Technical Study of a Plate Feeder

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Esa Turkia
Vaunusyöttimen tekninen tutkimus

Opinnäytetyö 51 sivua, joista liitteitä 9 sivua
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Opinnäytetyön tarkoituksena oli kehittää vaunusyötintä, jota käytetään kaivostoiminnassa. Syötin toimii kaivoksilla käytettävissä murskauskokonaisuuksissa, jossa kiviaines prosessoidaan. Vakio vaunusyöttimen syöttötaso on yksiosainen. Materiaalin purku tapahtuu syöttötason paluuliikkeen aikana, jolloin syöttimen takaseinä estää materiaalin liikkeen.

Tavoitteena on tehdä tekninen perusselvitys vaunusyöttimen rakenteesta ja toiminnasta, kun sen syöttötaso muutetaan yksiosaisesta kaksi- tai kolmeosaiseksi. Moniosaisempi syöttötaso mahdollistaa tasaisemman materiaalipurun. Työssä käsitellään 3,2 metriä leveän syöttimen teknistä tarkastelua ja mietitään, kuinka hyvin voidaan käyttää jo olemassa olevia vakiovaunuja uuden syöttimen kehittämiseen.

Uuden moniosaisen syöttötason omaava vaunusyötin on hyvin laaja suunnittelutyö. Tämän vuoksi opinnäytetyön pääpaino on tärkeimpien asioiden tutkimisessa, kuten syöttötasojen toiminnassa ja niiden rakenteessa.

Asiasanat: syötin, kaivos, kehittäminen

ABSTRACT

Tampere University of Applied Sciences
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The aim of this thesis was to make improvements to a plate feeder which is used in the mining industry. The plate feeder is part of a processing chain for crushing rocky material. The feeding platform on the original plate feeder is constructed in one piece. The material is discharged as the feeding platform moves backwards; the back wall prevents the material from flowing backwards, which forces the material to discharge from the feeder.

The goal was to make a technical study of the plate feeder's structure and function when its feeding platform was modified from a single piece to a 2 or 3 part structure. Dividing the feeding platform into several parts should enable a smoother material discharge. The thesis studies the technical feasibility of using 3, 2 meter-wide plate feeders, and ponders whether it would be possible to use already existing plate feeder models to create the new modified one.

The modification to the plate feeder is a big development task. Because of this, the primary target of this thesis is to inspect the most important matters such as the functionality of the feeding platforms and their structures.

Key words: feeder, mine, developing

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1 INTRODUCTION

The meaning of this thesis is to make a technical study for a plate feeder which will be modified. Plate feeder is an important component in rock material handling processing and it is used in mine industry. It is usually installed with other critical machines, such as crushers and screens. Plate feeders' main purpose is to feed the rock material in certain given speed which gives the phase for the rock material processing.

Technical inspection includes investigating on plate feeders' critical components, which might be re-calculated or modified during the modification. The aim is to inspect 3-3.5 meter wide two part feeding platform structure and a capability to use Sandvik's current feeders to create the new modified plate feeder.

2 SANDVIK

2.1 Sandvik history

''The Company was founded in 1862 by Göran Fredrik Göransson, who was first in the world to succeed in using the Bessemer method for steel production on an industrial scale. At an early stage, operations focused on high quality and added value, investments in R&D, close contact with customers, and exports. This is a strategy that has remained unchanged through the years.'' (Sandvik, 2014)

In year 1997, Sandvik-group bought a company called Tamrock. Since then Sandvik Rock Tools and Tamrock have been joined as the same which creates todays Sandvik Mining and Construction. (Sandvik, 2014)

2.2 Sandvik today

''Sandvik is an engineering group in tooling, materials technology and construction.'' (Sandvik, 2014). Sandvik consists from three different units, which are Sandvik Mining and Construction, Sandvik Tooling and Sandvik Material Technology. They have approximately 49 000 employees worldwide and they operate in 130 countries. (Sandvik, 2014)

2.3 Sandvik in Finland

Sandvik's activity is wide in Finland. It includes all three Sanvik's field of know-how. The biggest factory works in Tampere, which falls under the Mining and Construction category. Sandvik Mining and Construction manufactures equipment's for rock drilling, mining, crushing and material processing. Sandvik works also in Hollola, Lahti, Nokia, Lohja, Turku and Vantaa. (Sandvik, 2014).

2.4 Sandvik Mining and Construction Hollola Oy

Sandvik Hollola is located in Keskikankaantie 19, which includes the office building and a warehouse. In the past, there was a manufacturing of rollers and other conveyor components, but since then the manufacturing have been re-located and the old factory is now replaced with a warehouse. Spare parts and project components are now distributed from there to clients. Sandvik Hollola is specialized in conveyors, crushers and screens and feeders.

3 FEEDER FOR ROCK MATERIAL HANDLING

Feeder's main purpose is to feed the rock material in specific and smooth phase. Feeder types are chosen by the amount and quality of the transferring material. It's commonly used in mobile or stationary crushers.

3.1 Feeder models

Sandvik provides many different feeder models. The engineers have developed these feeders for various usages so they can cover mine industry's most needs.

3.1.1 Vibration feeders

Vibration feeder assembly includes a non-central shaft. It's connected to a power source which produces the requisite power. The shaft creates the vibration effect which can be adjusted for exact rotation speed. The vibration movement can also be created by using an electric unbalance vibrator. In this application, user can adjust the movement speed and the frequency even more specific. (Sanvik M&C, 2014)

Sandvik have two different types of vibration feeders. Grizzly feeders include SV-H, SV, SW and ST –models. Pan feeders include SP-model. Grizzly feeder's structure is similar to one another. Picture 1 demonstrates the structure of SV-H feeder. It has springs under it so it can be vibrated. (Sanvik M&C, 2014)

Picture 1: Grizzly feeder, SV-H series (Sandvik M&C, 2014)

3.1.2 Vibration free feeders

The difference compering vibration free feeders to vibration ones is that they don’t use non central shafts or magnetic vibrators to transfer the rock material. There are two types of non-vibration feeders, plate and belt feeders.

Because the lack of vibration movement, the vibration free feeders transfers the rock material with other methods. Plate feeder includes a moving feeding platform which transfers the rock material with its back and forward movement. The plate feeder can be seen in picture 2.

Picture 2: Plate feeder, SH series (Sandvik M&C, 2014)

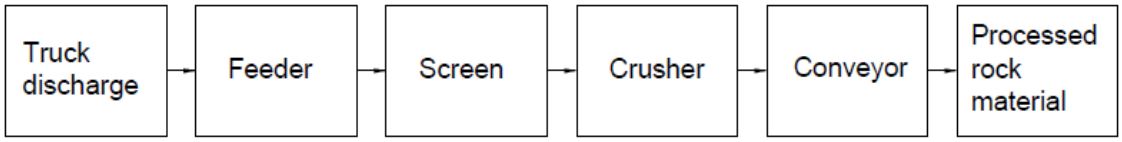
Belt feeder uses conveyor components to transfer the rock material. It was used only for soft and fine rock material earlier because the hard rock material broke the belt. Because of the development of the belts and the higher usage and rupture resistances, they can be used even more in todays' assemblies. (Sandvik M&C, 2014). The belt assembly is located under the feeding chute in picture 3.

Picture 3: Belt feeder, HF series (Sandvik M&C, 2014)

3.2 Where feeder is used

Feeders are used in various mobile and stationary applications which can be seen in attachment 1. Feeder is an important part of the rock material processing chain. They are synced with other equipment's which enables the material flow to be continuous.

There can be more than one crusher in crusher applications. This is because the rock material needs to be crushed several times before it is in certain size. Jaw crusher is usually been used in preliminary crushing. This is the first mechanical crushing function after mining. This function will crush the bigger rocks to smaller size where they can be transferred to other crushers such as middle crushing or grinding. Rock material is transferred with all types of applications, such as belt conveyors or grizzly feeders. Usually there will be more than one sized rock material at the end of the processing chain. This can be done with different sizes of screens, which will separate the bigger rocks from the smaller ones. (Kaivos- ja louhintatekniikka, 2011)



Picture 4: Feeder's position in crusher application

Feeders are usually located before crushers, screens or conveyors as picture 4 demonstrates. There are different types of feeders for certain rock types and applications. This means that the engineers have to calculate and determine on which feeder type is the most efficient in any given situation. Picture 5 demonstrates where the feeder can be located.

Picture 5: Plate feeder (Sandvik M&C, 2014)

In this picture 5, the plate feeder is located right after a truck discharge place. The discharge chute focuses the rock material to go into certain way and the chains will keep the rock material from falling off from the feeding platform. This enables a good and exact feeding speed. Plate feeder is transferring rock material to the crusher in certain speed, so that the crusher is able to handle all the rock material.

4 THE ORIGINAL PLATE FEEDER

The purpose of this thesis is to create a plate feeder which feeding platform is modified from a single piece to a two part structure and study is it possible to use Sandvik's already existing feeder models to create it. The new modified feeder enables feeding platforms out of phase movement which leads to a smoother capacity. The original feeder has one feeding platform, which moves forward and backward. Because the mechanical execution should be similar in the new feeder, it's wise to try to use already existing feeder and its components.

4.1 SH Plate Feeder

The original feeder is called SH Plate Feeder. Like all the other products, a plate feeder also exists in various sizes for different usages. Feeder size reflects to its capacity to handle rock material and different feeder models are made for various materials. SH plate feeder is designed for a big and hard rock material. The structure is designed to carry the impact from the flowing rock material which is caused by its drop from the feeding chute. (Sandvik M&C, 2014) The plate feeder's model in picture 6 is SH 1645.

Picture 6: SH Plate feeder (Sandvik Hollola)

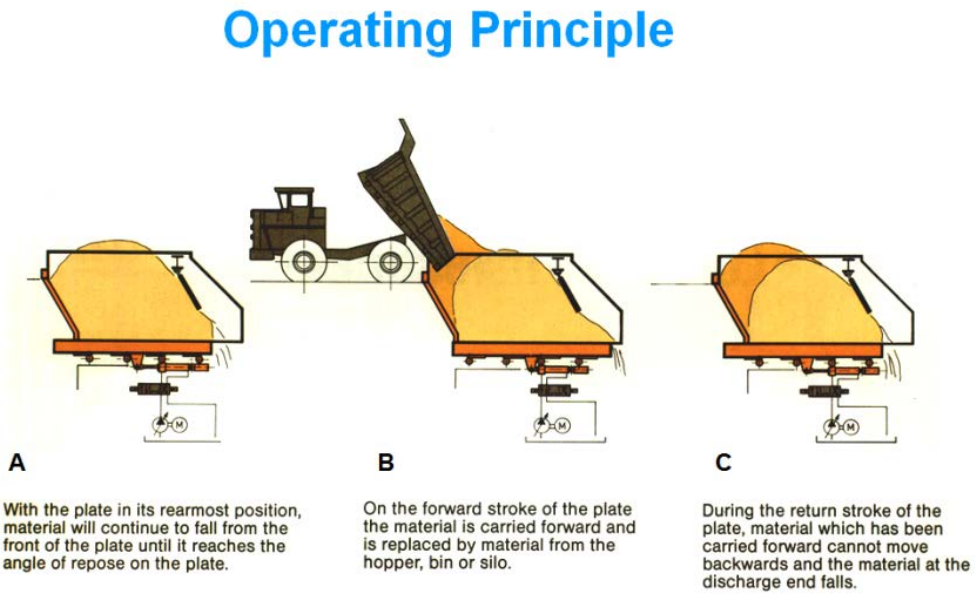
4.2 Mechanism

Plate feeder's operation principle is a back- and forward movement of the feeding platform. This platform gains its movement hydraulically from a power source. The hydraulic cylinder is located under the feeding platform.

Feeder's structure is designed to sustain a heavy pressure and to carry the impact from the flowing rock material. Plate feeder has three side walls, which are located at both sides and at the feeding end of the feeder. Side walls forces the flowing rock material to a right direction and the rear wall prevents the rock material from getting backwards while the feeding platform makes it backward movement. The usage of the plate feeder is demonstrated in picture 7.

''During the forward stroke of the plate the material on it is carried forward. However, the rear wall prevents the material from moving back on the return strike and it falls down from the end of the feeder.'' (Operating & Maintenance Instructions Sandvik Plate Feeder, 2014)

SH Plate feeder's structural execution on side walls is made for big and heavy rock material. Feeder's side walls are heading away from each other at the end of the feeding platform. This enables the flowing rock material to move more freely and therefore the blockages on top of the feeding platform will be minimal.



Picture 7: Operating principle of Plate Feeder (Sandvik M&C, 2014)

Feeder's operation speed and other functions can be adjusted locally from a control panel or by a remote control. The feeding speed is determinate by the speed of the hydraulic cylinder. The cylinder piston must never use its maximum movement length and it's installed to move around 50 mm shorter than the maximum stroke length would be. This will make the feeding platform to move more smoothly and it prevents any breaks which might be caused to the cylinder.

Feeding platforms stroke length can be adjusted by movable devices and limit switches which are attached to the side of the feeder. (Operating & Maintenance Instructions Sandvik Plate Feeder, 2014). The speed of the platform is chosen so that the feeder is compatible to other machines in the rock material processing chain. *''Suitable stroke length is determined by the lump size, type of material, its tendency to arch and by required feeding rate.''* (Operating & Maintenance Instructions Sandvik Plate Feeder, 2014).

4.3 Capacity

Capacity is the maximum feeding amount what the machine can handle. Sandvik's feeder's capacity can be up to 1700 m^3/h in SH units. 1,6 meter wide feeder's, which model is SH1661, capacity is 0-700 m^3/h. Capacity is measured from the flowing rock material which falls down when the feeding platform goes backwards and the back wall prevents the rock materials movement. Capacity comes only when the feeding platform makes its movement backwards. Plate feeder's capacity can be found from Sandvik's feeder brochure in picture 8 and in attachment 2. (Sandvik M&C, 2014)

Technical data SH and SH Unit for primary feeding

	SH					SH Unit		
Model	Height (mm)	Weight (kg)	Motors (kW)	Max feed (mm)	Capacity range (m3/h)	Height (mm)	Weight (kg)	Hopper volume (m3)
SH1041	860	3 450	11	700	0-300	3080	12 500	15
SH1351	918	5 250	22	1000	0-450	3610	21 600	30
SH1661	1110	9 000	37	1300	0-700	4400	39 300	45
SH2071	1420	17 100	55-90	1800	0-1100	6400	57 500	75
SH2571	1450	21 000	55-110	2400	0-1700			

Picture 8: SH feeder capacity worksheet (Sandvik M&C, 2014)

Feeder's size reflects to its capacity and ability to function with bigger rock material. Installation angel, feeder's inclination and gradation also reflect to its capacity. (Sandvik M&C, 2014)

5 CRITICAL PARTS IN THE MODIFICATION

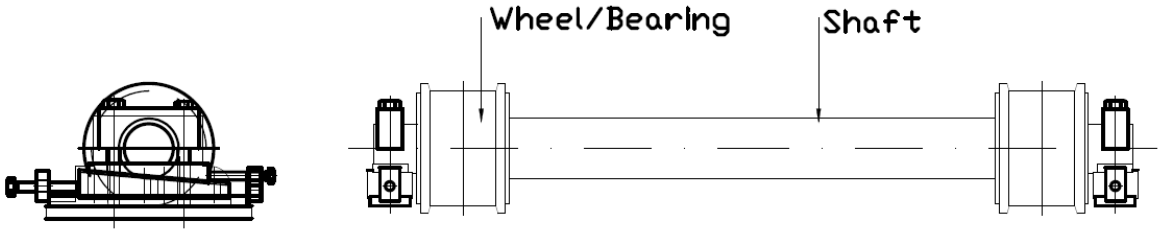
The modification will require developments on the original plate feeder's structure and its components. The biggest consideration should be on plate feeder's bearings and its various sealing's. When modifying the original feeder, the structural parts will be the same or at least they are not modified greatly. Even though the structural execution changes will be minimal, they should still be calculated and scaled for the new plate feeder.

5.1 Bearings

Bearings are critical part of SH plate feeder. Since the rock material falls through the feeding chute, it has a huge impact to feeding platforms supportive structures. The goal is to use original 1, 6 meter wide feeder and its components to create the new plate feeder. The original feeder and it's all components are calculated and scaled for its specific size and usage. The bearing loads are also calculated for the certain pressure which the flowing rock material creates. Since the feeder's width will be doubled, there should be an inspection for bearing loads.

The meaning of bearings is to support and direct rotation parts. Bearings can be separated into two different groups depending on loading cases: radial- and axial bearings. Greasing is critical thing in bearings functions. It will increase bearings usage life and it will make bearings to work properly. (Koneenosien suunnittelu, 2009)

In the SH plate feeder, bearings are located at the end of each support shaft, which are located under the feeding platform. Picture 9 demonstrates the assembly of this supportive structure.



Picture 9: Supportive structure

It uses a spherical roller bearing, which is made to carry a heavy weight. Roller bearings, in picture 10, are good alternative for SH plate feeder, because of the impact which occurs from the falling rock material. *''Spherical roller bearings are self-aligning bearings that are consequently insensitive to misalignment of the shaft, they have two rows of rollers so they are able to carry heavy radial loads, all sizes are available with cylindrical or tapered bores.''* (Bearing-King. SKF Bearing details, 2013)

Picture 10: Spherical roller bearing, SKF (Bearing-King. SKF Bearing details, 2013)

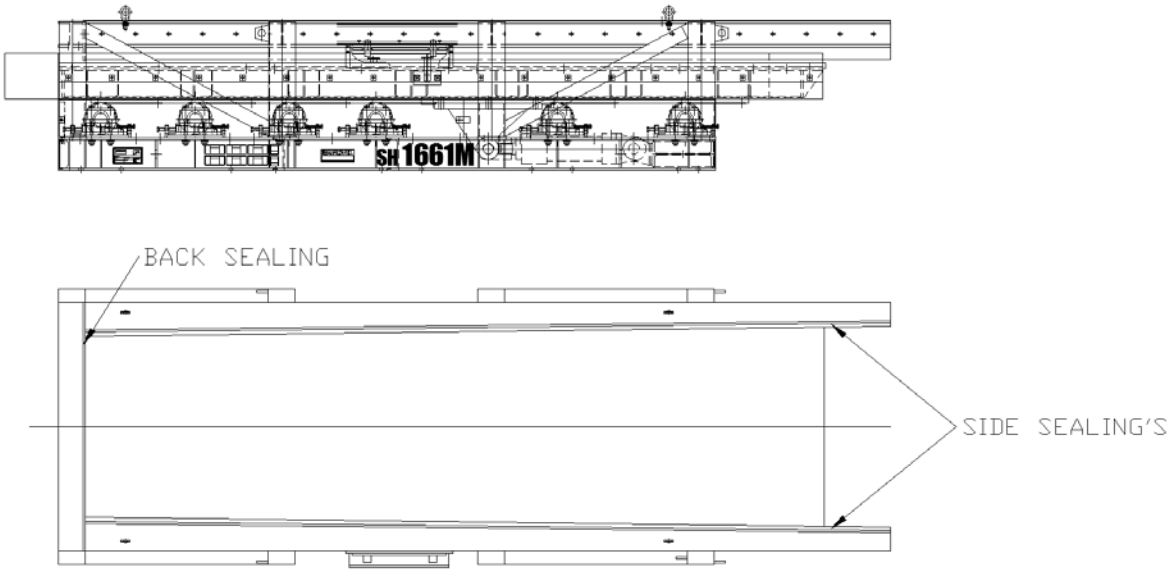
Loading type affects substantially to a bear type. Generally speaking roller bearings can be stressed more than ball bearing. Roller bearings can also handle axial stresses. (Koneenosien suunnittelu 2009). Because of the huge impact which occurs on the supporting structures, these parts should be somewhat flexible and durable. A spherical roller bearing is able to self-center which is required because of the bending of supporting shafts.

5.2 Sealing

Plate feeder processes high amounts of rock material. This generates a lot of dust which can get into critical machine parts. These parts are well protected by themselves but it is wise to use sealing's which prevents the dust from getting away from the feeder.

5.2.1 Plate feeder sealing's

Main sealing's are located on every side of the plate feeder. Side sealing's prevents the dust from spreading around. They also direct the material flow to right direction. Plate feeder's side sealing locations are demonstrated in picture 11. The side sealing is made out of rubber plate. These plates are installed diagonally against the moving platform which ensures the dust from getting away from the feeding platform. Because of the high pressure between the rubber seal and the moving platform, the rubber will wear out and it should be changed after certain time of usage. Rubber is a soft material and it won't wear the feeding platform. The rubber sealing is installed by using fasteners and other structures and they are located next to the side walls wear plates. Wear plates and sealing's create a good and tight seal for the side wall.



Picture 11: Plate feeder's sealing's

Back wall of the feeder uses polyethylene as a sealing material. The sealing is located behind the back wall and it is positioned a little lower from the back wall and it is against the feeding platform**.** The location of the back wall sealing can be found from the picture 11. When the feeding platform makes its backward movement, the sealing will push the dust and other small rock material back, just like the back wall does to the bigger rock material. Both side and back sealing's are adjustable because they are attached by an angel holder which is fastened by set of screws.

5.2.2 Sealing materials

Rubber is an elastic material which advantages are its flexibility, elasticity and ability to return into its original form. Rubber is widely used in mechanical structures. (Koneenosien suunnittelu, 2009). It's sometimes seen in places where the impact of the material needs to be decreased. It can be located under the critical parts so it can absorb some of the impact from the machine part to itself. Even small amounts of rubber can affect greatly to mechanical parts durability.

Plate feeder's back wall sealing is made from polyethylene which is the most common used plastic in the world. It is used also in piping, containers and in wear durable places such as gears and roller manufacturing. . (Koneenosien suunnittelu, 2009). Because of its durability, it's good alternative to be used in back wall sealing. It is not compatible material for side sealing, since it has minimal elasticity.

Bigger sealing's can be created by using an abrasion resistant plate, AR 400. This material is also used on top of the plate feeder's feeding platform and side walls as a wear plate. *''Rocks, sand, coal, minerals, scrap metal and any other hostile material have a hard time making a lasting impact…''* (Hardox, 2014). It has good technical properties for mine industry's usage. *''Due to its high toughness, good bendability and weldability, the plates can also be used for load bearing duties in certain applications.''* (SSAB, 2014)

6 MECHANICAL CHALLENGES

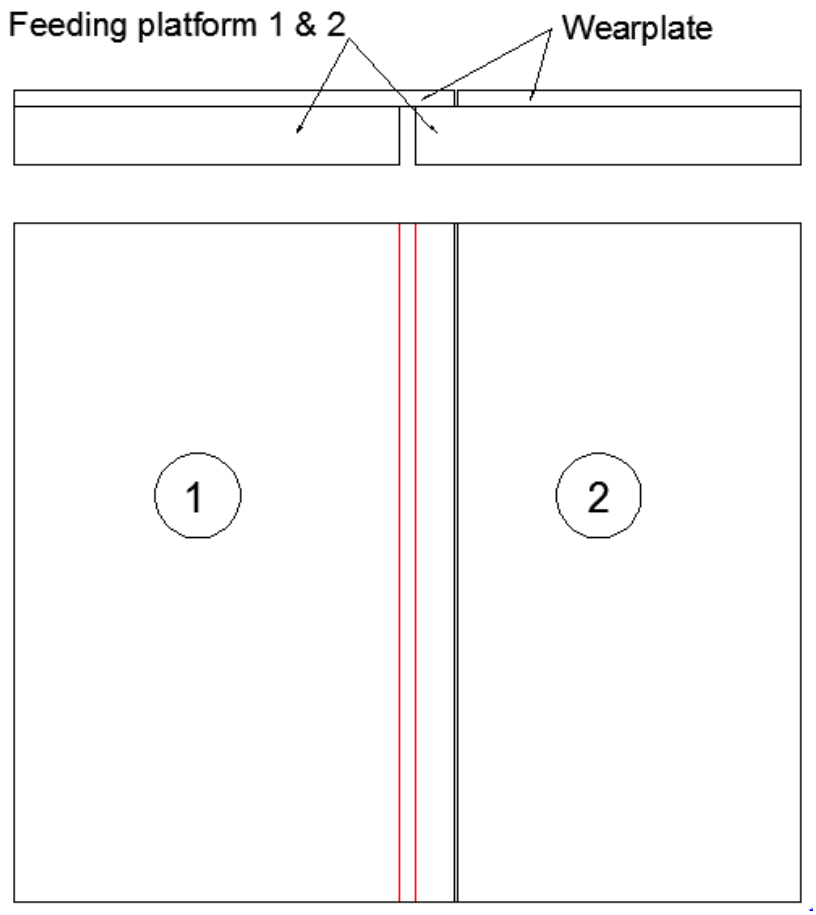
Modifying a standard plate feeder will create challenges in mechanical and functional sectors. A good research and development tries to understand all the possible challenges which might occur when designing a new modified product. Recognizing the problems in the outline stage of the feeder will help developers to improve the product to a right direction.

Because the feeding platform will be modified, it is an important thing to inspect the sealing, which has to be created between these two platforms. Rock material and dust should be blocked from getting down from the feeding platform just like side seals are doing in original SH plate feeder. Bearings and other mechanical structures can be scaled by loads.

6.1 Sealing between feeding platforms

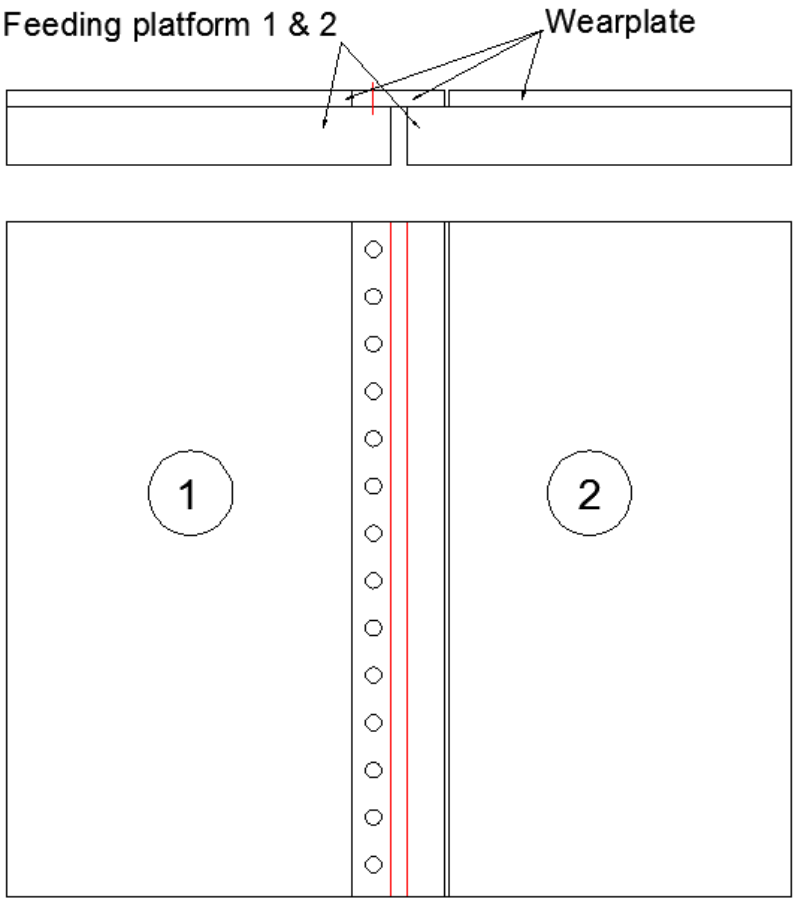
The gap between the feeding platforms must be sealed. This will create challenges because the platforms will run out of phase to each other which mean that a little gap must be left between them. The seal will ensure that the dust leaks will become as low as possible. The dust leaks can’t be completely sealed because of the movement space between the feeding platforms is required. Some rock dust will go through the seal but the amounts are minimal compared to the dust which is sealed. There shouldn’t be any critical parts under the feeder which may go broke if the amount of rock dust will increase too much. Machines in the mine industry are designed to be dust proof so the minimal dust leaks shouldn’t have any effect to other machines or structures.

The first sealing solution is demonstrated in picture 12. The developed sealing option should be viable for the modified plate feeder.



Picture 12: Sealing solution between feeding plaforms

The solution seals most of the rock dust from getting through the feeding platforms and the mechanical solutions are quite easy to design and install. This sealing capitalizes already existing wear plates on top of the feeding platform. The seal is created by increasing the size of the wear plate and dragging it over the other feeding platform. This enables the wear plates to be interlocked against the feeding platforms. This assembly doesn't require any bothering on other sealing materials life time, wearing out and other properties since the original plate feeder's wear plates are used for sealing the gap. The amount of friction between the feeding platforms and the wear plates are also minimal when there is no flowing rock material on it, which has little to no affect to feeders operations.

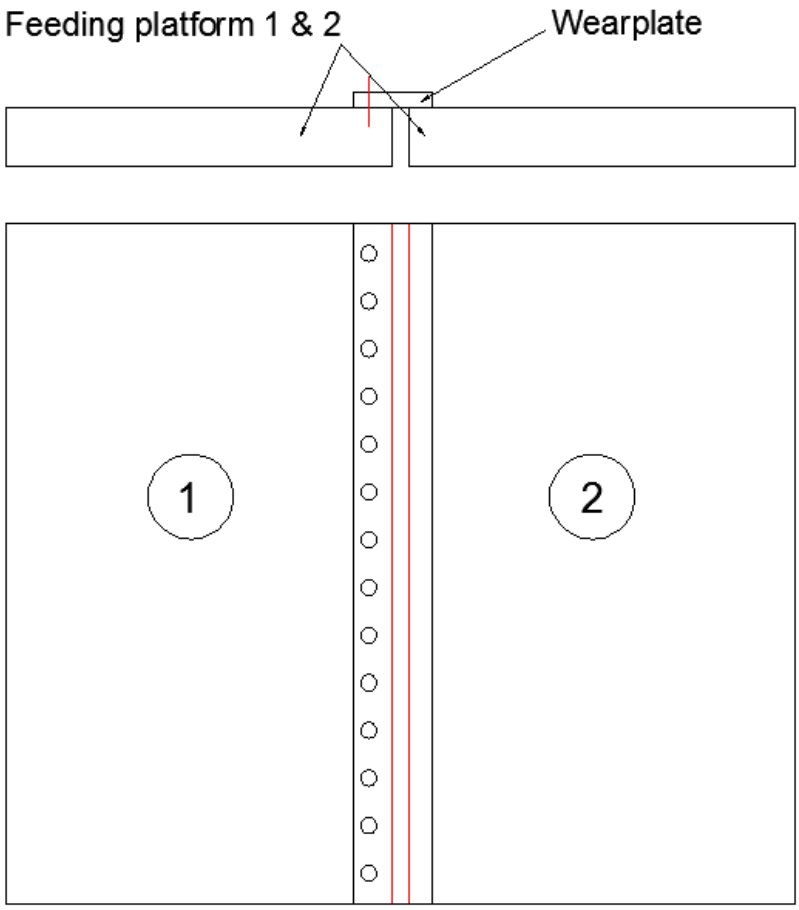


Picture 13: Sealing solution

More seals can be added as the picture 13 shows. There should be some examinations for the wear plates when the feeder is running. Because of the sealing assembly, the flowing rock material will create load and stress over it. Feeding platforms will function out of phase to each other and it will create a lot of friction between the seal and the other feeding platform. The rock material on top of it will increase the friction significantly. The wear plate has good technical properties for hard usage which enables its usage as a sealing material. Sealing alternative in picture 13 has an extra wear plate installed to the feeding platform. This assembly may be in order if the wear plates will wear out fast because of the friction between the wear plate and the feeding platform. An extra wear plate is the only component which needs to be changed if the friction wears it out. This assembly will be easier to maintenance and it will become cheaper in long term, since the spare part will become much smaller.

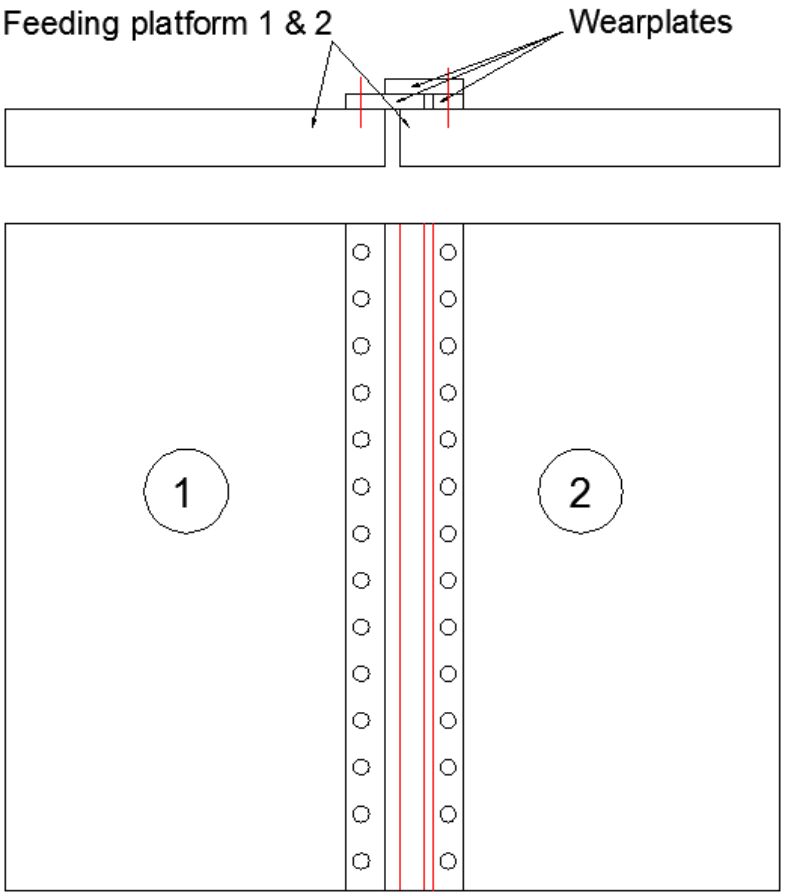
6.2 Alternative sealing between feeding platforms

Another sealing alternative is demonstrated in picture 14. This sealing assembly includes AR 400 wear plates, which are installed on top of the feeding platform and its wear plate.



Picture 14: Alternative sealing option

Picture 15 sealing alternative has an additional wear plate installed on top of the first wear plate. This should give a better and tighter seal. Wear plastic can be installed under the wear plates to the contacting surfaces to decrease the friction. Spare parts are easy to change because they are installed with bolts to the feeding platform.

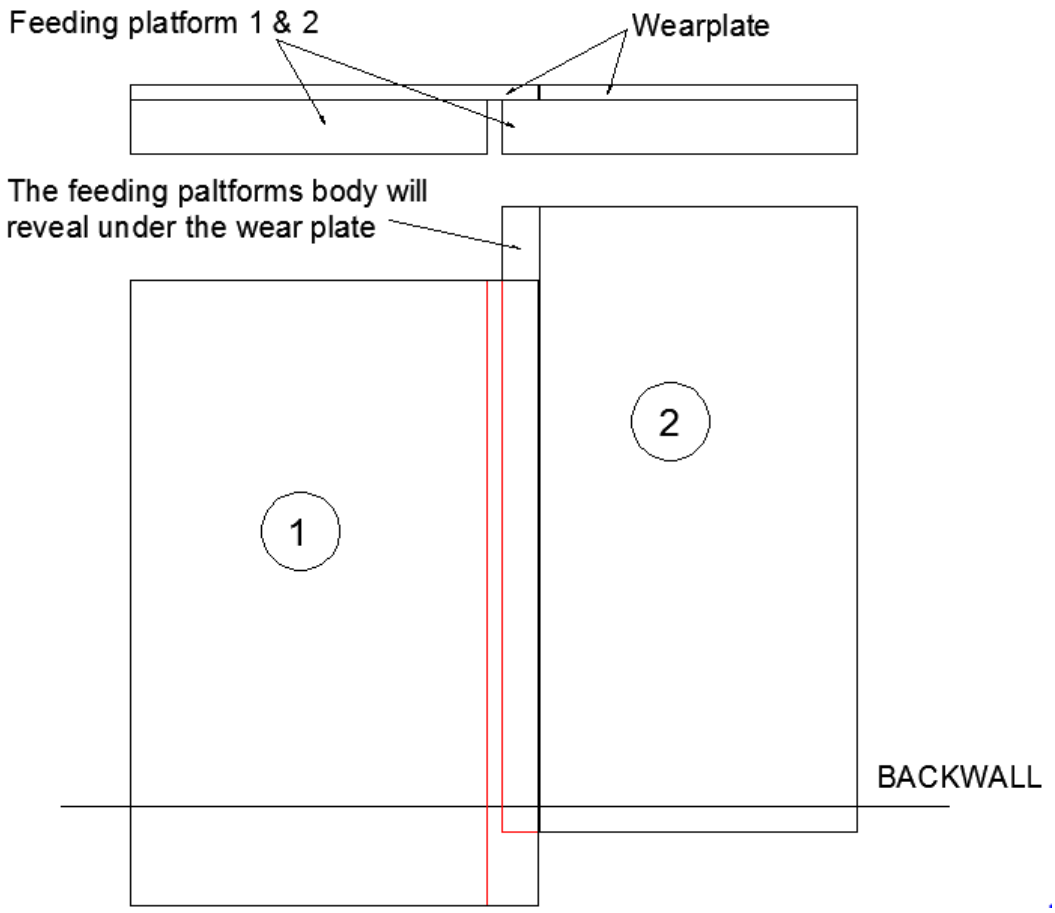


Picture 15: Additional wear plate installation

These sealing options are more difficult to execute than the sealing's in pictures12 and 13. This is because the wear plates are installed on top of the original wear plates. Because of their higher positioning, these sealing's will crush into the back wall when the feeding platform makes its backward movement. This sealing alternative is viable option but it requires a modification to the back wall. Back wall should be modified so that it enables the sealing's to go through.

6.3 Added sealing sections

Feeding platforms out of phase movement to each other leads to a gap on top of the feeding platform at the feeding and discharge ends. This gap needs to be sealed, which can be seen in picture 16.

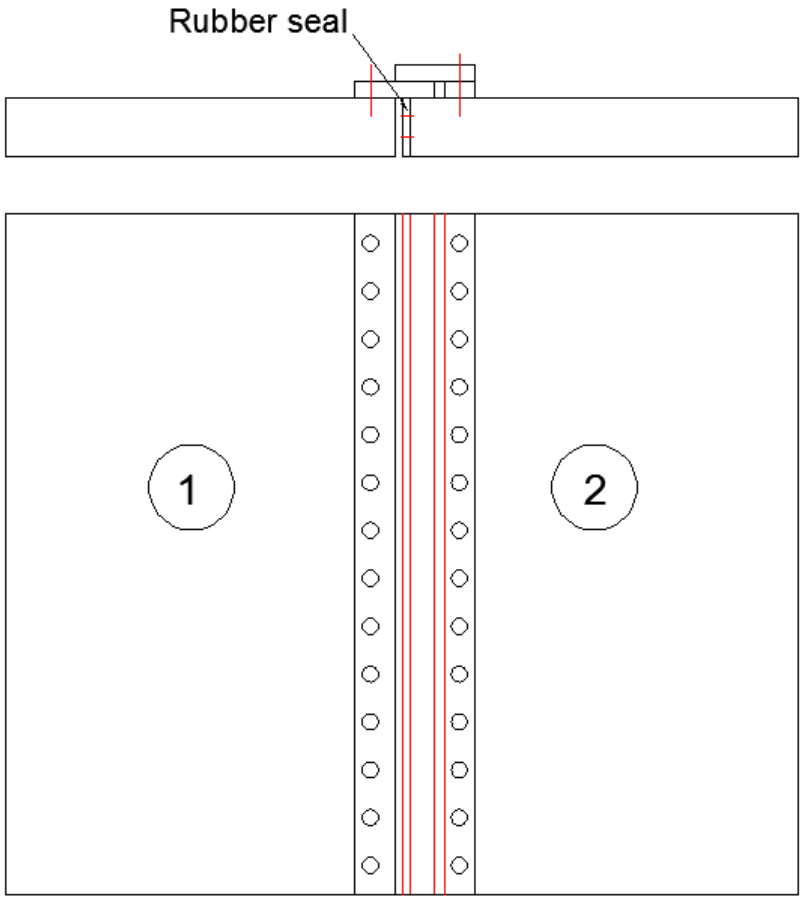


Picture 16: Feeding platforms body reveals

Feeding platforms body will show up under the wear plate. The part of the body can be hidden by increasing the size of wear plates. Their length should be increased to both ways, since the body will also be revealed at the feeding end. Lengthened wear plates will ensure that the body will not be shown when the feeding platforms make their back and forward movements. Extended wear plates will require supportive components to be installed to the feeding platform. They can also be overlapped to each other. Wear plates should be thinner at the connection side which enables the overlap assembly.

Plate feeder is created to handle big rock materials in mines, which means that the feeder's tolerances are high. The middle sealing can't prevent all the rock dust from getting

through the feeding platform. An additional sealing can be added between feeding platforms. The rubber plate can be installed to the side of the feeding platforms body as the picture 17 demonstrates. The rubber seal should be scaled so it won't have any effect to feeding platforms movement which means that a suitable gap should be left between the rubber seal and the feeding platforms body.



Picture 17: Rubber plate installation

6.4 Bearing loads

The flowing rock material through the feeder will stress the supportive components. Bearings are located under the moving feeding platform, at the end of each shaft. Support shafts are build-in to the structure and the only moving parts under the feeding platform are bearings and wheels attached to them.

Bearing loads should be scaled from the 1, 6 meter wide feeder the new one, which will become 3, 2 wide. Bearing and support points will be doubled if we mirror the original feeders feeding platforms supportive components. These bearings might not be in order in the new plate feeder, since they might be over or under scaled.

6.5 Positioning of bearings

Plate feeders' supportive structures are positioned to carry the heavy weight from the flowing rock material. Roller bearings, wheels and support shafts installations are more frequent at the feeding end of the feeder. This is because the falling rock material causes an impact to shafts and other supportive structures. Shafts are installed in sparse in a discharge end.

The new modified SH plate feeder will have the same division on these support installations. The operational principle will still be the same and the modifications to supports are not required. The amount of support shafts can be increased or decreased if the load from the rock material will be significantly changed. This also needs much more deeper inspections when creating the new plate feeder.

6.6 Power source

The feeding platform gets its movement from the cylinder which is attached underneath it. It is positioned to discharge end of the feeder which ensures a lower impacts from the dropping rock material. The new plate feeder's feeding platforms must have their own power supplies, their own hydraulic cylinders attached to them which will enable the platforms to run out of phase to each other. This is the easiest way to ensure it. The hydraulic cylinder and the power source must be calculated and scaled for the new modified plate feeder. The power source for hydraulic cylinders can be seen in picture 18.

Picture 18: Power source (Sandvik Hollola)

7 CALCULATIONS

In theory, bearing loads will increase on a modified feeder, because the number of bearings is doubled but the increased flowing rock material weight will counter their supportive capability. This is because the feeding platform will be transferred to a two part structure and it will have the same mechanical execution as the original one. Because of the supportive components will be doubled, the pressure is now divided to more support points. (Statiikka, 1998). This will mean that the bearings can be changed to bigger ones, because the smaller ones on original feeder aren't now required if the calculations supports the theory.

In the original feeder, bearings are calculated for a1, 6 meter wide plate feeder. Since we now modify the feeding platform to a two part structure, it will become 3, 2 meter wide. This should be considered when calculating new bearing loads because the rock material quantity on feeding platforms will increase. The feeding platforms surface will be increased which leads to higher pressure coming from the flowing rock material. The stress to bearings from the flowing rock material can be calculated by using a certain formula. Because of the confidential issues, the attachment is hidden.

As the calculations shows, the pressure for each bearing will be increased greatly. This is because of the rock materials increased pressure to the structure. The width of the feeder has been doubled which means more rock material will be processed at the same time. More accurate calculations need to be made for bearings and other supportive components. Original feeders' bearings are most likely calculated by using a safety factory, which leads to over scaled bearings. This doesn't mean that these same bearings should be automatically used in the new plate feeder. Another alternative for handling more pressure is to install more support shaft assemblies underneath the feeding platforms. This will ensure more divided load for supportive structures.

The feeder will become more expensive to create if more supportive components need to be installed. In larger scale, engineers should calculate and determine on what they should do when facing these kinds of options. In this case, it should be wise to increase the bearing and other supportive component size. Bearings low price (SKF bearings, 2014) enables engineers to standardize a certain size of bearing for several feeder sizes. This will make the design state of the machine much smoother and easier.

8 STRUCTURAL CHALLENGES

Structural changes need to be made for the connection points of the new plate feeder. In theory, it is possible to use the current 1, 6 meter wide SH plate feeder body for the new one. The feeder's body can be reflected without the middle side walls which allow the feeding platforms to run out of phase. This is the easiest way to design a new feeder in our requirement. It can only been used if the critical connection parts between the old feeder can be used. If this isn't possible, then higher amounts of engineering design needs to be done in order to create the new 3, 2 meter wide plate feeder.

The sketch has been created for the new plate feeder. It is created by using the original plate feeder's mechanical drawing. It should be possible to use already existing plate feeder's mechanics and structural selections, as attachment 3 demonstrates. Some calculation needs to be done because the stress from the flowing rock material will increase due the fact that the feeding platform surface will become larger. The critical supporting components need more inspections and calculations. The attachment is an approximate sketch and it isn't accurate. This sketch has been made for more information for the new plate feeder. It should help out developers to make the right calculations and changes to critical parts of the feeder.

The gap between the supporting points under the shafts is measured in the attachment 3. This gap should be large enough which prevents any collisions between the supportive shafts and other structural components when the feeder is running. The dimension suggests that the supportive shafts can be installed at the same line. If the space between the structures were smaller, the assembly would have required changes for the shafts positioning. Shafts can be installed in imbricate, which enables any contacts between them.

Original plate feeders supporting components under the feeding platform can be used in the new plate feeder. Because the operation principle stays the same, the roller bearings are viable option for this new modified feeder. Supporting shafts and wheels from the original feeder are also good alternative when creating the new modified one.

9 FUNCTIONALITY CHALLENGES

The modified plate feeder's functions should be verified after the engineering developments are done. Some functional things can be ensured during the development state, but the overall functionality of the machine needs to be simulated with programs. This will tell us how the material flow will behave on the feeding platforms contact surfaces. Test feeder should be created after the simulations, so it can be ensured that the machine works like it was intended.

9.1 Capacity

The biggest reasoning why the new plate feeder is being developed is that the capacity and the discharge of the machine will become more constant. Because of its constant material flow, the capacity itself will become smoother. This is because the feeding movement is now being done twice, which enables the feeder to process more rock material than its original version. The challenge is to get the two separated feeding platforms to run in phase and in a certain movement speed to guarantee the best run for the feeder.

The feeder sets up the phase for the whole rock material processing chain. It's important to get a smooth capacity from the feeder which enables a constant material flow. This helps out the other machines in rock material processing such as crushers, conveyors and screens. More problems might occur if the feed is uneven and it can also create blockages in the processing chain.

The original plate feeder is designed to have the lowest possible dead time, which means the feeding platforms movement forward when the rock material is filled on top of it. The new plate feeder guarantees a lower dead time and smoother material flow.

10 TESTING MODIFIED PLATE FEEDER

It is wise to make some smaller tests to inspect plate feeder's critical structures and its functions. In theory, all the critical parts can be calculated, designed and scaled but the test runs always shows possible flaws, which might occur.

10.1 Plate feeder simulation

The main reasoning for a simulation is to inspect the reality functions for designed models and thoughts. Simulation will show how the machine will probably work in a real usage but it won't be as exact as the real prototype. It will also tell the flaws of the machine and it priorities critical parts which need to be redesigned. Usually the simulation is in order because it is much cheaper compared to a prototype. Simulation enables minimal flaws which might occur in a prototype. Nowadays the simulation programs are very practical which explains their popularity.

10.1.1 Middle seal and movement

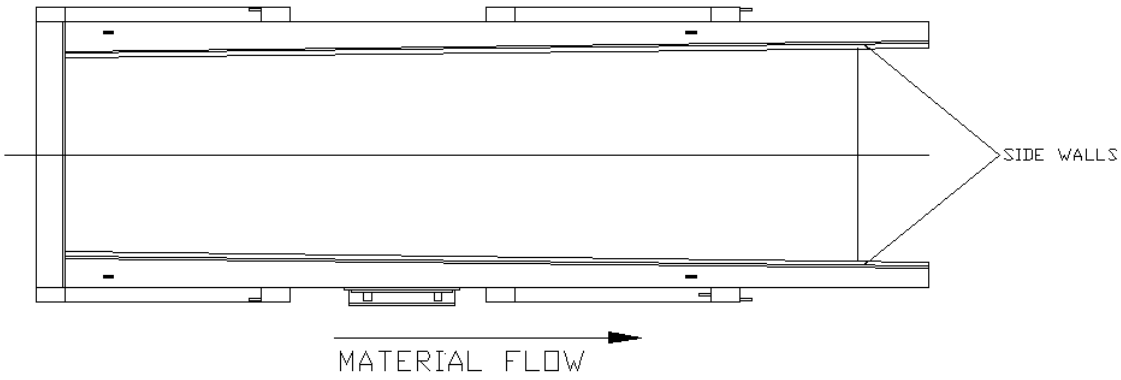
When a modified plate feeder is designed and calculated by using modelling programs and all the critical components are taking care of, the model should be simulated. Simulation will tell how the material flow will behave in the connecting points of the feeding platforms. This is a critical part because the feeding platforms are moving to different directions and it may cause some whirls to the material flow. Because of the whirl, the material in the middle of the feeding platforms might get seized. It is impossible to tell how the material will react, which makes the simulation a viable option for a development state of the machine.

The modified plate feeder should act the same in all other places since the side walls and the back wall will not be modified. They will stay the same and they won't need a deeper examination.

10.1.2 Feed and discharge

The material discharge from the feeding platform can't be predicted precisely. There are still some references from the original feeder on how the material will react when the feeding platform makes its backward movement. More feeding platforms will ensure that the material won't no longer discharged in clumps. Two feeding platforms will enable two times more discharge strokes. It will automatically reflect to a discharge ends material behavior.

The modifications won't have a huge effect on a feeding end of the feeder. Feeder usually has a chute on top of the feeding end so that the material can be directed to a certain direction. The new plate feeder will make the material to roll out smoother in the chute than in the original feeder. The material flow on top of the feeding platform will increase its forward movement since there are now two platforms. The original plate feeder's side walls are designed so that they will recede from each other when going towards the discharge end which is shown in picture 19. This prevents any major clumps to be created on top of the feeding platforms. This same execution should be used when creating the new feeder.



Picture 19: Plate feeder's side walls

Discharge differs from the original feeder. It will become smoother but it might also create some other differences and challenges. The next machine in the processing chain might need to be adjusted so that it can handle the constant material flow from the feeder. This shouldn't be a big problem and the adjustments should be minimal. It is still a thing, which needs to be inspected when installing the new modified plate feeder.

10.2 Test machine

After the simulation and mathematical developments are done, the next step on the feeder's development is to create either a miniature of the prototype or the feeder in a full scale. If some critical functions of the feeder can't be sort out with simulation tools, the miniature of the prototype is good way to examine these things. It will be cheaper than the full scale feeder and it will give the required data of its functions. In this state of the development, the changes can still be made fairly easily.

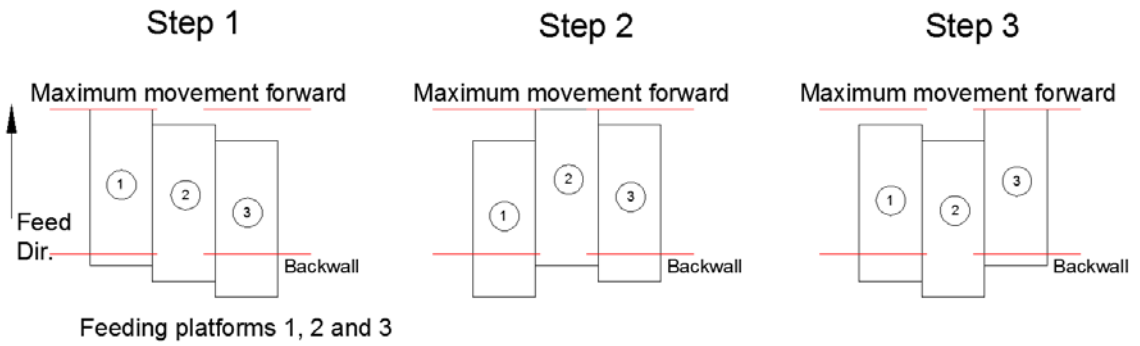
The full scale test machine should be installed to the site. Firstly it should be trial ran to see how it functions without any rock material on it. If tests are pleasant then the test feeder should be installed to the processing chain next to other machines. After certain time of usage, the feeder can be adjusted so it can work on its full potential and search any development spots if necessary. This kind of prototype test run will make the ultimate reliability of the feeder's capability to function on the site. If the feeder fails to work as it was intended and it can't be used as a new modified plate feeder, it can always be synced so that it will work as the original feeder. Uninstalling of the feeder from the site is unnecessary because it has the same features than a normal plate feeder.

11 THREE PART FEEDING PLATFORM STRUCUTRE

The new modified feeder can be developed even further. This enables a rough estimate for a three part feeding platform structure.

11.1 Feeding platforms operations

Three parted feeding platforms' operation principle stays the same as the modified plate feeder but the movement of the feeding platforms will be adjusted. The main idea behind the three parted feeding platform is the out of phase movement between the platforms. Feeding platforms adjustment, which allows their backward movement to be three times faster than forward movement is, will enable overall forward forces to be higher. This means that the material flow is always going forward and there is no need to empty the feeding platform from the rock material with other devices.



Picture 20: Feeding phase demonstration

Feeding phases' demonstration can be seen in picture 20. The first feeding platform is in its maximum position, doing the forward movement, when the rock material is being loaded to the feeder. In step two, the first feeding platform makes its way backwards three times faster than the forward movement is. At the same time the other feeding platforms moves forward in a normal speed. At the third step, the second feeding platform makes it movement backwards three times faster than the other makes their movement forward. The synced movement between the feeding platforms is constant which makes the feeders discharge and capacity smoother.

11.2 Technical data

A normal stroke speed of small model plate feeders feeding platform is approximately 20 stokes / minute on its maximum load. Bigger feeders strokes per minute drops down to approximately 15. These numbers mean the overall strokes per minute, for example the 20 stoke / minute platform makes its movement forwards 10 times and backwards 10 times in minute. Usually an original feeders platforms moves at the same speed forward and backward, which makes the discharge somewhat constant.

Three part feeding platforms structure smoothers feeder's capacity. This is because there will be always one feeding platform making a backward movement, which is the feeding movement. Original feeder feeds the rock material in bigger clumps compared to a three parted feeding platform feeder.

11.3 Structural

All the critical supportive components need to be calculated and scaled. Since there are three feeding platforms, the stress from the rock material will be divided even more on supportive points. It is wise to lower the amount of support shafts if the calculations demonstrate that there's no need for so many supports. If we scale the amount of supports from the original plate feeder to the new modified feeder, the amount will increase significantly which means that more calculations needs to be done. Calculations will tell the exact amount of required supportive components.

The sealing's between the platforms can be the same as in the two part feeding platform structure. It can be used to seal all the connection points between the feeding platforms. The amount of platforms won't affect to its functionality.

The new modified plate feeder has the same basic elements as the original one. It needs three power sources, hydraulic cylinders, underneath every feeding platform. This enables the out of phase movement of the platforms. It can also be designed by using the original feeder's mechanics and structures. It will need some minor changes and design.

Because of the one extra feeding platform, the usage of this feeder will be much more complicated compared to single platform feeder. In developing state, it is safe to design the two part feeding platform structure first, simulate it, create a test machine and fix possible flaws. This will give a lot of data and knowledge on how the three parted feeder will function and it is much easier to deal with its flaws.

In this n, the material flow on the discharge can’t be predicted as easy as on original one. Although the material flow will be smoother, the rock material will fall off from the platforms differently. Simulation with computers will tell us approximately how the material will react to three platforms in discharge and feeding ends. It will also demonstrate if there will be any whirls between the feeding platforms, as they move out of phase to each other. The new modified plate feeder has the feeding forces always ahead which describes that the whirls will be minimal and the material will be unloaded.

12 SPECULATION

Creating this thesis required a deeper researching in feeder's structural components and its functions. The knowledge on feeder's operation principle was in order when making changes for the plate feeder. Although the feeder's primary job is to feed the material in certain speed, it still has many various models for different usages and materials. These models are surprisingly different from each other. This thesis has taught me how the crusher application works, what it includes, how it works and more. Developing a plate feeder is easier when understanding mechanics and structure.

Multi feeding platform feeders has been developed already, which means that there is definitely a need for these kinds of redeveloped products. This new plate feeder is one example on a continuous development and the opportunities to develop other machines in other industries. When developing new alternatives for existing models, it will reflect to company's competition on a global market.

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ATTACHMENTS

Attachment 1. Mobile crushing and screening

1(3)

Mobile crushing and screening
Product offering

A world leader in construction

SANDVIK

Sandvik Mobiles
Product offering

WORLD LEADING RANGE

Sandvik Mobiles are world class manufacturers of high quality tracked, wheeled and portable plant which provide a total solutions package for a large variety of applications worldwide. Designed with customer's requirements in mind, all units are user-friendly, easy to operate with quick set-up times, highly efficient and offer optimum productivity.

With unprecedented experience and knowledge within the crushing and screening industry, Sandvik have designed market leading technology which features many unique and advanced concepts such as the Prisec™ impact chamber, Hydrocone technology and the patented Doublescreen system.

The extensive range encompasses jaw, impact and cone crushers; three-way split screens, the world's only range of tracked Doublescreens, scalpers and triple deck screens. They are all compatible and can be inter-locked, or operate as independent units to produce a range of fractions, with certain models being capable of independently producing three or four different fractions plus fines.

Our products are supported by a global distributor network, which combined with our global customer support team, are always available to provide our customers with all their necessary parts requirements, training and service needs worldwide.

Quarrying | Demolition and Recycling | Surface Civil Engineering

PREMIUM RANGE

Mobile Jaw Crushers

QJ341 QJ241
QJ331

Mobile Cone Crushers

QH440 Hydrocone
QH331 Hydrocone

Mobile Impact Crushers

QI441 Prisec™
QI240 Prisec™

Mobile Screens

QA451 Doublescreen
QA440 Doublescreen
QA340 Doublescreen

QA331
QA140

Mobile Scalpers

QE440
QE341
QE140

HD RANGE

Mobile Jaw Crushers

UJ440i UD440
UJ440E

Mobile Cone Crushers

UH440i UH440E
US440i US440E

XHD RANGE

Mobile Jaw Crushers

UJ640
UJ540

Mobile Cone Crushers

UH640

HD WHEELED

Crushers and Screens

UH430 UV320
UH421 UH320

UF320

WHEELED RANGE

Crushers and Screens*

UV312 US310
UH311 UJ310

UJ210 UI210
UD211

*These new machines are currently CE certified

Attachment 2. Sandvik feeders

Sandvik
Feeders

SANDVIK

A full range of proven feeders
- and the people to support you

Sandvik offers you a wide range of quality feeders. But that is not all. Many of our sales people have a long experience with many types of feeders and are well qualified to help you select the right equipment for your plant. Whether you need just a feeder or a complete process solution, Sandvik can provide you with equipment that is easy to install and fully functioning from day one.

Sandvik has actually designed, manufactured, supplied and serviced top-of-the-line feeders for mining and aggregates customers worldwide for over half a century.

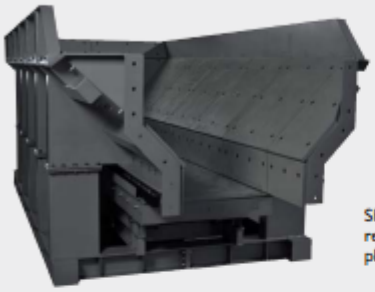
Extended equipment life with Sandvik wear protection.

Sandvik offers a wide and versatile range of wear protection products for numerous and diversified applications. Extended equipment life, safe & easy handling, minimized noise levels and reduced maintenance and operating costs are only a few of the many assets of the top-quality product offering.

Worldwide experience and expertise with local flavor.

Sandvik has an unrivaled network of subsidiaries and a strong local presence in all major countries. We have a tradition and conviction that there can be no substitute for direct service and direct contact. Our some 130 market companies assure easy access to specialists whenever required. More importantly, Sandvik service is a united global team of experts. They can assist each other when required, or put together special teams for specific cases. Sandvik service and stocking is managed locally with central support. Moreover, we have one simple aim: to benefit your bottom line.

Sandvik
reciprocating plate feeders



SH primary reciprocating plate feeder unit

SH secondary reciprocating plate feeder

SH primary reciprocating plate feeder

Rugged, reliable, vibration-free, hydraulic reciprocating plate feeders for primary crushers, as well as for numerous secondary and other feeding applications.

Sandvik offers a range of hydraulic powered linear plate feeders for primary and secondary applications, all of which featuring easy and minimal maintenance.

EXCELLENT OPERATING CHARACTERISTICS
The SH feeders can be subjected to high head loads without affecting the feed rate. They handle sticky material well and can allow dumping of large size material directly since they always retain some material on the reciprocating plate.

MULTIPLE FEED RATE ADJUSTMENT POSSIBILITIES
The feed rate is easily adjustable, both by changing the stroke length and the stroke frequency. Stroke adjustment can be done without stopping the feeder, completely automatically, remotely or manually by hand. The feeder can be started and stopped as often as required with shorter delays in the feeding than with a vibrating feeder.

SH – PRIMARY RECIPROCATING FEEDER
SH is a heavy reciprocating feeder for large primary stations with large volume, high drop height or where very large dump trucks are used. It has a robust feeder plate, skirts with an effective double wiper side sealing system and rear sealings, wear liners and a hydraulic drive unit with hydraulic cylinder, hoses and a control system (optional). SH feeders are supported from below and a separate feed hopper or chute is used.

SH UNIT – PRIMARY RECIPROCATING FEEDER WITH HOPPER
This is a complete feed unit including a SH-feeder and in addition a complete heavy duty primary dump hopper with inclined walls. The hopper is equipped with wear liners and overflow curtain (optional). The volume of the hopper can be increased with hopper extension.

SH–SECONDARY RECIPROCATING PLATE FEEDER
The secondary range is primarily designed for tough secondary applications. These feeders are normally mounted underneath a silo or a bunker in order to discharge material at a belt conveyor. However, a special option is available for truck loading procedures (e.g. commonly used in underground mines).

MINIMUM OPERATING COSTS

- Low power consumption thanks to the low operating speed required.
- The reciprocating plate is the only moving part and the supporting rollers (with ball bearings) are never exposed to any dirt or dust.
- The long life wear liners are of a simple design, they can be made very thick and are easy to replace.

SIMPLE, SELF-PROTECTING WEAR FREE DRIVE

- One hydraulic cylinder means a simple system to power the feeder.
- Oil lubrication of the hydraulic system minimizes wear and need for maintenance.
- The feeder is completely vibration free and the dynamic loads very small.

SPECIAL OPTIONS

Special options for either high or low ambient temperature are available.

Technical data SH and SH Unit for primary feeding

	SH					SH Unit		
Model	Height (mm)	Weight (kg)	Motors (kW)	Max feed (mm)	Capacity range (m³/h)	Height (mm)	Weight (kg)	Hopper volume (m³)
SH1041	860	3 450	11	700	0-300	3080	12 500	15
SH1351	918	5 250	22	1000	0-450	3610	21 600	30
SH1661	1110	9 000	37	1300	0-700	4400	39 300	45
SH2071	1420	17 100	55-90	1800	0-1100	6400	57 500	75
SH2571	1450	21 000	55-110	2400	0-1700			

Technical data SH for secondary feeding

Model	Overall width (mm)	Overall height (mm)	Motors (kW)	Weight (kg)	Hopper volume (m³)	Max feed (mm)	Capacity range (m³/h)
SH0835	1280	1460	7,5	3 000	1.5	250	0-150
SH1035	1480	1460	11	3 200	1.5	300	0-200
SH1335	1780	1460	15	3 500	2.5	400	0-250
SH1645	2250	2015	30	8 700	4	500	0-500
SH1645H	2250	2615	30	11 000	7	700	0-650
SH1955H	2550	2615	37	13 750	12	900	0-750
SH2255H	2850	2615	30-74	15 000	15	1200	0-950
SH2555H	3150	2615	60-110	17 000	18	1800	0-1100

* Capacity in m³/h at 0° inclination. Capacities depend not only on feeder size but also feeder inclination, feed gradation, etc.

SANDVIK

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Attachment 3. Sketch for the new plate feeder