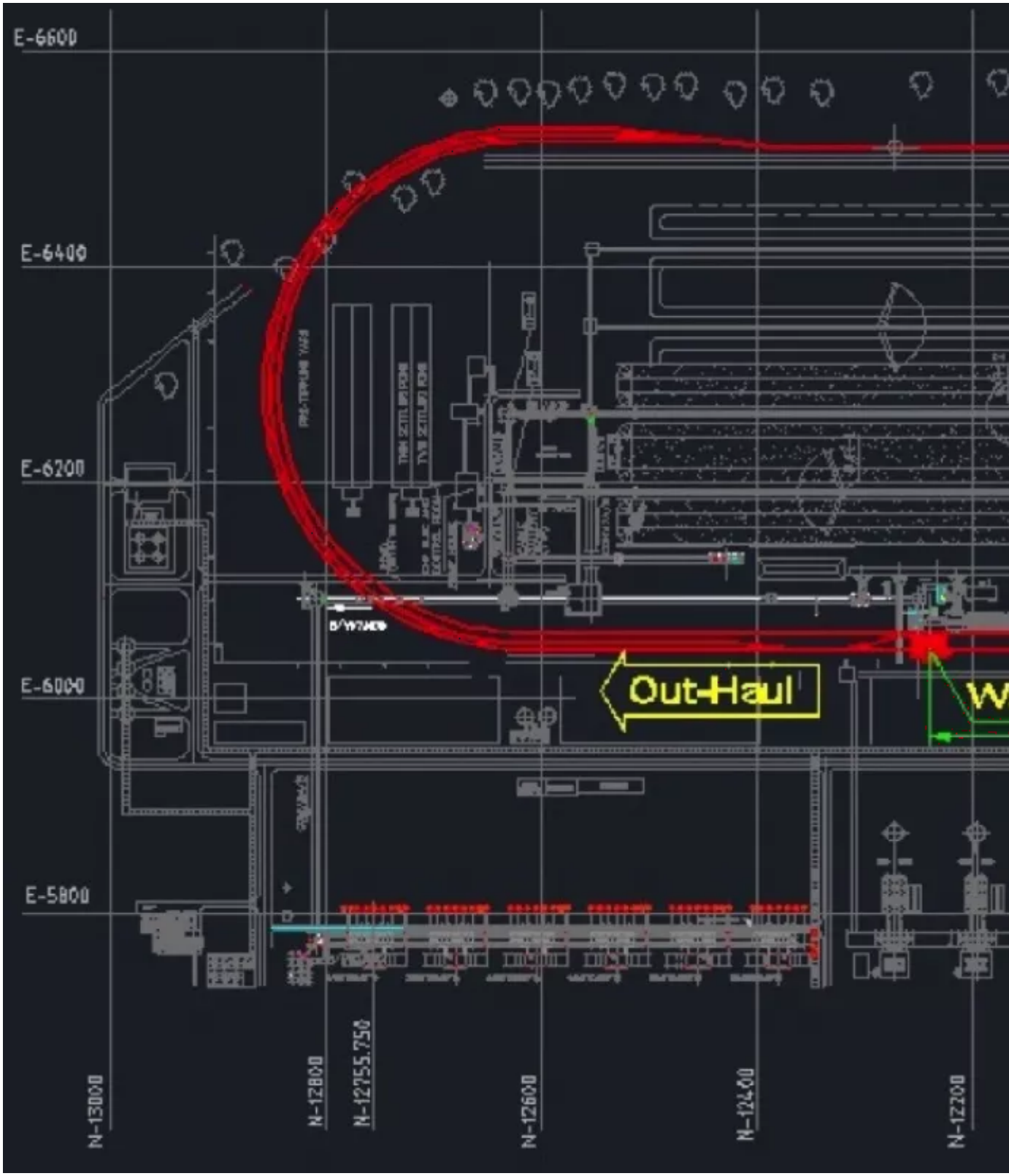

Fig. 7: Plant layout with circular rail track.

Transfer platforms can be used in conjunction with side discharge tipplers, single or tandem rotary tipplers.

Hence to conclude, rotary C-frame type tandem tipplers with transfer platforms are an ideal choice for steel plants, bulk port terminals and power plants to

unload bulk materials at a higher rate. Utilisating such equipment reduces demurrage charges and optimises plant rail infrastructure.