Construction, Working and Maintenance of Stackers and Reclaimers for Bulk Materials

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The information contained in this booklet represents a significant collection of technical information about construction, working and maintenance of stackers and reclaimers for bulk materials. This information will help to achieve increased reliability at a decreased cost. Assemblage of this information will provide a single point of reference that might otherwise be time consuming to obtain. Most of information given in this booklet is mainly derived from literature on the subject from sources as per the reference list given at the end of this booklet. For more information, please refer them. All information contained in this booklet has been assembled with great care. However, the information is given for guidance purposes only. The ultimate responsibility for its use and any subsequent liability rests with the end user. Please view the disclaimer uploaded on http://www.practicalmaintenance.net.

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Content

Need of Stackers and Reclaimers

Since bulk materials arrival time at a plant is much shorter as compared to their consumption time, they require to be stocked/stored. Due to this, stackers are needed to create stockpiles of the bulk materials. Buffer storage of the bulk materials in the stockpiles is also necessary to take care of any disruptions in the transport system or in the mines due to which material cannot be received at the plant on such days. The capacity of the stockpiles ranges from 7 days to 45 days requirement of the plant.

For example, in India, the general practice is to provide a 7 to 15 days coal stock in the stockpiles in case of a pit head power plant depending on the reliability of the mines and the conveying system. In case the power plant is far away from the coal mines, coal stock of about 30 days requirement is provided. In case coal is received by ships, stockpile of about 45 days capacity is provided because the reliability of shipping will be less due to variations in the weather conditions especially during the monsoon period.

This mixing operation of more than one material is called blending. The blending operation, when applied to only one material to make it uniform in characteristics, is termed as homogenizing operation. Stackers and reclaimers are also required for homogenization / blending of bulk materials. Homogenization / blending is often necessary in the cement industry, in cases where the raw material chemical composition varies greatly. With the increasing variation in the grades of coal used for coal firing installations, there is a growing need for homogenization and storage of coal. As the mixing operation i.e. blending of more type of materials or homogenization of more grade of single material is functionally same, only word blending is generally used for blending as well as homogenizing operation.

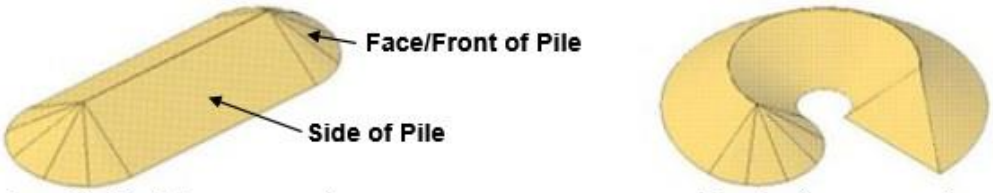
The material so stored needs to be retrieved (reclaimed) to suit its gradual consumption in the plant. Therefore, stock yard needs reclaimer machines to reclaim the material. Since the stackers and reclaimers have to store and reclaim material over a long distance, they are mounted on rails.

It may be noted that in cases where the storage capacity is less (for example, 50,000 T coal), the stockpile can be formed by telescopic chute arrangement and by dozing (using bulldozer). Telescopic chutes are used to minimize the height of material fall into stockpiles to minimize dusting. The telescopic sections are usually cable-connected in such a manner that a winch can successively lift the sections of the chute. The lower end of the chute is always kept just clear of the top of the stockpile to reduce dust generation. The reclaiming can be carried out by dozing the material in to a ground hopper.

Stackers

Information about stockpile layouts, stacking methods and stackers is given in this chapter.

Stockpile Layouts



Stockpile Layouts

The two basic stockpile layouts are: longitudinal stockpile arrangement and circular stockpile arrangement. Above figure shows stockpile layouts and nomenclature.

The longitudinal arrangement allows easy future expansion but requires more space, while the circular arrangement basically prevents any future expansion but has a more compact footprint. Longitudinal stockpile arrangement is used for high storage capacity.

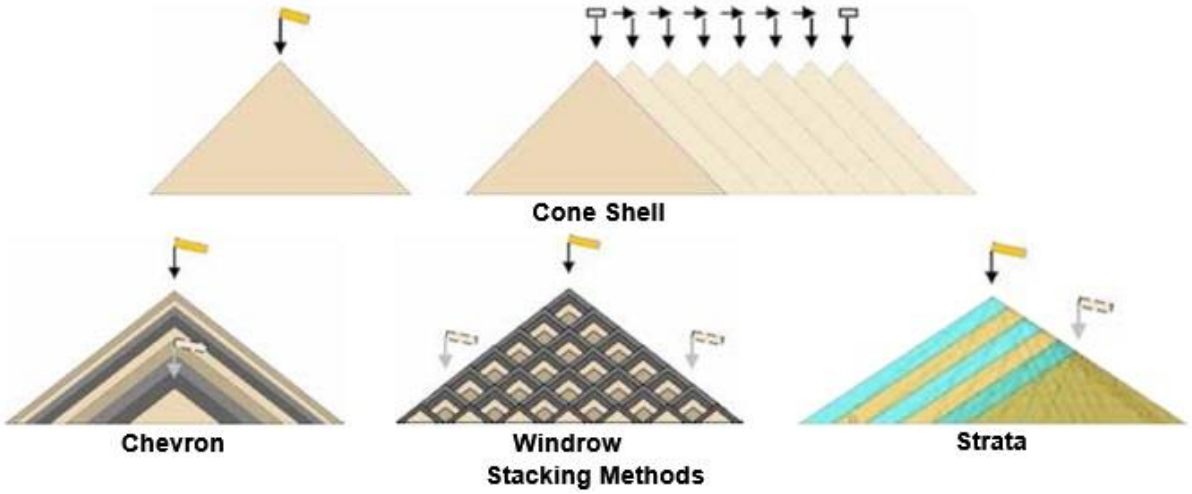
To protect the material from wind and rain and to avoided the problems associated with them, many times the entire stockpile and the stacker and/cum reclaimer machines are covered within a shed.

Cover Sheds

As shown in above figure, for longitudinal stockpiles, longitudinal shed is constructed whereas for a circular stockpile, a dome type shed is constructed. In a dome type shed, the shape of the shed will be in the semi hemispherical form. There will be a concrete wall up to a certain height from the ground level and the structure will be erected above this wall. The dome structure of various sizes could be adopted depending on the storage required. With a dome type shed, material gets protected from wind and rain.

It may be noted that where there is a constraint for the land, large capacity silos could be used for storing the material.

Stacking Methods



The most commonly used stacking methods for making longitudinal stockpiles are Cone Shell, Chevron and Windrow. Basically these methods consist of stacking a large number of layers on top of each other in the longitudinal direction of the pile.

In the Cone Shell method, the pile is formed by depositing material in a single cone from a fixed position. When this conical pile is full, the stacker moves to a new position and a new cone is formed against the shell of the first one. This process continues in the longitudinal direction of the store until the stockpile is complete.

In the Chevron method material is deposited by the stacker moving to and fro over the centre line of the pile. However, the Chevron stacking method causes segregation of the material with fine particles in the central part of the pile and coarse particles on the surface and at the bottom of the pile. To ensure proper blending a Chevron pile must therefore be reclaimed from the face of the pile, working across the entire cross section.

In the Windrow method, material is deposited from a number of positions across the full width of the pile. This method needs a luffing and slewing stacker. The Windrow method prevents segregation and ensures more even distribution of fine and coarse particles across the pile. The Windrow method is preferred in cases where the reclaimer is only operating in one part of the pile cross section at a time or in cases where segregation would make an open pile base unacceptable.

Sometimes stacking is carried out by Strata method. The Strata method needs a luffing and slewing stacker. In the Strata stacking method, the stockpile is built up in inclined layers. The stacker builds the first layer travelling along the storage area with its boom at a low elevation. The stacker then moves towards the stockyard centre in pre-set steps while gradually lifting the boom. The result is superimposed inclined layers, matching the angle of repose of the bulk material and providing a good blending as the reclaimer cuts into each of the many layers.

In view of above, if no blending is required, Cone Shell, the simplest stacking method will be chosen. It requires no slewing mechanism/gear in the stacker and simplifies the movement of the stacker during stacking. If blending is necessary, the Chevron and Windrow methods are used. Chevron is the preferred choice, as it does not require slewing mechanism in the stacker.

Continuous Chevron

As shown in above figure, in circular stores, Continuous Chevron stacking is the most commonly used method. In this method, a ring-shaped pile is being continuously stacked at one end and reclaimed at the other. Stacking takes place in a fan shaped arc, typically 120°. With each sweeping movement, corresponding to two layers of material, the whole sector advances approximately 1/2° ahead.

The blending operation require separate stacker and separate reclaimer machine. Also, at least two stockpiles are necessary in the stock/storage yard, so that when one stockpile is under formation, the other formed (readymade) stockpile can be used for reclaiming purpose. This amounts to reduction in usable (readymade) stored material, compared to simple storage (without blending) and reclaiming.

Stackers

A stacker is chosen based on the stockpile layout, the material properties and the required stacking method. For example, a stacker must reach the whole cross section of the pile, if Windrow stacking is required; for Chevron or Cone Shell stacking, it is enough to reach the center of the pile only. The stacking process can be done by a simple tripper car (overhead) or it can be a stacker equipped with a travelling and luffing or luffing and slewing mechanism. Feeding of the stacker itself is carried out by a belt conveyor with tripper car.

Stacking by Tripper Car

Typical Tripper Car

As shown in above figure, stacking in a covered stockyard (A-frame building) can be done by a simple tripper car. The tripper car is installed in a structure suspended from the building roof. The travel of the tripper car is PLC controlled and programmed to build either a Cone Shell or a Chevron stockpile.

Following are the three basic movements in a stacker:

Travelling - Bogie move the machine on rail track along the stock/storage yard.

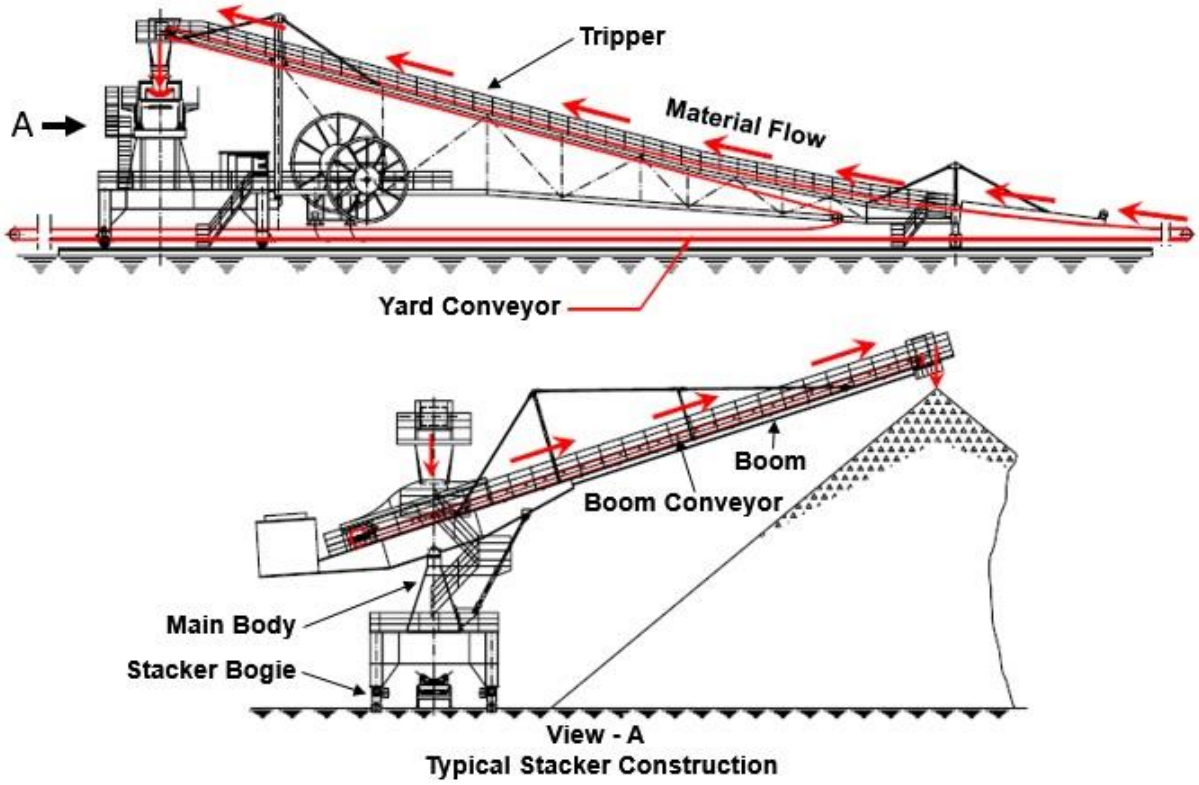
Luffing - This is the vertical up/down movement of the boom mostly powered by two hydraulic cylinders.

Slewing - This is rotation of the boom around its central axis to discharge the material on the stock yard where required.

Types of Stackers

Above figure shows types of stackers based on boom features.

Stacker Construction



Typical Stacker Construction

Above figure shows construction of a typical stacker with luffing mechanism. A stacker includes a tripper and main body. The tripper and main body are mounted on bogies to move the machine on rail track along the stock/storage yard. The main body includes stacking boom conveyor. The stationary yard conveyor passes through tripper and discharges

material on to the boom conveyor. The boom conveyor discharges the material on the stock yard to form the stockpile. The luffing mechanism of a stacker is driven either by a hydraulic drive unit or a winch. The stacker shown in above figure is driven by a hydraulic drive (hydraulic cylinders).

Luffing Stacker

Above figure shows a luffing stacker (stacker without slewing mechanism). Luffing stackers can make stockpile in Chevron and Cone Shell type of formation.

Stockpiles on Both Sides of Luffing and Slewing Stacker

Above figure shows a luffing and slewing stacker. Luffing and slewing stackers are used to make stockpiles on both sides of the machine. In addition to Chevron and Cone Shell type of formations (due to luffing capability), they can make stockpile in Windrow and Strata type of formations also (due to slewing capability).

Twin Boom Stacker

Above figure shows a twin boom stacker. Twin boom stackers are having two booms, one on each side of the machine with luffing arrangement. Two booms make it possible to form stockpiles on both sides of the machine without the slewing mechanism.

The tripper car and yard conveyor is often equipped with a bypass arrangement, use of a bifurcating chute and a diverter/flap gate, that enables material to bypass the stacker boom and continue along the yard conveyor (to meet plant requirement).

The material conveyed from the tripper is discharged on the bifurcating chute. The chute has two legs, one for directing the material towards the boom conveyor during stacking and the other for discharging the material in to the central chute over the impact table for bypassing the boom conveyor (direct loading to the yard conveyor). A diverter gate, operated by an electric actuator or hydraulic cylinder closes any one of the legs and allows the material to pass through the other, as required.

Reclaimers

There are wide varieties of reclaimers to suit specific need (buffer storage or storage for blending), material properties (free flowing or stick material) and reliability. The two types of reclaimers in use are: scraper reclaimers and bucket reclaimers. Each type has varied designs to suit an application.

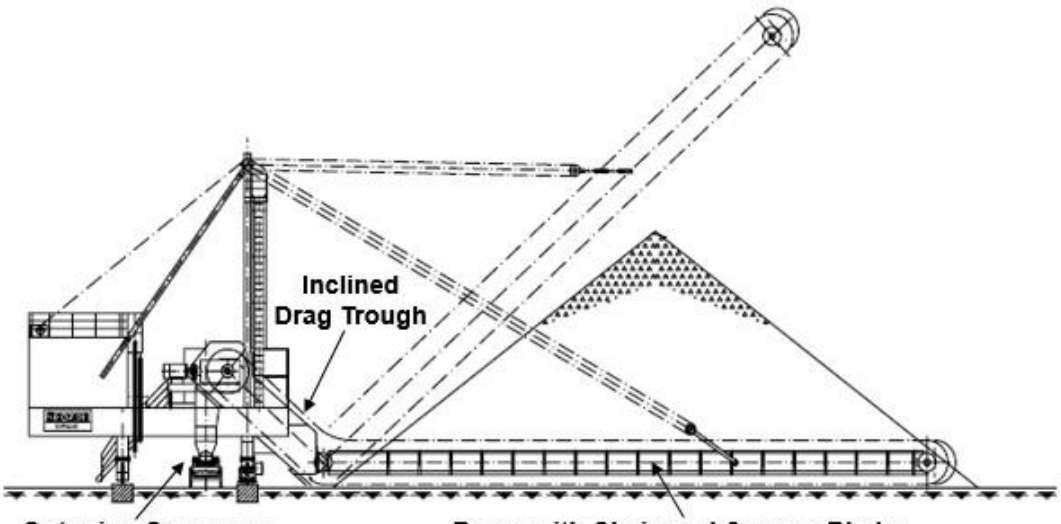
In scraper reclaimers, scraper blades (toothed rectangular steel plates) are attached to two parallel strands of chain at regular interval. The travel of chains along with scraper blades, scrapes/drags the material from the stockpile and discharges it on the yard conveyor.

In bucket reclaimers (bridge type bucket wheel reclaimer, boom type bucket wheel reclaimer and drum type reclaimer), scooping buckets scoop the material from the stockpile. The scooped material falls on the receiving/intermediate conveyor (bridge conveyor, boom conveyor or barrel conveyor). The receiving conveyor in turn discharges the material on the yard conveyor.

In general, if blending is required, material is scraped/scooped from the face/front (whole cross section of the pile) of a pile. Whereas if blending is not required, material is scraped/scooped from the side of a pile. When material is scraped/scooped from the face of a pile, there will usually be a harrow/rake that brings the material to the bottom, from where it is taken up by scrapers or buckets.

The scraper type reclaimer machines are lighter in weight and less in price as compared to boom type bucket wheel reclaimers. However, in scraper type reclaimer machine, more numbers of components (chain links, pins, guides and scraper blades) are subjected to material abrasion as compared to boom type bucket wheel reclaimer. In boom type bucket wheel reclaimer, only bucket edges are subjected to abrasion during reclaiming operation which can be easily constructed for wear resistance and easily maintained. Hence, boom type bucket wheel reclaimers are used for heavier duty and reliable operation.

Side Scraper Reclaimer



Side Scraper Reclaimer

Above figure shows construction of a typical side scraper reclaimer. It is also called a pylon or cantilever scraper. The side scraper reclaimer travels on a track arranged along one side of the stockpile. Two parallel strands of chain running on chain guides are installed on boom

of the reclaimer. The scraper blades are mounted onto the two strands of the chain at regular interval. The boom is provided with a pivot which is located at the discharge end near the base of the stockpile. A winch using a wire rope and sheave system is used to lift the free end of the boom to place it on the side of the stockpile.

Two Strands of Chain with Scraper Blades

At tail end the chains pass around tail sprockets, and at the head/discharge end driven sprockets. Above photograph shows tail sprockets and two strands of chain running on chain guides with scraper blades mounted on them. The scraper blades reclaim the material from side of the stockpile and conveys it to the discharge point above the outgoing conveyor through an inclined drag trough. Side scraper reclaimers are suitable for reclaiming sticky materials. However, because side scraper reclaimers reclaims material from side of the pile, they are suitable for buffer storage (non-blending) application only. The side scraper can reclaim a pile completely. As the machine rides on / over stockpile, it can move to any area of the pile and start reclaiming or can move to any of the stockpiles in series. Side scraper reclaimers are the most economical solution for small stockyards up to 30 m pile widths (span).

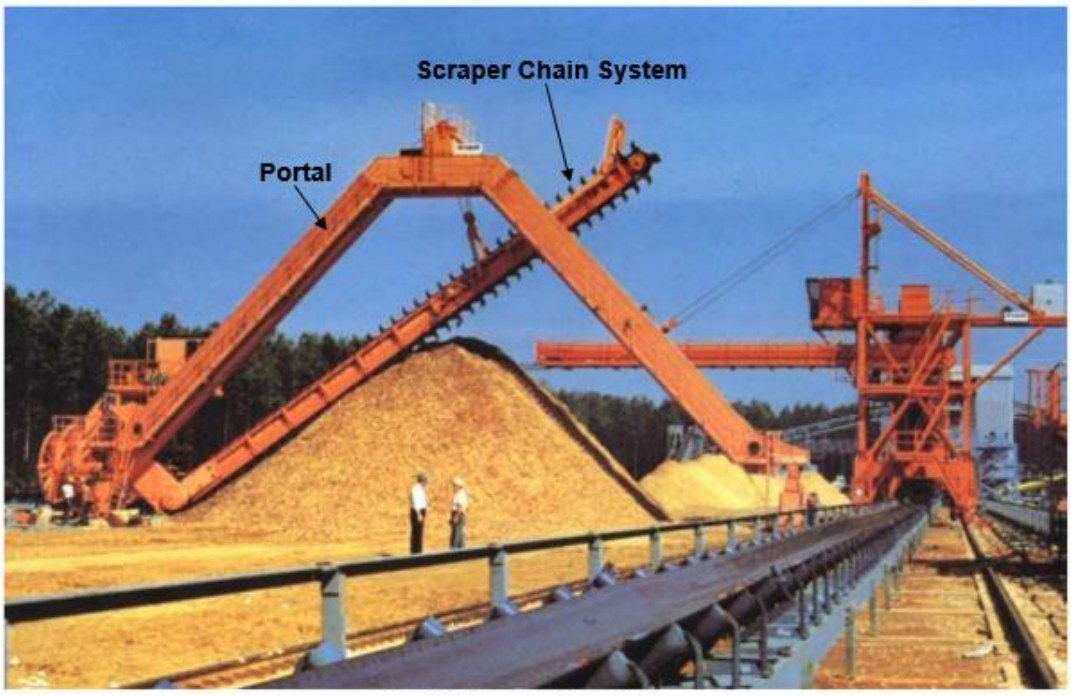
Photograph of Side Scraper Reclaimer

Side scraper reclaimers are used for open as well as covered stock yards. Above photograph shows use of a side scraper reclaimer in a covered stock yard. Side Scraper reclaimers are used extensively for low capacity non-blending applications mainly in cement plants for additives, correctives and coal.

Portal Scraper Reclaimers

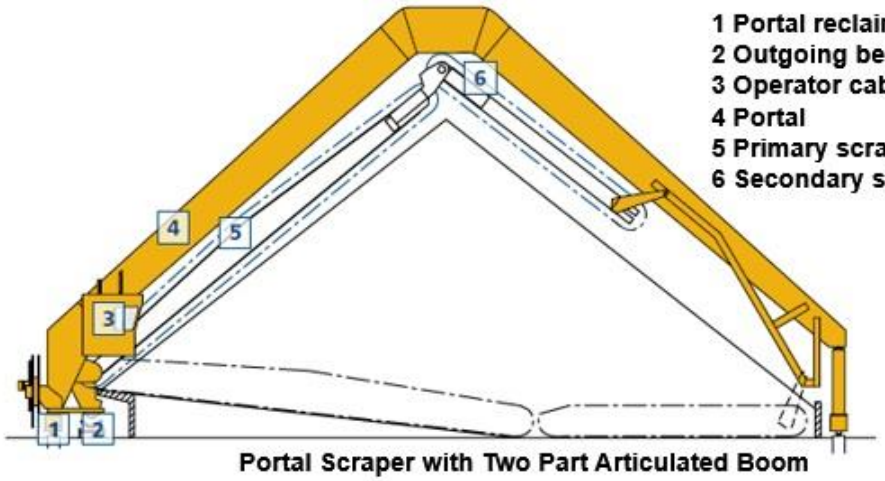
A portal scraper reclaimer is named after the shape of the reclaimer body connecting the two end carriages. This structure is usually similar in shape to an inverted " V "or a portal frame.

As portal scraper reclaimer reclaims the material from side of a pile, it is principally similar in operation to the side scraper reclaimer but overcomes the restriction of limited boom length (up to 30 m pile widths) of a side scraper reclaimer which is due to its cantilever type arrangement, by having rail (bogie) on both sides of the stockpile. Thus wider pile widths can be handled by a portal scraper reclaimer.



Portal Scraper Reclaimer

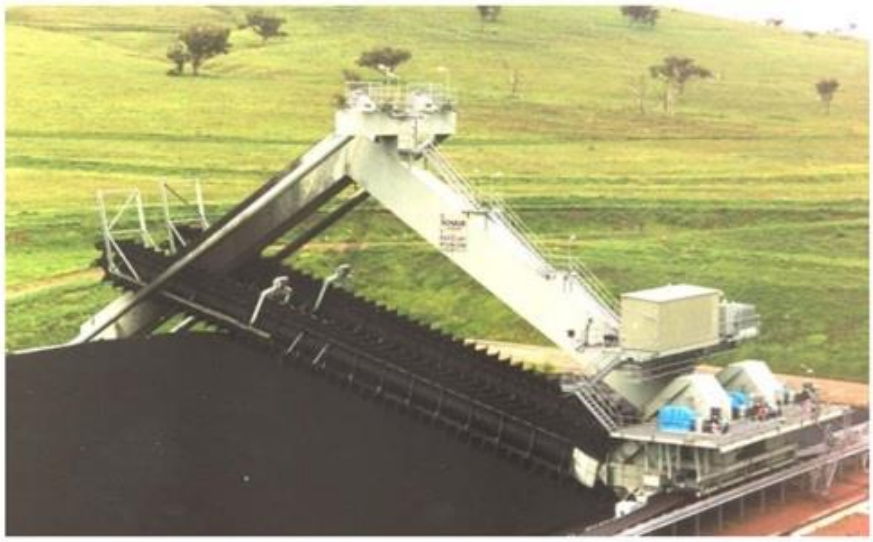
As shown in above figure, a portal scraper consists of a portal frame with a scraper chain system (boom with chain and scraper blades).



1 Portal reclaimer bogie
2 Outgoing belt conveyor
3 Operator cabin
4 Portal
5 Primary scraper chain
6 Secondary scraper chain

Portal Scraper with Two Part Articulated Boom

As shown in above figure, a portal scraper with a two part articulated boom (two arms) has a primary and secondary scraper chain working on either side of the pile while the portal moves to and fro. The primary and secondary scraper chain systems are linked together at a knee joint. The secondary scraper chain lifts the material to the crest of the pile, feeding the primary scraper chain system. The primary scraper chain system conveys the material to the outgoing belt conveyor.



Portal Scraper with Two Scraper Booms

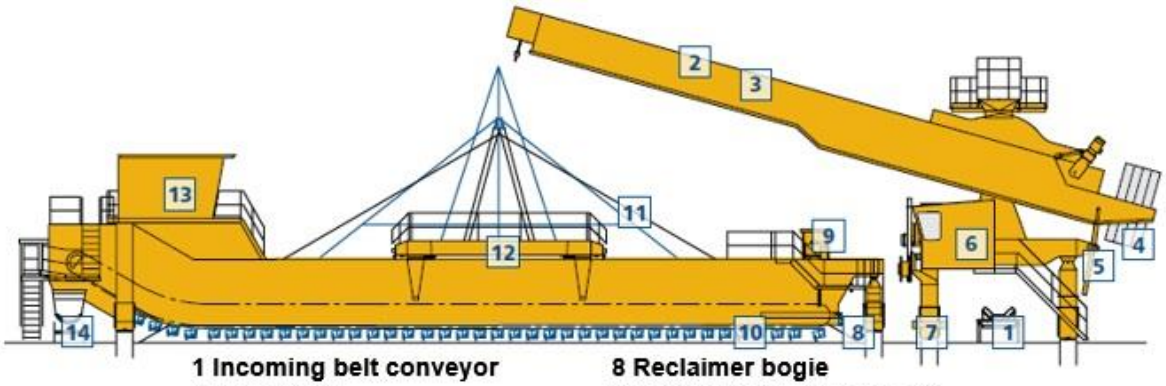
As shown in above figure, larger capacity machines could have two scraper booms working in parallel.

Semi-Portal Scraper Reclaimer

For indoor operation, the best ratio between the building section and the stockpile section is, in most cases, achieved with a semi-portal scraper reclaimer. The height of the retaining wall inside the building is defined to provide full use of the available storage area. Semi-portal scraper reclaimers are the ideal solution for stockyards with limited space or stockyards divided into compartments. Above figure shows photograph of a semi-portal scraper reclaimer.

Bridge Scraper Reclaimers

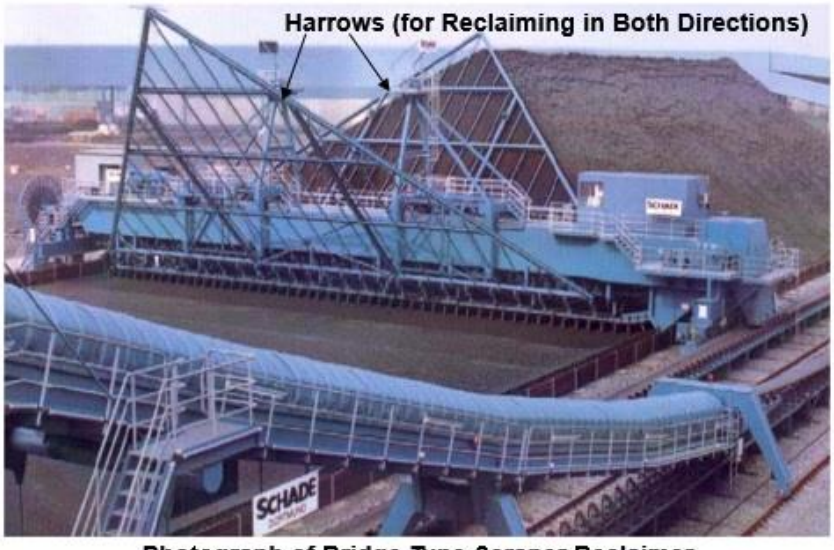
Where reclaiming must be carried out from the face of a stockpile (for blending), a bridge type reclaimer is necessary. The bridge reclaimer is named after the reclaimer body connecting the two end bogies (carriages). This structure, spans from one end bogie to the other, and is a bridge like beam, parallel to the ground. In a bridge type scraper reclaimer, a scraper chain system is mounted on the bridge type structure.



1 Incoming belt conveyor
2 Boom (Jib)
3 Conveyor belt on boom
4 Boom counterweight
5 Luffing unit
6 Operator cabin
7 Stacker bogie
8 Reclaimer bogie
9 Hydraulic tensioning unit
10 Scraper chain
11 Raking harrow
12 Raking car
13 Operator cabin
14 Outgoing belt conveyor

Bridge Type Scraper Reclaimer

Above figure shows construction of a typical bridge type scraper reclaimer. A travelling luffing stacker is also shown in the figure to explain stacking and reclaiming operation. The material entering the stock yard on a belt conveyor is discharged from the boom of the stacker traveling on rails alongside the stock yard at a preset speed to make a stockpile (by Chevron method). The height above the crest of the pile is kept at a minimum to reduce dust emission. Reclaiming takes place from the face of the stockpile (full cross section of the stockpile) at the natural angle of material slide. The bridge of scraper reclaimer runs on rails on either side of the stockpile. On the bridge is mounted a raking harrow system whose sweeping movements cause the material to slide to the pile base. A scraper chain system mounted on the bridge conveys the material to the outgoing belt conveyor.



Photograph of Bridge Type Scraper Reclaimer

Above figure shows photograph of a bridge type scraper reclaimer. As shown in the figure, a harrow is a grid frame mounted onto the bridge and is positioned onto the stockpile face. It is moved across the face of the stockpile with an oscillating/reciprocating action of a rake system (typical construction shown in the following figure). The oscillating rake system disturbs the material in the stockpile across its entire width causing it to slide down the slope of the stockpile (to stockpile base), into the path of the rotating scrapers. If the reclaimer is required to reclaim in both directions of the stockpile, then one harrow is required for each direction (total two harrows). To loosen sticky and non-free flowing materials, it is recommended to use active live-harrows. For more information on active live-harrows, please contact FLSmidth (www.flsmidth.com).

Photographs of Rack System

To reduce harrow wear, it is recommended to use a full facing harrow, i.e. the harrow that covers the total cross-section of the stockpile because small sized harrows (harrows which only cover a small cross-section of the stockpile) need a long stroke to cover the total cross section, while the full facing harrow needs short stroke, i.e. a short travel distance. A full facing harrow also has the distinctive benefit of ensuring perfect homogenization and a constant material flow onto the outgoing/reclaiming belt conveyor.

Portal Bridge Reclaimer

The bridge type reclaimers have the disadvantage of being trapped between stockpiles and are therefore only able to reclaim from adjacent stockpiles. To overcome this disadvantage, as shown in above figure, a portal bridge type reclaimer having a liftable/luffable horizontal scraper boom (bridge) may be used which combines the benefits of the bridge type and the

portal type reclaimer. The horizontal scraper boom carries a roller-mounted sledge moving back and forth driven by a rope winch to move its harrow (instead of a rake system in a bridge type reclaimer). The back and forth movement of the sledge drags the harrow like a wiper across the pile slope. Portal bridge type reclaimer are manufactured by SCHADE Lagertechnik GmbH (www.schade-lagertechnik.com).

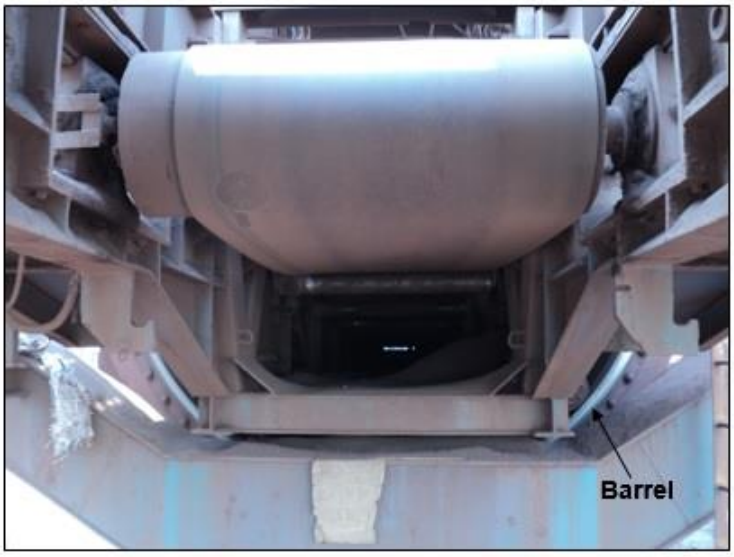
Alternatively, if required, in the case of parallel stockpile arrangements, a transfer car is provided, running in a pit across the open end of the stockpiles, to enable a bridge type reclaimer to be positioned on any pile. A bridge type reclaimer may also be equipped with slewing bogies to permit transverse travel on rails laid at ground level. Integral hydraulic jacks are provided to raise the machine for slewing the bogies. With this design, the need for the transfer car and its pit are eliminated.

Barrel/Drum Reclaimers

Barrel/drum reclaimers and bridge type bucket wheel reclaimers are used when robust systems are needed for the high performance blending and reclaiming of bulk materials, especially when the materials are semi-hard to hard.

Barrel Type Reclaimer

Like the bridge type reclaimers, a barrel type reclaimer is used where reclaiming must be carried out from the face of a stockpile for blending. As shown in above figure, a barrel reclaimer comprises of a bridge spanning the stockpile which is supported on “A” frames at each side. These frames are carried on motor-driven bogies which run on rails laid on each side of the pile. The rotating barrel is supported from the bridge structure. The barrel is fitted with a large number of reclaiming buckets arranged along its length and around it circumference. They pick up the material that has been fed to the base of the pile by means of a harrow which traverses across the pile face. The oscillating rake system disturbs the material in the stockpile across its entire width causing it to slide down the slope of the stockpile into the path of the rotating buckets. Material collected in the buckets is discharged onto a belt conveyor contained within the barrel, and is then delivered to a downstream yard conveyor running alongside the stockpile.



Belt Conveyor Contained Within the Barrel

Above figure shows photograph of belt conveyor contained within the barrel.

Barrel Drive Pinion and Support Rollers

Above figure shows photograph of drive pinion and support rollers in a barrel drive.

For bi-directional operation, the barrel drive is made reversible and buckets are oriented to suit either direction of rotation. In addition, a harrow is provided on each side of the machine. Like the bridge type reclaimers, barrel reclaimers also have the disadvantage of being trapped between stockpiles and are therefore only able to reclaim from adjacent stockpiles. If required, in the case of parallel stockpile arrangements, like in the bridge type reclaimers, a transfer car or slewing bogies can be provided to barrel reclaimers for positioning them on any stockpile.

Bridge Type Bucket Wheel Reclaimer

Similar in function to the barrel reclaimers, the bridge type bucket wheel reclaimers use rotating bucket wheel/s to extract and feed the material in place of a rotating drum. The digging action is more positive with a bridge type bucket wheel reclaimer; however, the homogenizing effect is lower. The machine is used for heavy-duty application of blending-cum-reclaiming.

Bridge Type Bucket Wheel Reclaimer

Above figure shows photograph of a bridge type bucket wheel reclaimer. As shown in the figure, the machine has a horizontal bridge supported on rail track spanning the stockpile width. The rotating bucket wheel/s make to-and-fro linear travel along the bridge. The machine moves with slow speed (by steps) into stockpile face. The to-and-fro motion of the rotating bucket wheel and steady advancement of the machine into the stockpile face results in to blending-cum-reclaiming operation.

Boom Type Bucket Wheel Reclaimers

Bucket wheel reclaimers are the ideal means of handling and moving large amounts of bulk materials in the shortest possible time and can be designed as reclaimers or as combined stacker/reclaimers.

Boom Type Bucket Wheel Reclaimer

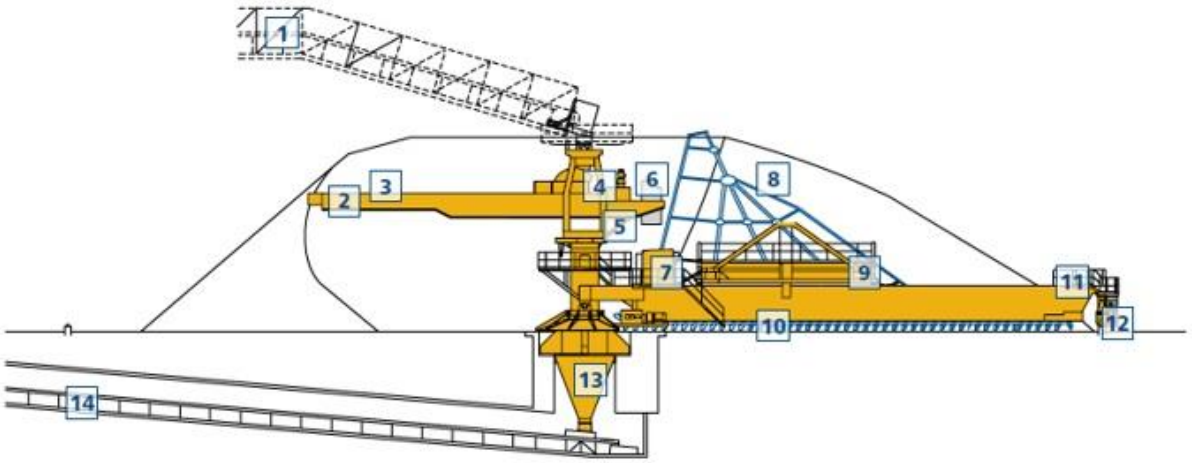
Above figure shows photograph of a boom type bucket wheel reclaimer. As shown in the figure, the machine has a slewing boom. The boom is supported at machine center by a

slew bearing. The bucket wheel is at far end of the boom. Reclaiming is done by combining rotary motion of the bucket wheel with slewing of superstructure. The travel motion of the machine is in steps, to create depth of cut into the stockpile face. The reclaiming operation comprises of travel step, followed by slewing pass, followed by travel step in a repetitive manner, for continuous reclaiming of the selected bench. As the blending effect is marginal, the machine is mainly used for reclaiming operation. The reclaiming of material primarily occurs during slewing motion of the boom. The bucket wheel rotates at steady speed, whereas the slewing speed varies automatically during slewing pass. The slewing speed is least when boom is nearly parallel to yard conveyor. The slew speed is highest when boom angle with yard conveyor is nearly perpendicular.

Combined Stacker and Reclaimers (Stacker cum Reclaimers)

Combined stacker and reclaimer machines (called stacker cum reclaimers) can stack the material to form the stockpile or reclaim the stockpiled material and feed onto the main line conveyor.

Circular stacker cum reclaimer machines are used for stacking and reclaiming functions in circular stockpiles in plants where space is a constraint. In a circular stacker cum reclaimer machine, slewing and/or luffing stacker can be combined with bridge, pylon or portal reclaimer to form the circular stacker cum reclaimer. Information on construction and working of circular stacker cum reclaimers is given in this section.



1 Incoming belt conveyor
2 Boom/Jib
3 Conveyor belt, boom
4 Central column
5 Luffing unit
6 Boom counterweight
7 Operator cabin
8 Raking harrow
9 Raking car
10 Scraper chain
11 Hydraulic chain tension unit
12 Bogie
13 Outlet hopper
14 Outgoing belt conveyor

Circular Stacker cum Reclaimer

Above figure shows construction of a typical circular stacker cum reclaimer. The stacker is mounted on the centre column, which allows rotation in both directions simultaneously with the vertical movement of the boom. Its height above the crest of the pile is kept at a minimum to reduce dust emission. Reclaiming takes place at the natural angle of slide. A raking harrow is mounted on the bridge reclaimer. The sweeping movements of the harrow system cause the material to slide to the base, where the chain system then conveys it to the centrally placed outlet hopper. The homogenized material leaves the stockyard by an underground belt conveyor. To loosen sticky and non-free flowing materials active live-harrows are available.

Information on boom type bucket wheel stacker cum reclaimers is given in the next chapter.

Boom Type Bucket Wheel Stacker cum Reclaimers

A boom type bucket wheel stacker cum reclaimer (also called stacker cum reclaimer) is used for stacking material (building stockpiles) on either side of the track rails and subsequently reclaiming the material from the stockpiles and feeding them for onward usage. The boom conveyor is reversible, enabling stacking in the forward direction and reclaiming in the reverse direction. A bucket wheel, like that of a bucket wheel reclaimer is used for positive digging and feeding of material onto the boom conveyor. Stacker cum reclaimers with bucket wheel boom are primarily employed where medium, large or very large material flows are to be stacked and then later reclaimed by the same machine.

Boom Type Bucket Wheel Stacker cum Reclaimer

Above figure shows a boom type bucket wheel stacker cum reclaimer. For stacking material, tripper of the yard (main line) conveyor (installed on the tripper car) transports the material to the boom conveyor and then to the stockpile. For reclaiming the material, a bucket wheel is used for feeding of the material onto the boom conveyor and then to the yard conveyor.

Stacker cum reclaimer generally comprises of the following main assembly groups:

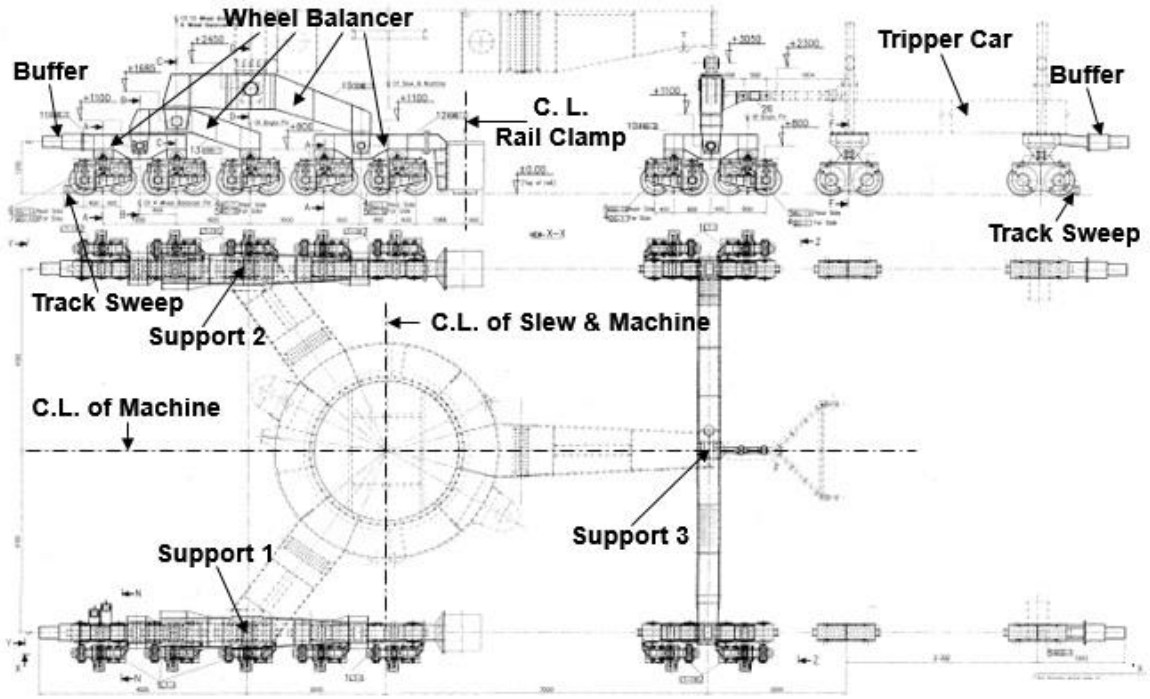
- Set of travel gear bogies
- Substructure
- Superstructure with slew assembly
- Bucket wheel boom and bucket wheel body
- Pylon and counter weight boom
- Tripper and intermediate conveyor structure
- Conveyor systems for boom, tripper & intermediate conveyor

Detail information on various assemblies/items, operation and maintenance is given in the following sections. Henceforth, sometimes, stacker cum reclaimer will be called the machine.

These machines are mounted on rails. The weight of machine is shared by travel bogies, in accordance with permissible wheel load. Travel bogies are of robust construction and are provided with forged and case hardened steel travel wheels. The travelling gear (set of travel gear bogies) consists of driving wheel bogies (each comprises of 2-wheels), follower wheel bogies (each comprises of 2-wheels) and single wheels. One of the wheels in each driving wheel bogie is driven by a shaft-mounted drive unit. The drive unit is supported by a torque arm from the bogie. The bogies are provided with wheel fracture props. Wheel fracture props provided in each bogie restricts its fall (generally to 25 mm only), in the unlikely event of failure of the wheel axle.

The tripper car moves along with the machine. It is connected with the machine by a tie member with spherical seat hinge or pins. The tripper lifts the yard conveyor belt and, after passing over the tripper pulley and bend pulleys, returns it to the yard level. The power cable reeling drum (CRD) and the electrical house are mounted on the bottom frame of the tripper.

As 3 points in space determines the specific plane, the machine body is supported on wheel assemblies as '3 points support' to avoid twisting of structure. The 3 points support can have 4 corner wheel assemblies. The design ensures machine stability in all applicable conditions.



3 Points Support Having 4 Corner Wheel Assemblies

Above figure shows typical 3 points support having 4 corner wheel assemblies. Two pier legs (supports) project from the machine on one side and a third leg connection on the other side.

The substructure, a ring girder (also called gantry portal), consists of outer ring and inner ring with top and bottom plates welded and is a circular frame of box construction. The substructure ring girder with its 3 legs transfer forces from the slewing super structure of the machine over the supporting points of bogie system. A chute is provided in the centre through which material to be handled is discharged to yard conveyor. An annular surface is machined on the upper inner edge of the top plate (ring girder deck) for accommodating the slew bearing.

Impact table is bolted underneath of substructure and is a structural framework of channels and plates. It .is to accommodate yard conveyor passing over impact idlers mounted on fixed channel frame.

Buffers and Track Sweep

The extreme two wheel balancers (also called equalizers) of the stacker cum reclaimer, away from the tripper car, and the extreme two bogies (balancers) of the tripper car, away from the machine are fitted with buffers and track/rail sweeps.

The slewing superstructure includes the slew platform with vertical projections for the pylon bearings, pylon, bucket wheel boom, counter weight boom and the bucket wheel boom conveyor. The slew platform consists of welded rectangular frame box construction with inner drum shell. The rotating connection between the superstructure and substructure circular frame is formed by a slew bearing designed to safeguarded the superstructure from lifting and also absorb alternating axial and radial loading with high tilting moments. The gear rim (outer ring) of the slew bearing is bolted to the substructure ring girder by high tensile bolts and the inner ring of slew bearing is bolted on the slew platform by high tensile bolts. Slew movements of the superstructure are introduced by two (or three) slew drives located on the slew platform (or gantry portal), whose drive pinions mesh with the gear rim of the slew bearing. The gear rim and pinion of the slew assembly have a cover/casing which is bolted under the slew platform to protect the gear and pinion teeth from accumulation of dirt.

Typical Bucket Wheels

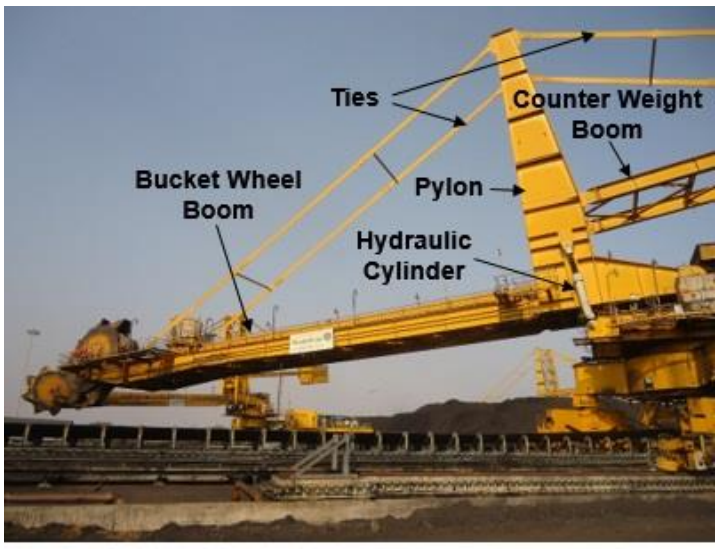
The bucket wheel, generally of cell-less design with buckets fixed around its periphery is installed at far end of the bucket wheel boom. The buckets are fabricated from high tensile steel plates (e.g. SAILMA 350HI plates by SAIL, India having Yield Strength = 350 MPa, minimum and Ultimate Tensile Strength = 490 MPa, minimum; Hardox 400, etc.) with digging lips of wear resisting steel (cast manganese steel). Many times, buckets are provided with replaceable digging teeth of manganese steel with holders welded onto the lips. Normally the bucket wheel is installed at about 10° inclinations to ensure continuous material discharges on to the side chute. All chutes (bucket wheel chute, central chute, etc.) are fabricated of steel plates and provided with wear/abrasion resistant liners (e.g. SAILHARD plates by SAIL, India; Hardox, etc.). Mostly the liners are bolted to the chutes for easy replacement. While stacking, the bucket wheel chute is lifted up by a hydraulic cylinder to clear the material on the conveyor. The bucket wheel drive is reversible type to facilitate withdrawal of the bucket wheel in the event of excessive under cutting.

Electric Motor and Gearbox Hydraulic Motor and Power Pack

Bucket Wheel Drives

As shown in above figure, the bucket wheel is driven by either electric motor with fluid coupling (for starting and safety), brake and gearbox or hydraulic motor and power pack.

The boom for the bucket wheel is of slewing and luffing type. The boom is slewing because it is held by the super structure, which is supported at machine center by the slew bearing. Generally, the slewing rang is ± 100/105°. However, it may be noted that the boom operation angle to yard conveyor is generally limited up to 75°.



Luffing of Bucket Wheel Boom

Luffing (raising/hoisting or lowering) of the bucket wheel boom is carried out by two double acting hydraulic cylinders (and power pack) connected between the pylon and the slew platform. The cylinders are sized such that, in the event of one cylinder failing, the other is able to sustain the total load of the system (out of operation) alone as an emergency feature. Like slewing range, the machine is also designed for certain luffing range (for example: max. down = − 6°, max. up = + 9° and parking = − 4°). The upper and lower positions of the bucket wheel boom (extreme luffing positions) are limited by limit switches.

Protection of Piston Rod and Seals

For long life of the hydraulic cylinders, protection of piston rods and seals (wiper ring and rod seal) is very important. The piston rods and seals are protected by leather bellows. As shown in above figure, if piston rod gets exposed to environment (due to damaged bellow, or the bellow coming out from bellow holding down screws), piston rods and seals will get damaged resulting in oil leakage.

The pylon, comprising two plate girders connected by K-bracings, is pivoted/hinged to the slew/revolving platform by means of plain spherical bearings. The bucket wheel boom with its ties is pinned to the front of the pylon structure whereas the counter weight boom and its ties are pinned to the rear of the pylon. The bucket wheel boom tie and counter weight boom tie, connects the pylon top with the bucket wheel boom and counter weight boom respectively.

Bucket wheel boom is of fabricated double plate girder construction adequately braced by rolled sections in a K-lattice construction. The bucket wheel with drive and the mechanical components of the boom conveyor are mounted on this boom. Necessary service walkways are provided along both sides of the bucket wheel boom. The operator's cabin is positioned on the opposite side of the bucket wheel to give good visibility to operator and kept levelled by means of hydraulic cylinder regardless of the changing inclination of the bucket wheel boom. The counter weight boom is of two sturdy joists adequately braced together. It supports the counter weight. The counter weights serve to balance the boom deadweight as well as approx. 50% of the live loads and incrustation. This ensures minimum shift of the center of gravity and similarly minimum possible loading of the boom hoist.

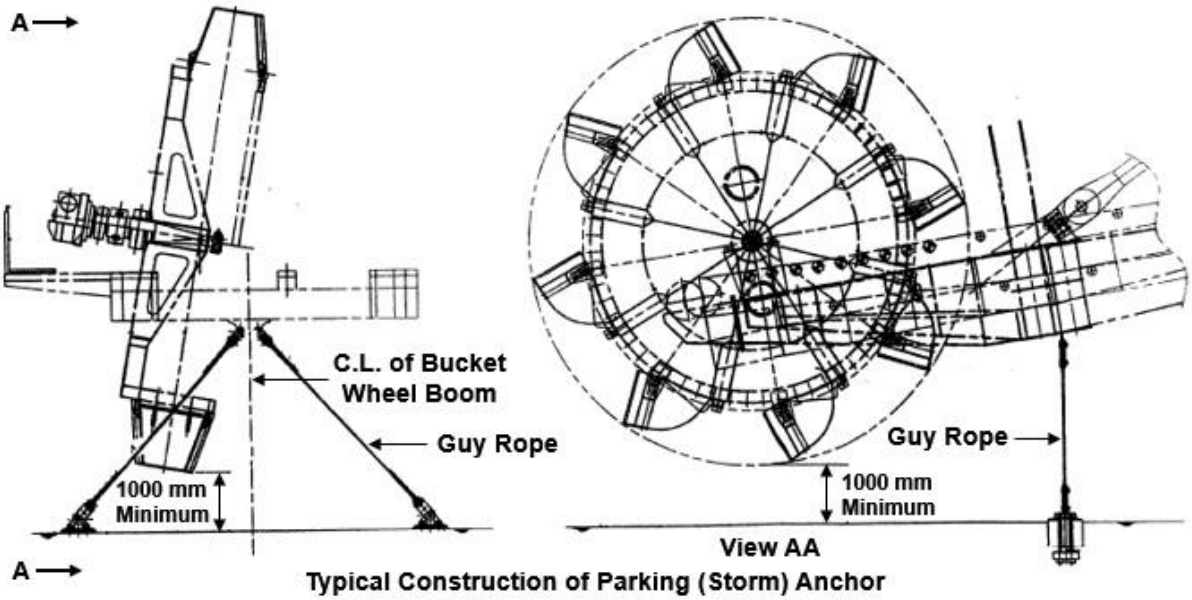
Many times the pylon, bucket wheel boom, counter weight boom with counter weight and ties is called a bascule (or rocker assembly) which in turn is pivoted to slew platform.

Electronic belt weigh scale is provided optionally on the boom conveyor to measure the flow and also to regulate the reclaiming capacity of the machine.

The machine is provided with an anemometer (wind warning device). The anemometer is generally installed on top of the pylon. When the velocity of wind exceeds the set value, the control system of the machine gives audio/visual signal to the machine operator. The operator thereby applies the rail clamps and stops the travel movement of the machine. In case of high wind, a heavy lug below the boom head structure is utilized for the holding down arrangement (guy ropes) of the boom. Alternatively, adequate locking arrangement is provided between the super structure and lower structure to make the machine withstand storms and cyclonic winds.

Rail Clamp

Above figure shows photograph of a typical rail clamp. The holding force of the clamp is produced by means of the friction (coefficient of friction is about 0.25 and corresponds to normal grease free conditions) occurring between clamp shoes and railhead. There are two types of rail clamps: manual and automatic (hydraulically operated). Automatic rail clamps are released by hydraulic cylinders which actuate limit switches to permit travel motion. As the hydraulic rail clamp is closed via spring operation and opened electro-hydraulically, opening requires electric current. In case of current failure, the clamp closes automatically.



Typical Construction of Parking (Storm) Anchor

As shown in above figure, guy ropes (steel wire ropes) connected to the foundations are used for anchoring the boom for parking the machine.

Stacker cum Reclaimer with Intermediate Conveyor for Bypass

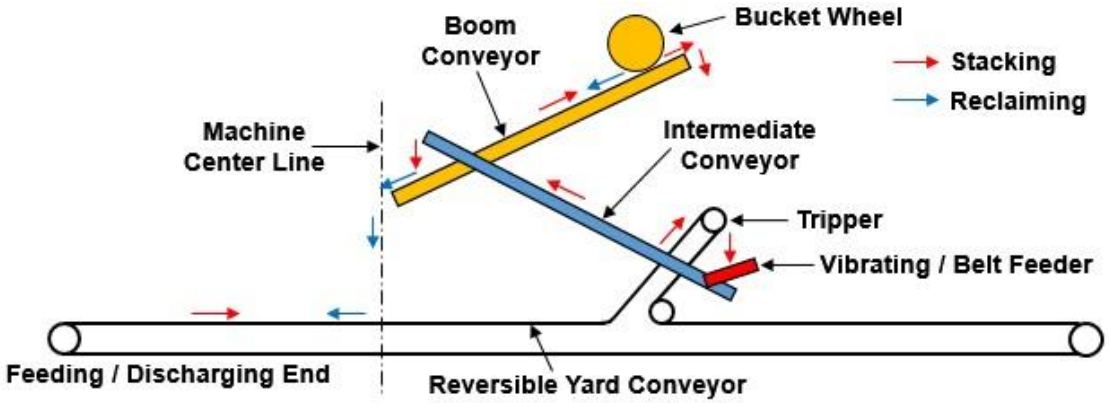
The yard conveyor is often equipped with a bypass, a bifurcating chute (chute with two legs) with diverter gate after the tripper. One leg directs the material towards the boom conveyor during stacking whereas the other enables material to be discharged in to the central chute (bypassing the boom conveyor) for bypassing the boom conveyor and continue along the yard conveyor. As shown in above figure, many times a stacker cum reclaimer is provided with a bifurcating chute and intermediate conveyor for bypassing the boom conveyor, a more efficient method (material is not required to be lifted up to the boom conveyor) of bypassing.

Stacker cum Reclaimer with Intermediate Conveyor for Bypass - Close Up View

Above figure shows close up view of a stacker cum reclaimer with a bifurcating chute and an intermediate conveyor for bypassing the boom conveyor.

Stacker cum reclaimers can be designed for unidirectional flow or reversible flow depending upon the application. In case of reversible flow stacker cum reclaimer, the machine is

designed for working with a reversible yard conveyor with the provision for feeding at one end for stacking and discharging at the same end during reclaiming.



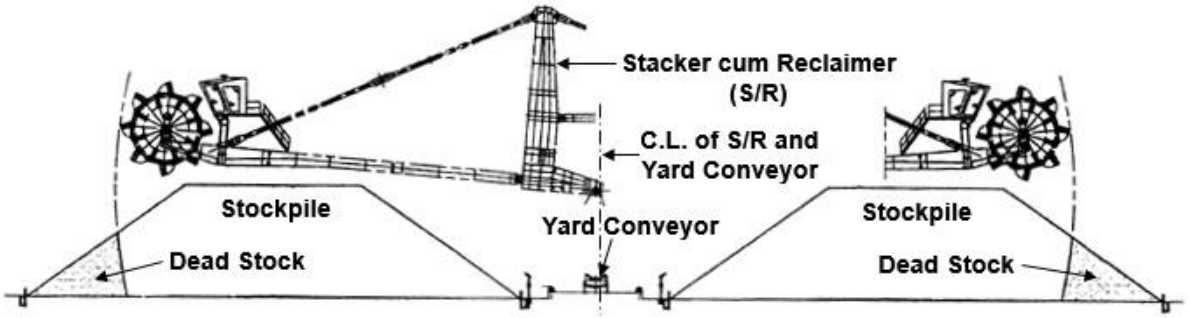
Material Flow Directions in Stacker cum Reclaimer for Reversible Flow

Above schematic figure shows material flow directions in a stacker cum reclaimer designed for reversible flow (discharging also from the feeding end). For stacking the material, the material on the forward moving yard conveyor is raised by tripper and discharged through a vibrating / belt feeder onto an intermediate conveyor which lifts the material and ultimately discharges on to boom conveyor. For reclaiming the material, boom conveyor discharges the material on the yard conveyor after its direction is reversed.

Tripper Discharging on Vibrating Feeder | Tripper Discharging on Belt Feeder

Transfer of Material from Tripper to Intermediate Conveyor

Above figure shows transferring of material from a tripper to intermediate conveyor using vibrating feeder and belt feeder. It may be noted that in case a chute is not having adequate slope, a vibrating feeder may be used to overcome chute chocking problem.



Stockpile Geometry of Boom Type Bucket Wheel Stacker cum Reclaimer

Above figure shows stockpile geometry of a boom type bucket wheel stacker cum reclaimer. Travelling the machine along the length of stockpile does the stacking while slewing the boom does reclaiming. Since the boom cannot reach the farthest point of the stockpile base, as shown in above figure a dead stock will be left behind after reclamation of the pile. If required, the dead stock needs to be bulldozed into the reclaimable area so as to be able to reclaim the same by the bucket wheel.

Stacker cum reclaimers are mostly designed as per ISO 5049-1, Mobile equipment for continuous handling of bulk materials - Part 1: Rules for the design of steel structures.

A stacker cum reclaimer will serve better when operated correctly and maintained properly. In view of this, important information on its operation and maintenance is given in the following sections.

Stacker cum Reclaimer Operation

It is forbidden to use the machine during a storm and in bad visibility conditions, at a mist or a torrential rain.

Before starting operation, the operator should carry out visual checks of brakes, gearboxes, hydraulic cylinders and components, limit switches, belts and motors to ensure that all important systems are healthy. The operator should also check that HT transformer temperature is normal.

Before starting operation of the machine, any existing locking devices (locking pins of guy ropes, rail clamps) should be released. In the event of danger of gales (strong wind), all anti-drift devices should remain applied in so far as possible.

Before starting the machine, siren has to be switched on for 20 to 30 seconds.

True running of belt, belt tensioning, belt cleaning devices, removal of spillage and heavy deposits should be given regular attention.

Although it may be easily possible to exceed the peak reclaim capacity with various material, this should not be done with due consideration to stressing, rail loading and stability of the machine.

The reclaiming of the stockpile is done in layers or benches The height of the bench should normally be kept at 50 to 60% of the bucket wheel diameter. If the material avalanches in a very uneven manner, the height of the layer selected should be reduced. Care should be taken that the bucket wheel is not buried in the event of sudden avalanching of the whole stockpile.

A buried bucket wheel should never be freed from the pile by travelling the machine and neither should the boom be slewed nor the machine travelled while the wheel is stationary. In case the bucket wheel gets buried, it should be rotated in the reverse direction and then lifted out carefully. If the wheel is buried deep, some of the embedding material should be removed before attempting withdrawal.

Attention should also be paid that the buckets come into contact with the material being reclaimed over the lip length only and no contact occurs at the bucket wheel body, boom conveyor pulley or other parts on the boom.

End positions should be approached only at reduced speed.

Safety devices (overload trips, limit switches) should not be interfered with, altered, made in-operative or switched off. Limit switches should be adjusted so that a sufficient running-out distance remains.

Generally, automatic motorized dual-line centralized grease lubrication systems are provided for the lubrication of bearing points on sub-structure (covering bearing points on the stationary part of the machine and tripper) and the super-structure (covering bearing points on the revolving part of the machine). They are energized automatically (generally on starting the machine) at least once every 24 hours. In case of any fault, instruments fitted on the lubrication system takes necessary action and the fault is annunciated. For examples: Low grease level switch stops the pump in case of low grease level in reservoir whereas a pressure loss monitor (a timer) trips the circuit in case the pump fails to build up the system pressure within a preset time. Prompt action should be taken by the operator to get the faults attended. It may be noted that effective lubrication is essential to achieve a satisfactory service life.

Areas in which electrical equipment are installed must never be used for storage of lubricants or other combustible materials.

The machine should not be utilized for towing and pushing.

Maintenance

Before starting any maintenance activity, a close study should be made of the relevant general arrangement and assembly drawings.

General Precautions

It is advisable to carry out removal and installation of mechanical parts with machine positioned for parking (anchoring against storm) so that in case storm possibilities at short warnings (particularly for sea-shore installations) the machine can be quickly anchored.

Before removal of any component, care should be taken to disconnect all associated accessories like lubrication pipeline, electrical components and wiring, etc.

Reusable parts should be marked with their installation positions.

Special care should be taken while handling or slinging components. Wherever lifting lugs are provided, only those should be used for lifting the parts Where lugs are not provided, slinging should be done with due consideration of the centre of gravity of the component. Suitable protective wooden blocks or similar devices should be used with slings to prevent damage to the components.

All fasteners must be assembled in lightly oiled condition and tightened with the torque wherever specified on the drawing.

At all joints with HSFG bolting, mating surfaces of plates should be rendered free of dust, dirt, oil, grease, loose mill scale, paint, lacquer, etc., and/or any foreign/loose material. If necessary, the area shall be blast or flame cleaned before fastening the bolts.

When carrying out welding work (electric arc welding) the earth cable is to be clamped in close vicinity to the welding place. In no case what so ever may welding currents be conducted via the ball bearing, slewing gear, gearboxes or via anti friction bearings.

Mostly only general instructions and precautions are given for removal and fitting of various parts in the operation and maintenance manual. Hence, for any major maintenance work like replacement of slew bearing, the work should be carried out under the supervision of OEM's personnel. This is necessary since such repairs may cause, if not properly carried out, a greater shift in the centre of gravity endangering stability of the machine.

Bucket Wheel Assembly

Every week check wear of the buckets and take corrective action.

Periodically check and ensure proper fastening of the bearing housings of the bucket wheel assembly.

If any repair calls for the bucket wheel gear unit or the complete drive to be taken off, another heavy part of the same weight should be attached or the counterweight tail should be underpinned before attempting to remove these parts. The same precaution should be observed when dismantling the bucket wheel, buckets, shaft and chute. To facilitate the application of temporary weights by means of rope lashings, generally a lug is provided at the boom head.

Some manufacturers are providing a boom fork and recommending to lower the boom on the boom fork and remove a counter weight block from the counter weight boom before removing any item for maintenance.

Please follow the instruction given in the maintenance manual by the machine manufacturer.

If above precautions are not taken, the centre of gravity is changed to such an extent that the machine may topple over.

Travel Gear Wheels / Bogies

When carrying out maintenance work on travelling gear wheels, it is recommended that the respective bogie is removed and the necessary repair work is carried out in the workshop.

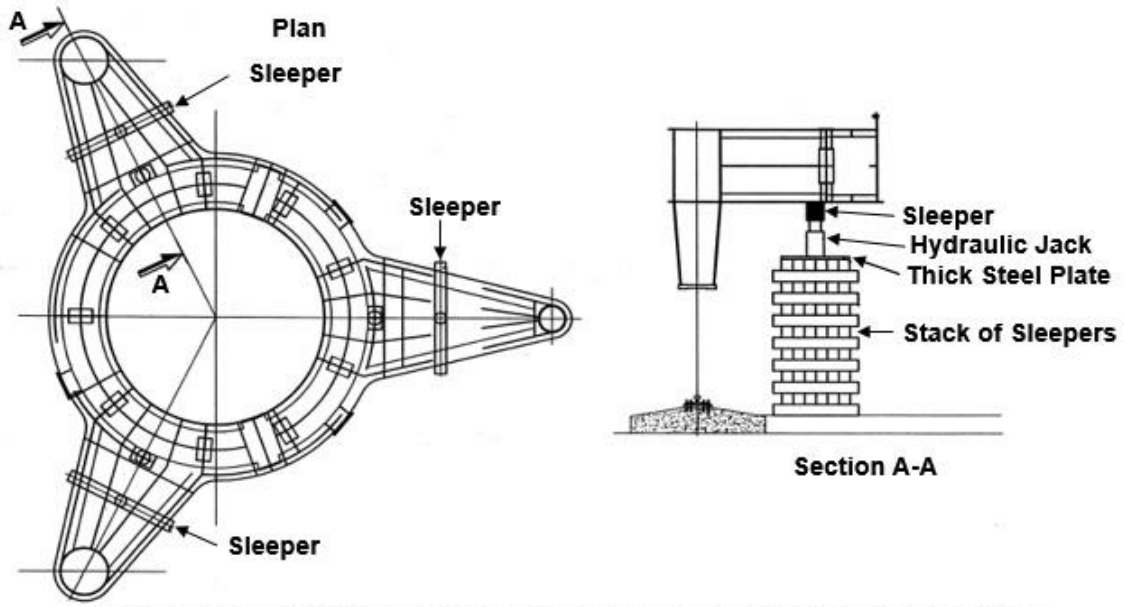
The bogie of any undercarriage support can only be dismantled when appropriate undercarriage support is raised. For stability of the machine, only one support (under one travelling gear group) should be raised at a time.

Before removing any wheel bogie, block the machine on the tracks in such a way that it is prevented from making any travelling movements.

To facilitate removal of wheels, bogies or balancers at any corner, the boom should be located over the corresponding leg (dismantling side) and raised to its highest position (e.g. +9°) so that the load on that corner is minimum. Some manufacturers recommend that the bucket wheel boom be brought into horizontal position. Follow recommendation of your machine manufacturer.

To remove the wheels or bogies or balancers, one jack should be applied on either side at the pads (plates) below the wheel balancer pin and portal pier leg, as applicable. No attempt should be made to apply jacks at any other points.

Instead of providing pads below the wheel balancer pin and portal pier leg, some manufacturers provide pads at the bottom plate of substructure.



Typical Jacking Arrangement of Substructure for Maintenance of Travel Gear

Above figure shows typical jacking arrangement of substructure for maintenance of travel gear. As shown in the figure, a stack of sleepers with strong top plate of steel or grating support is to be provided for relieving load of the bogie group on which hydraulic jack is to be placed. The jack is to be placed below the pressure pads positioned at the bottom plate of the substructure. The jack capacity depends on weight of the machine. Please use capacity and stroke of the jack as recommended by the machine manufacturer.

It is recommended to use the hydraulic jack with a lock nut. The lock nut on the piston must be constantly tightened during raising and must be brought to rest against the face of the cylinder barrel, to prevent unintended lowering of the load in case of possible failure of the jack seal, the hydraulic pump or of the hydraulic line. If possible, the jack used for lifting work should not have stroke greater than 150 mm.

Slew Gear

Periodically (say every fortnight / month) replenish missing grease on the teeth of slew gear and meshing pinions after removing/dismantling their cover/casing/shield.

Slew Gear with Cover **Slew Gear without Cover**

Slew Gear Cover (Casing)

Above figure shows a machine with cover and without cover. Covering of gear and pinion is very important. Cover may be fabricated if it was not provided by machine manufacturer.

Every six months, after taking off all the segments of the cover, visually inspect the gear and pinion teeth. Before inspection, remove old grease and clean/wash the teeth with kerosene. If condition of the teeth is satisfactory, put a coating of fresh grease thereon and then refit the cover.

Teeth may break if impurities get jammed in the area of engagement between slew gear and pinion.

Gear teeth become smoothed and worn in the course of use. A permissible wear limit depends very much on the application. Experience indicates that a wear value of up to 0.1 × module per flank is permissible.

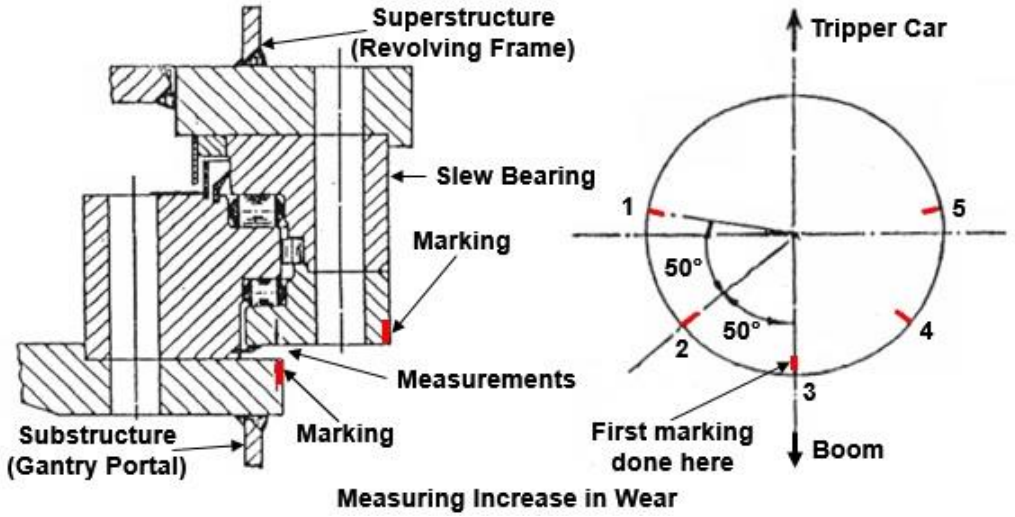
If teeth are broken or there are cracks or excessive wear, consult the machine manufacturer to explore technical possibilities of carrying out reconditioning or repair without dismantling.

Slew/Slewing Bearing

Measuring the power intake of the superstructure slew assembly motors carries out a general check of running characteristics of the slew bearing.

The measured values of power when slew bearing was in new condition should be recorded in the operating manual. The measured values of power may then be compared with the earlier recorded measurement. Considerable increase in the power intake is a sign of damage to the slew bearing.

Since wear in the slew bearing will result in increased internal clearance and lowering of the upper structure, the change in the dimension of the gap (nominally about 10 mm) between the upper race and the seating surface of the lower race (shown as measurements in the following figure) provides an accurate and direct measure of the amount of wear in the slew bearing. Hence the wear measurements enable early detection of technical problems (foresee the need for replacement) before they result in unscheduled plant stoppage.



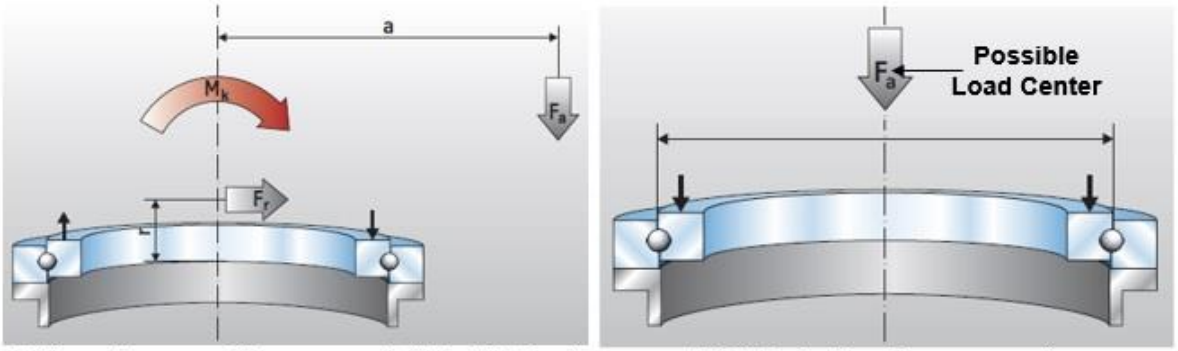
Measuring Increase in Wear

As per one leading Indian manufacturer of stacker cum reclaimers, with reference to above figure, the following procedure may be followed to measure the increase in the internal clearance of a slew bearing (wear of a slew bearing).

- The measurements should be timed only when the wind velocity is minimum (almost zero).
- Remove all foreign material from the machine and ensure that there is no material in the buckets, bucket wheel, chutes or on the belt.
- Orient boom exactly horizontally and parallel to the tracks (opposite to tripper car).
- Put a paint mark on the lower inner surface of the bearing race which is bolted to the superstructure (in between two bolts) and also a corresponding mark, vertically below it, on the edge of the seating surface on the substructure (gantry portal).
- Put four more similar marks on the substructure support, at 50° apart (half of sluing range), on either side of the first mark and number them from 1 to 5 as shown in above figure.
- Measure the gap (accurate to 1/10th of a millimeter) at each of the five marked points.
- Slew the boom so that the mark on the bearing inner race is vertically above each of the markings on the substructure one by one and, at each position of the boom, measure the gap at all five markings.
- Record all readings in a tabular form. These readings should be taken during commissioning of the machine (new bearing, without wear).

Every three months, under the same loading conditions, the measurements at the five points for each position of the five boom should be noted and tabulated along with the earlier readings.

After the initial setting-in period, the readings will remain substantially constant throughout the life of the bearing. Whenever a marked change in the readings is observed, the frequency of measurement should be increased and when the difference of the reading with the first reading (when bearing was new) reaches the maximum permissible wear value, the bearing will have to be replaced with a new one.



Tilting Clearance Measurement (Axial Motion) Axial Reduction Measurement

Wear Measurement Methods

As shown in above figure, depending on the application, the increase in wear can be measured by: tilting clearance measurement (axial motion) or axial reduction measurement.

Following table gives maximum permissible wear values in mm for BF* 12, 13 and 19 (roller bearing slewing rings, i.e. roller type slew bearings) type slew bearings by ThyssenKrupp Rothe Erde (www. thyssenkrupp-rotheerde.com). * BF = Design Type

BF 12, 13 and 19 by ThyssenKrupp Rothe Erde (Roller Bearing Slewing Rings)													
Measuring Method	**Roller Diameter, mm**												
	16	20	25	28	32	36	40	45	50	60	70	80	90	100
	Maximum Permissible Wear Values up to mm												
Axial Reduction Measurement	0.8			1.2			1.6			2.0		2.4	
Tilting Clearance Measurement	1.4			2.0			2.8			3.5		4.2	

For information on wear values for other types of bearings and the integrated wear measuring device which enables online inspection of bearings, please see Slewing Bearings by Rothe Erde® (www. thyssenkrupp-rotheerde.com).

Grease samples may be taken in parallel with, i.e. at the same time as, the wear measurements. Sometimes slewing ring is provided with grease sampling ports. If sampling ports are not provided, one or more grease samples are taken at the seal. The grease samples should be taken from the main loading zone. The analysis of the used grease provides additional information about the raceway condition.

It is advisable to check the bolt torques of the bolted connection on a regular basis and to retighten the bolts to compensate for any settlement phenomena.

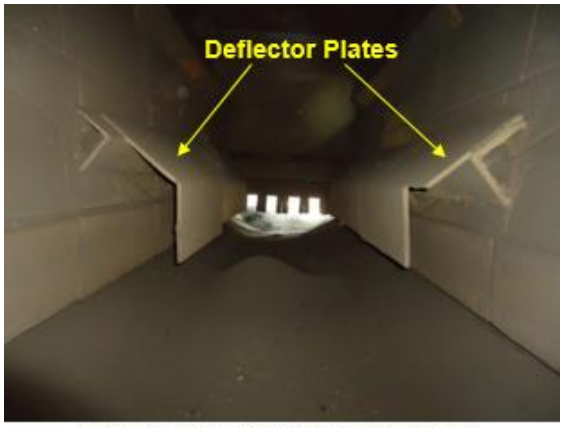
It is recommended to install an automatic central lubricating system for lubrication of the bearing. The bearing system and the gearing must be greased immediately after installation and periodically relubricated at the recommended intervals. The bearing must always be greased liberally so that a collar of fresh grease forms around the whole circumference of the bearing gap and lip seals. The bearing should be rotated during relubrication. Standard design bearings are suitable for operating temperatures ranging from − 20°C to + 60°C. The amount of lubrication will need to be increased and the lubrication intervals shortened in extreme conditions, e.g. in the tropics, where humidity levels (moisture) are raised, exposure to dust and dirt is high, and extreme temperature fluctuations prevail. It may be noted that the grease fill prevents friction, provides protection against corrosion and is a component of the seal. Use grease specified/recommended (lithium saponified mineral oils of NLGI Grade 2 with EP additives) by the machine manufacturer only. Relubrication is absolutely essential before and after prolonged shutdown of the equipment.

When cleaning the equipment, care must be taken to prevent cleaning agents or water from damaging the seals or penetrating into the raceways.

The seals prevent dust and small particles entering the raceway and retain fresh lubricant in the bearing gaps. As sealing materials are subject to ageing when exposed to a number of environmental conditions, seals require maintenance and, depending on their condition, may have to be replaced. Check seals at least every 6 months, renew the seal if it is damaged.

Chutes and Skirts

The chutes and skirts should be inspected for wear and clogging. To avoid damage to the main structure the wear plates must be replaced immediately if they show signs of heavy wear. Check fastening of the wear plates.



Deflector Plates in Central Chute

Since one sided loading of the belt leads to belt off tracking, as shown in above figure, deflector/diverter plates are provided at bottom of the central chute. Periodically inspect their condition and take corrective action to prevent off center loading of the material on the belt. Many times, during commissioning, alteration/modification is carried out to these plates to overcome the problem of off center loading of the material on the belt. It is important to record the alteration carried out in the maintenance manual so that repair can be carried out as per the alteration. If alteration record is not available, repair will have to be carried out based on trial and error method.

Hinged Deflectors (Skirts)

Instead of fixed deflectors, as shown in above figure, sometimes long hinged deflectors (skirts) are provided at bottom of the central chute. For varying their slope, electric actuator with linkage is provided to them. The deflectors are designed long enough to work as skirt plates also.

Gearboxes / Reducers

Periodically check alignment and tightness of fasteners. Ensure that the breathers are clean and operating properly. Care should be taken not to paint over breather. Otherwise pressure will build up resulting in oil leakage.

Gearbox must be filled with correct grade of lubricant, not exceeding the specified level, as over filling causes oil churning, resulting in overheating and leakage. Weekly check the oil level and fill oil to the required level if found less. Take corrective action to stop oil leakage.

Time intervals between oil checking/renewals should be followed as per manufacturers instruction.

Hydraulic System and Lubrication System

Maintenance of hydraulic system and centralized lubrication system is very important for trouble free operation of the machine and to minimize the maintenance cost.

Check the pressure and temperature of the hydraulic oil/fluid every day. Also check the hydraulic system for leakage. Tighten the screws, replace faulty seals and keep the drive clean.

The hydraulic oil change should be made as per manufacturer instructions. For each oil change, the oil tank should completely be drained, and its bottom should be cleaned after removing the manholes.

Greases and oils should be protected against contamination by dust, solid matters and water.

Every time before lubrication by means of hand operated devices, clean thoroughly the end of lubricating nipples, nozzles of grease guns as well as the spatula and brush for applying grease.

Carry out maintenance of centralized lubrication system as per instructions of its supplier.

Thruster Brakes (Electro Hydraulic Brakes)

Periodically inspect the thruster brakes. Adjusted the gap between brake lining and brake drum (if automatic lining wear adjustment arrangement is not provided). Replace the brake shoes / lining when thickness of its lining reaches the recommended minimum thickness.

Brake linings and brake drum should not come into contact with lubricants. Brake linings, contaminated with oil or grease must be replaced by new linings without delay and the brake drum rinsed to remove any oil/grease.

Remove old hydraulic / transformer oil completely and refills it with clean oil as per OEM's recommendation (generally after 1 year; if oil is good, you may change after 2 years).

Track Rails

Check wear of the track rails. The maximum allowable wear at the sides of the rail head is about 7 mm (please follow OEM's maintenance manual). In case of higher wear, the rail head must be rectified by weld deposition and grinding or may be replaced. This repairing / replacing is essential so that the rail clamp can hold with the required clamping force against the storm wind.

Steel Structure

The entire structural steel work should be thoroughly inspected every year. Particular attention should be paid to welds (for possible cracks) and loose bolts which should be immediately retightened or replaced.

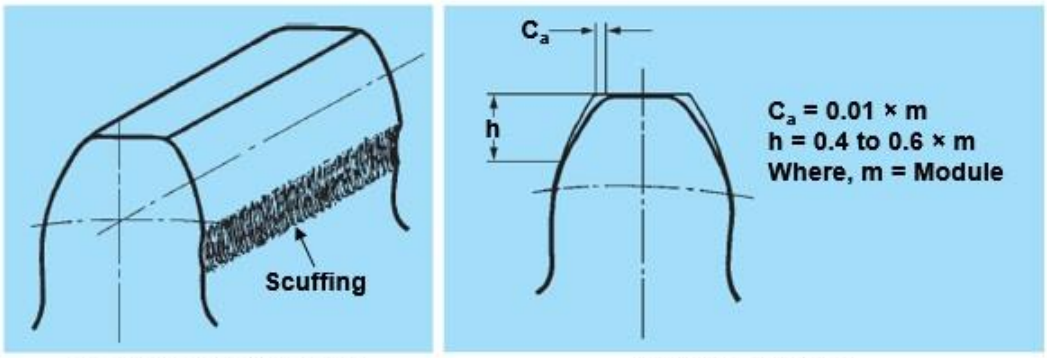
For information on maintenance of boom conveyor, please see the booklet titled "Construction and Maintenance of Belt Conveyors for Coal and Bulk Material Handling Plants" uploaded on www.practicalmaintenance.net

Design Considerations for Slewing/Slew Bearings/Rings

Slewing rings allow relative rotation of two machine parts whilst handling a combination of radial, axial and moment loads.

Large diameter bearings are in the majority of cases supplied with spur gears. A gear cut into one of the bearing rings offers the advantage that an additional driving gear wheel is not required, which helps to reduce design work and costs.

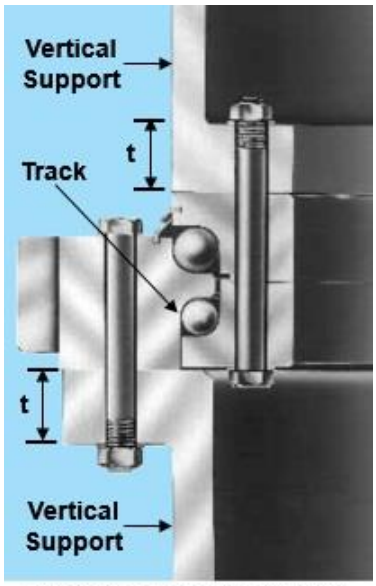
As shown in the following figure, despite geometrically correct profiles and theoretically adequate gears, meshing problems may still occur in highly stressed gears, e.g. "scuffing" or "chipping" at the dedendum flank of the gear wheel. Hence a pinion requires a tip radius and a tip relief. It is recommended to have a pinion with a tip edge radius of 0.1 - 0.15 times module and a tip relief as shown in the following figure.



Scuffing in Gear Wheel | Tip Relief in Pinion

Scuffing in Gear Wheel and Tip Relief in Pinion

For economic reasons, the cross sections of the bearings are kept relatively low in relation to their diameters. The bearings therefore depend on a rigid and distortion-resistant structure which to a large extent will prevent deformations in the bearings under the operating loads, provided a positive bolt connection is used.



Vertical Support Location

Cylindrical structure is usually adopted for installation of bearing support. The cylinder wall is aligned to the center of track/raceway. This is in order to keep any deflection of the support surfaces under maximum operating load within the permissible limits.

The suggested minimum thickness (t) of the companion structure flanges is indicated in the following table.

Raceway/Track Diameter, mm	500	750	1000	1250	1500	2000	2500	3000
Minimum thickness t, mm	25	30	35	40	50	60	70	80

The width of the companion structure flanges must at least equal the width of the ring it supports. Thick circular supports are preferred over thinner supports with reinforcement ribs.

Note: With modern finite element analysis, it may be possible to work with thinner materials.

As a rule, bearings and their companion structures should be connected by means of through bolts. Most commonly, high tensile bolts of Grade 8.8 and 10.9 are used.

It is important to tighten the bolts to the recommended torque in the correct order/sequence (e.g. star pattern) to ensure the bearing is allowed to settle onto its frame properly. Suitable torque wrench or hydraulic bolt tensioning device (stretch method) may be used for this purpose. For threads larger than M 30, the use of hydraulic bolt tensioning is recommended.

A flat mounting surface free of grease and oil is essential for the upper and lower ring to seat firmly. Welding beads, burrs, excessive paint and other irregularities must be removed prior to installation. Before the installation of a large antifriction bearing, it recommended that the contact areas be measured by means of an optical machine or a laser measuring system. As per Rothe Erde, the flatness values should not exceed the values shown in the following table to avoid tight spots or seizure.

Track Diameter in mm	**Flatness acc. to DIN EN ISO 1101 per support surface in mm for Slewing Ring Designs**		
	BF 01, BF 08	**BF 06, BF 09 and BF 25, 23, 28**	**BF 19, BF 13, BF 12**
up to 500	0.15	0.10	0.07
up to 1000	0.20	0.15	0.10
up to 1500	0.25	0.19	0.12
up to 2000	0.30	0.22	0.15
up to 2500	0.35	0.25	0.17
up to 4000	0.40	0.30	0.20
up to 6000	0.50	0.40	0.30
up to 8000	0.60	0.50	0.40

To avoid larger deviations and the occurrence of peaks in smaller sectors, any deviation in the range of 0° - 180° may only rise evenly once and fall again. Machining of the bearing connection surfaces on the connecting structure should be carried out if the values are exceeded.

If the frictional bond is not adequate, it is advisable to use a suitable compound (for example, Loctite 586) to increase the frictional bond.

Applications in a heavily dust-laden atmosphere, such as material handling equipment for coal and ore, will require special seals. The RD 700 type series (by Rothe Erde) is, for instance, equipped with additional steel labyrinths at the upper bearing gaps.

Installation of Slewing/Slew Bearings/Rings

Slewing bearings should always be transported and stored in horizontal position. If they have to be transported vertically, they will require internal cross bracing. Impact loads, particularly in a radial direction, must be avoided.

Bearings may be stored for approx. 6 months in roofed storage areas and approx. 12 months in enclosed, temperature-controlled areas (temperature > 12°C). Outside storage is not allowed. Longer storage periods will necessitate special preservation.

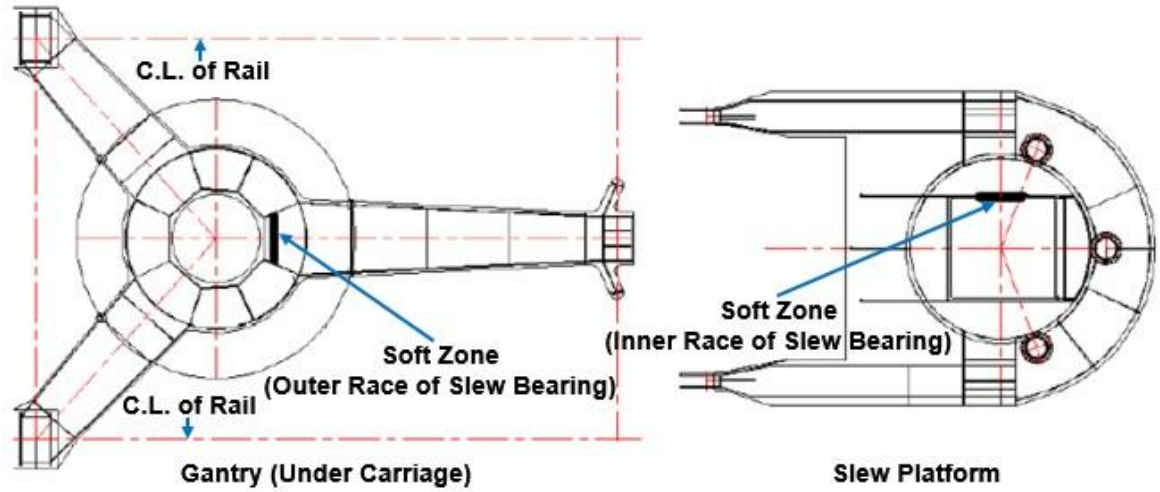
When removing the packing material, be careful to avoid cutting into the real ring.

The corrosion protection can be removed with an alkaline cleaner. Solvent must be prevented from coming into contact with the seals or the raceway. Remove the protective

coating from the upper and the lower mounting surfaces of the slewing bearing as well as from the gear.

Use of a blunt object / instrument to free any seal surfaces that may have become stuck to the running surface is recommended to avoid seal damage on start-up.

The unhardened (soft) zone between the beginning and the end of the hardened region of the raceway is marked with an "S" on the inner or outer diameter of each bearing ring. On the gear ring, the hardness gap is marked on the axial surface. Filling plugs (ball charge opening) are also positioned at the unhardened region of the raceway.



Soft Zone Location with respect to Gantry and Slew Platform

Above figure shows soft zone location with respect to gantry (under carriage) and slew platform. As shown in the figure, the hardness gap "S" must be positioned outside the main load carrying areas.


Backlash Measurement

As shown in above figure, the backlash should be adjusted relative to the three gear teeth marked in green (maximum radial runout point of gear) and should be at least 0.03 to 0.04 × module. After the final tightening of the bearing, the backlash should be rechecked over the entire circumference. A tip edge radius and a tip relief must be provided on the pinion.

Ensure that each pinion is properly aligned to the gear with good contact maintained over the full face width.

After assembly the clearance or total deflection of the slewing ring under known test conditions should be determined to serve as reference data for future clearance checks to determine the amount of wear in the bearing.

Replacement of Slew Bearing

Replacement of Slew Bearing

The adequately dimensioned slew bearing is not subject to any particular wear. However, if it is necessary to carry out the removal of the slew bearing, work should be carried out under the supervision of an expert (from OEM). At each stage of the work, every care and precaution must be taken to prevent possible accidents.

Before proceeding with the removal of the slew bearing, the machine should be brought into its parking position and secured by guy ropes to the left and right.

For replacement of the slew bearing, the superstructure must be raised using hydraulic jacks, after removing high tension (HT) bolts connection.

To lift up the revolving superstructure, generally four jacking pads are provided at the top of gantry portal and at the bottom of superstructure (revolving frame). With the boom parked as above, the corresponding jacking pads of gantry portal and superstructure will be exactly in line with each other.

Four remote control type jacks of adequate capacity each with a closed length of about 150 mm are to be employed for the work, connected in two groups, each group operated from one pump. The jacks should not be operated individually. Removal of the slew bearing calls for lifting of the superstructure by a height of approximately 100 mm.

The slew limit switch arrangement, the central chutes on superstructure and gantry portal and the lubrication piping, etc. are to be dismantled before the jacking up procedure.

When installing a slew bearing, it is recommended that the associated slewing gear pinion is replaced with fresh set of hardware.

Exact alignment of the slew gear with the slew pinions (meshing of teeth) and adjusting the backlash to recommended value are also very importance.

Supporting of Bucket Wheel Boom and Counter Weight Boom

For safety, as shown in above figure, sometimes, bucket wheel boom and counter weight boom are supported before lifting up of the revolving superstructure.

Steel Stools with Packer Plates

As shown in above figure, many times steel stools with packer plates are provided on either side of the jacks to prevent unintended lowering of the load in case of possible failure of the jack seal, the hydraulic pump or of the hydraulic line.

Jacks in Harsh Environment

On completion of work, shift the jacks to the tool room (store). As shown in above figure, if they are left in a harsh environment, they may not work when required next time.

Repair of Slew Gear

In this chapter I have shared experience of my friend (working in a large thermal plant in India) on a bucket wheel type stacker cum reclaimer. I am sure the information will be useful to tide over an emergency in similar circumstances.

Equipment Detail

Equipment: Bucket wheel type stacker cum reclaimer
Stacking capacity, rated / peak: 4000 TPH / 4500 TPH
Reclaiming capacity, rated / peak: 1600 TPH / 2000 TPH
Material to be handled: Coal, lump size (−) 50 mm
Bulk density, volumetric: 800 kg / m^3
Stockpile height / width at base: 12 m / 40 m

Slewing Data

Slew range: ± 105°
Slew speed: 3 - 30 m/min at bucket wheel tip
Slew drive motor rating: 11 KW, 150 - 1500 rpm, 2 Nos VVVF Drive
Type of slew bearing: Ball / roller with external gear rim
Size of slew bearing: 4236 OD × 221 mm height; Roller PCD = 3949

Gear Data

Gear PCD = 4180
Number of teeth; 209
Module: 20
Pressure angle: 20°
Ring material: 42CrMo4V

Problem

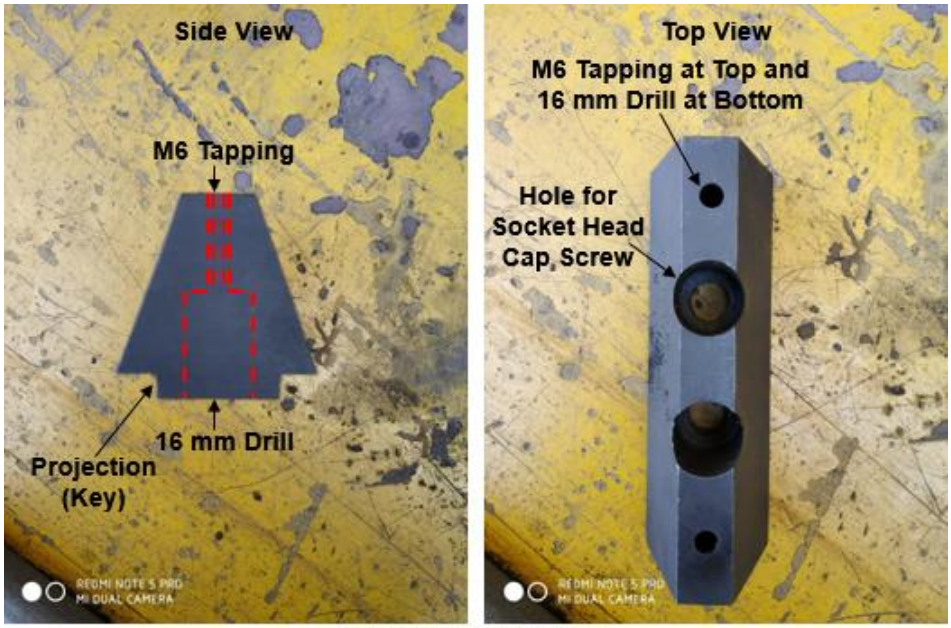
Over a period of time, the gear flanks had worn out by about 2.0 mm per flank (up to the maximum permissible value) leading to a clearance of about 4.0 mm between gear and pinion teeth. The boom is generally operated between 20° and 70°. One day, the three gear teeth, repeatedly subjected to sudden impact due to reversal of slewing operation on the boom reaching 70° (during the driving operation, three teeth of a pinion are remaining in contact with three teeth of the gear) having some more wear on them as compared to other teeth gave way (broke).

Solution

As it is recommended not to carry out any weld repair of the gear teeth, it was decided to attach new teeth on the gear ring so that the machine can be operated till the slew bearing is replaced.

For attaching new teeth, three teeth were machined from forged normalized EN24 material. Machining of new teeth was carried out based on a templet made from a gear tooth which was not subjected to any wear (near the unhardened, soft zone area of gear ring). Detail of new teeth for their fixing to gear ring is as under.

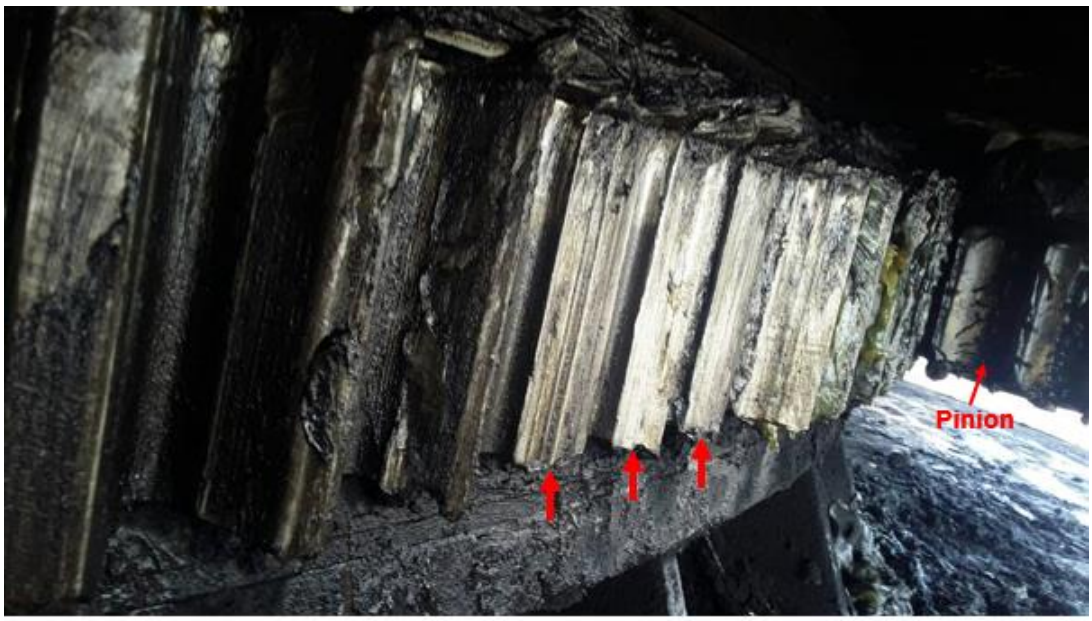
Machining of Gear Teeth



New Gear Teeth Detail

Above figure shows detail of the new gear teeth. As shown in above figure, two holes were drilled for fixing the gear tooth with the gear ring using class 12.9 hexagon socket head cap screws. A projection was also provided at the root of the tooth to act like a key. To hold the tooth in position (to prevent its dislocation), two 16 mm diameter holes were also drilled in the tooth bottom for fitting two cylindrical pins. M6 tapping were provided on top of 16 mm diameter holes for jacking out the tooth. The gear teeth were machined from EN24 (stronger material) instead of 42CrMo4V. After machining the teeth, they were heat treated to get hardness of HRC 40-42. No machining was carried out after the heat treatment.

Installation/Fixing of Gear Teeth

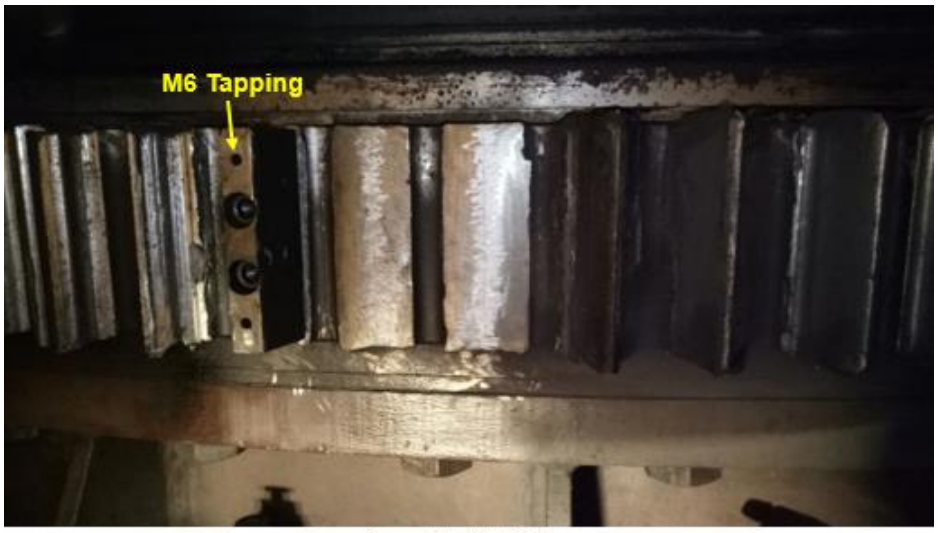


Slew Gear Without Three Teeth

Above figure shows the slew gear without three teeth (three teeth broken).

Milling and Drilling on Gear Ring

For fixing new teeth on the gear ring; on site milling, drilling and tapping was carried out on the gear ring. Special fixtures were made to carry out the machining. First milling was carried out to make the surface flat. Next, a groove was milled in the gear ring to accommodate the projection (key) machined at the root of new gear tooth. After that two holes were drilled and tapped in the gear ring for the hexagon socket head cap screws. It may be noted as it is difficult to drill a large size hole, first a small hole was drilled and then it was enlarges using larger size drill bits.



Gear Teeth Fixing

As shown in above figure, after tapping the holes for hexagon socket head cap screws, new tooth was fitted to the gear ring using two hexagon socket head cap screws. After tightening the socket head cap screws, two 5 mm diameter holes were drilled in the gear ring using the

M6 tapping on the new tooth as a guide hole. After removing the socket head cap screws and the gear tooth, 5 mm diameter holes in the gear ring were enlarged to 16 mm diameter for installing the cylindrical pins. On completion of enlarging the holes, two 16 mm diameter cylindrical pins (snug/tight fit) were inserted in the gear ring. Next the new tooth was inserted on the cylindrical pins and fixed to the gear ring by two socket head cap screws. To prevent damage/blockage of M6 tapings, hexagon socket set screws were fitted in them.

Slew Gear with New Tooth

Above figure shows photograph taken after installing the new tooth. The process was repeated for the other two teeth.

After fixing the new teeth, the slew gear ring was taken in to normal service. The slew gear is in operation for last six months (at the time of writing this chapter) without any problem.

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