The Development of Continuos Advance and Retreat Conveyor Systems for Longwall Mining in the Coal Industry

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It has long been recognised that the extension of conveyors in underground mining panels, in various tunneling projects and the advance and thence retreat of a conveyor in the longwall coal mining process is both inefficient and expensive due to the direct result of restricting production potential.

The recognition of this is that there have been many and varied processes developed or designed to either mitigate the inefficiencies or address the resultant constraints to production. However, none have also addressed the expense incurred of such processes.

The purpose of this paper is to focus primarily on the longwall mining of coal however the process described and for which patents have been applied for, can be adapted for many other applications where such inefficiencies are experienced. It is our intention in this paper to restrict our discussion to the longwall mining of coal application and leave the discussions in respect to the other uses of this process to later presentations.

In a coal mine where longwall mining techniques are the primary means of production, the productive use of the longwalling equipment is paramount. One of the major constraints to productivity & profitability is the fact that the conveyor belt system that takes the coal from the Armoured Face Conveyor (AFC) that runs along the longwall face, must be retreated usually after every 5-10 shears across the longwall face i.e. 5-10 metres of retreat.

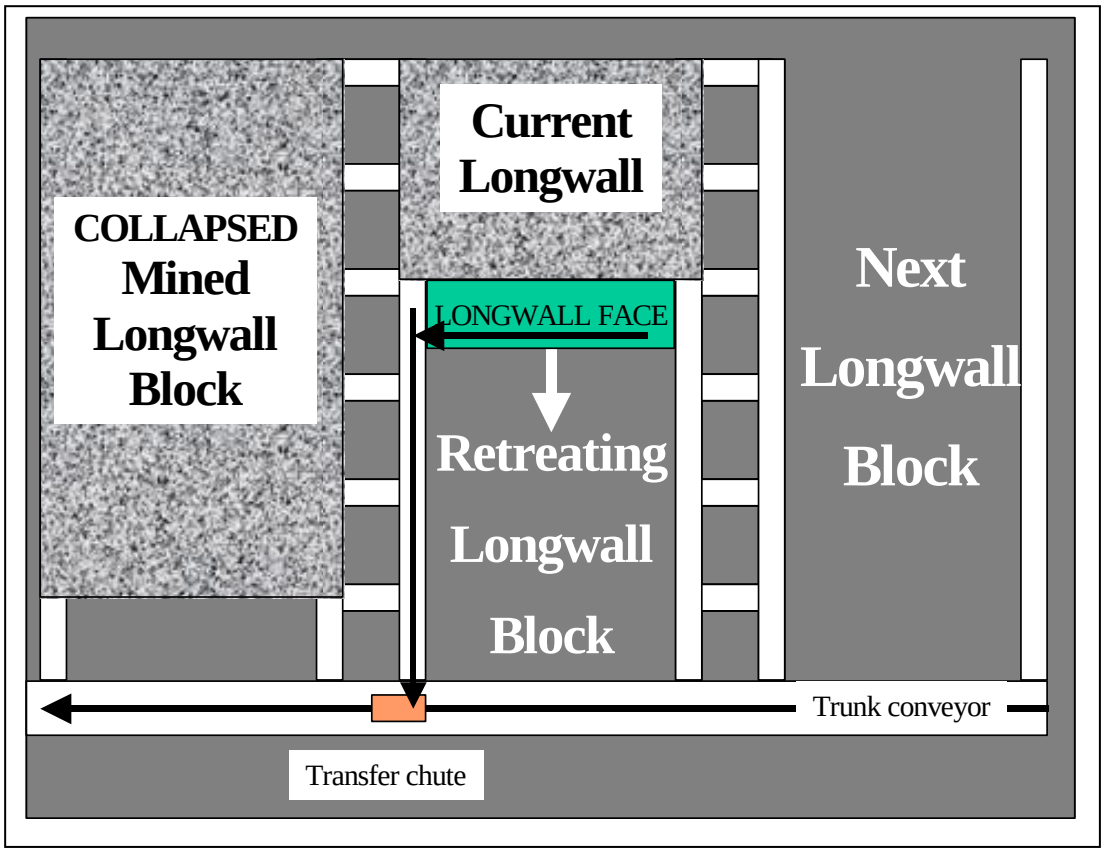


Figure 1 Typical longwall mining configuration

Given safety considerations it is necessary to stop the conveyor system and therefore the shearer for 10-20 minutes while conveyor structure is removed and the excess belt absorbed into a belt storage loop take-up arrangement (situated at the head end of the conveyor).

Further, the longwall process and the downstream processes perform more efficiently during constant material stream processes rather than when there are many fluctuations in material flow. For example, stoppages can lead to hydraulic pressure issues in the roof support system that have to be addressed before shearing re-commences along with other issues that can also delay a smooth resumption of production once the conveyor belt system has been retreated.

In studies undertaken, the full impact of having to remove structure from the conveyor system averages out to about ten (10) percent lost production. Given the production from a modern longwall mine is over 5MTPY this equates to over 0.5MTPY of lost production. This represents losses that can be recovered at no additional cost to the mine through greater efficiencies in conveyor moves.

There are however a number of other issues to be considered such as the maintenance and component life, especially the conveyor belt on longwall and longwall panel conveyor system is high. In most longwall coal mining operations between 50-70% of the maintenance and component costs are consumed by the longwall and longwall conveyor panels. As the conveyor system is a vital transport link in all underground coal mines it therefore represents a major cost centre. The issues that give rise to these high maintenance costs are as follows:

(i) As the conveyor system is extended in a longwall development panel, in 50 to 100 metre stages, the alignment of the conveyor system is usually poor. This leads to conveyor belt damage and usually requires the system to be fully re-aligned and stabilised once it has been fully extended. In many instances mines actually develop the panel with lightweight, cheaper structure and belt, then remove it and fully install a larger more robust system once the panel is fully developed. The total cost in labour, materials and component damage of such a system is high.

(ii) As the longwall retreats the fact that structure is being removed in such short sections sees idlers and structural sections poorly handled and damaged leading to reduced service life.

(iii) The mobile tail assembly that retreats with the belt is usually difficult to align and this in turn creates alignment problems and damage to the conveyor belt. Conveyor belt life in such operations is usually 20-30% at best of what is achieved on fixed trunk conveyors.

(iv) The addition of, during the panel extension, and the retreat of, during the longwall retreat, requires conveyor belt to be added and then taken out of the system. Unless this process is managed well, which is very rare, and then belt sections can be of varying and less than ideal lengths. Further, to speed-up this process, the conveyors are usually joined using belt clips rather than vulcanised. All this adds to conveyor belt maintenance issues and reduced conveyor belt life.

(v) The use of clips and the difficulty in maintaining high installation standards usually means spillage and carryback from the cleaners are also additional maintenance factors and costs.

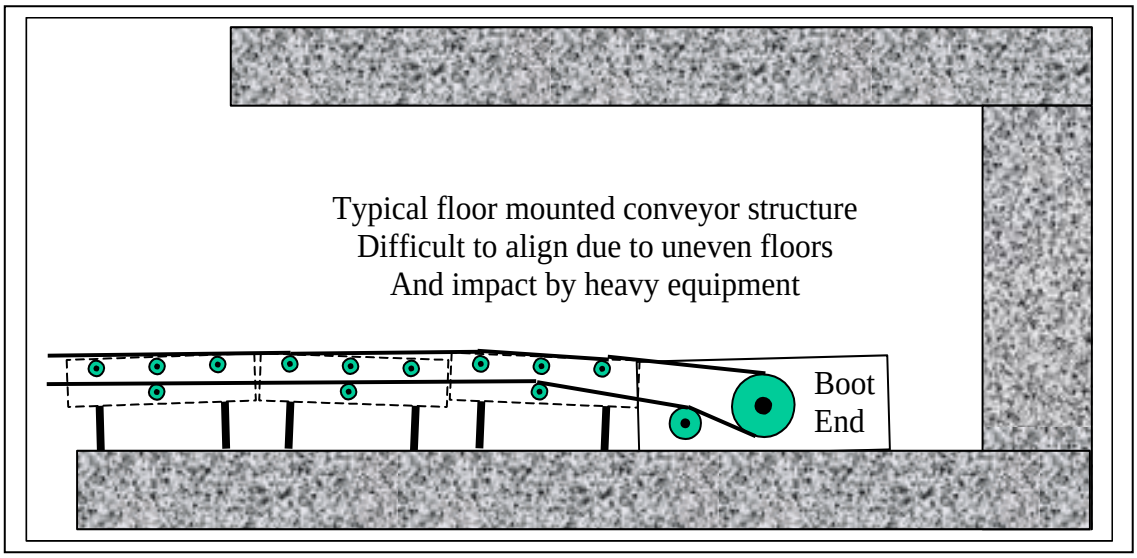


Figure 2 ~ Depicting a conventional floor mounted conveyor structure with its associated alignment problems

The following will describe how, through design and overall better management practices, a process whereby the production losses can be fully addressed while at the same time reducing the high maintenance/operating costs of these systems. The key is looking at the system as a single production unit and addressing the needs of this unit by designing out the current limitations. The process is applicable to all longwall panel/production conveyor system. The starting point is identifying the key issues. They are:

- The need to stop frequently on the conveyor system retreat.
- Safety
- The unplanned nature of the conveyor extension/retreat process due to the constraints placed on it by production
- Conveyor system alignment
- Cleaning and spillage
- The handling of the belt and conveyor structure that needs to be installed into or taken from the system

What will be describe now is how we address these key issues:

<u>Elimination of Frequent Stopping on the System Retreat:</u>

There are a number of systems that have been marketed to address this issue. All involve extendable/retractable conveyor sections of some sort. Those currently on the market have limitations either in their operations or the efficiency of how they work. The best of these systems have a dual rail system however as with dual rail systems, particularly ones in hostile environments, it is not unusual to see them can become misaligned and ‘lock up’. It is also difficult to install the larger systems or systems that are of a larger mass due to the limitations of using aluminum in underground situations.

This issue has been significantly addressed by:

(1) Using a patented tubular mono-rail to overcome the strength to weight limitations of conventional “I” beam monorail system

Figure 3 ~ View of the monorail section

(2) Using a single rail that can be hung from chains thus eliminating the need for closely toleranced alignment of the roof bolts

Figure 4 ~ View of the roof mounting system

(3) Reducing component weights

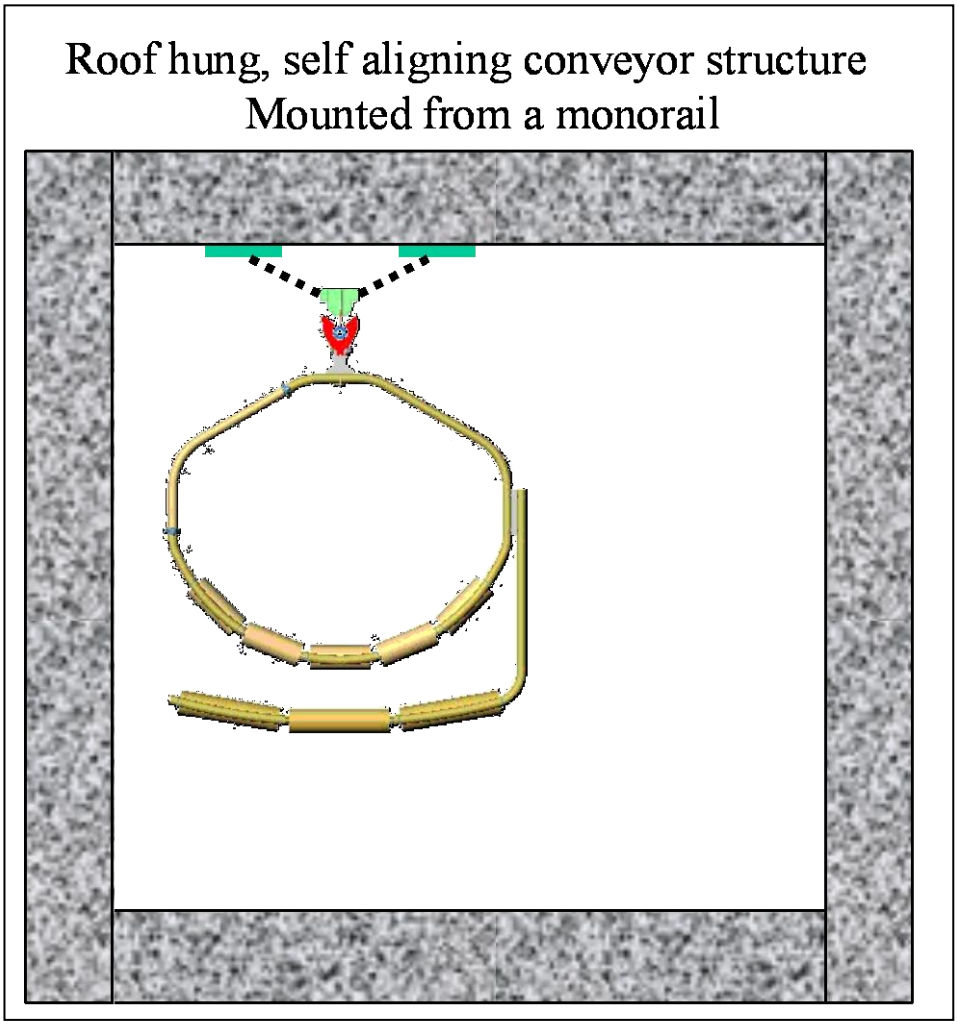
There are a number of other features that constitute a patent that has been applied for and is pending.

Safety

One of the key issues facing the mine operator, management & staff is the elimination of the need to directly contact or interact with the conveyor systems unless it is stopped. Also, when it is stopped, any interaction should not require heavy manual lifts.

This is issue is achieved by:

- Careful design of all components that may need to be manually handled is less than 30kg



- Installing hydraulic conveyor handling systems such as the system illustrated to manage the installation/removal of belting

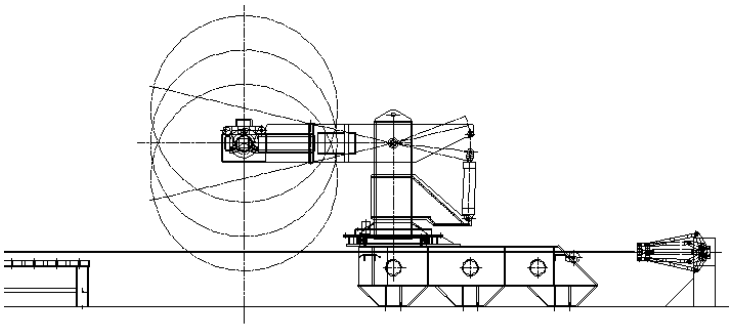


Figure 6 ~ Schematic of a commercially available belt reeling station

- Installation of fail-safe hydraulic clamping systems to secure the conveyor when a conveyor belt move is to be made

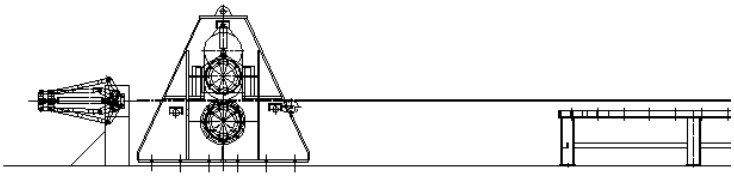


Figure 7 - Schematic of a commercially available belt clamping station

- The use of 'modular' conveyor structure sections that can be pre-assembled and then added to the system by a cassette loading method and removed the same way when retreating thus eliminating the need to man handle the equipment.

View 7 - Modular loading/unloading system

Creating Time to Plan

By having a structure that can extend or retreat by 100/150 metres without stopping the conveyor, all belt moves can be planned for normal maintenance shutdown periods. Usually such a shutdown period is at least 8 hours. In such a time it is possible to bring in contractors or 2 maintenance crews to:

- On the longwall panel advance add 200 metres of belt into the belt storage loop and add one vulcanised joint and replace the clip joint (this is facilitated by having only one clip joint in the panel conveyor and have this automatically located into the appropriate position once the belt system is stopped)

- At the same time compress the extendable conveyor structure and add new fixed structure or add another module from a cut through utilizing the features of the extendable structure

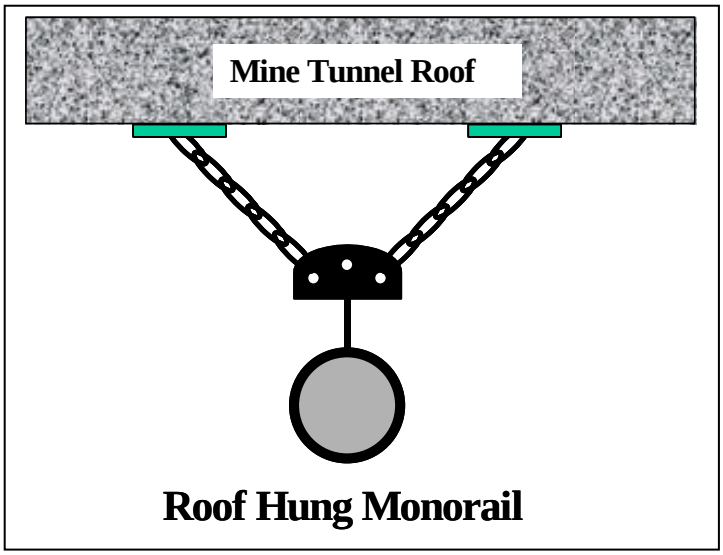
- On the retreat the reverse is done except it is simpler and quicker as you only need to remove and re-new one clip joint as each roll of belt is taken out

By such a process it is easy to maintain the conveyor belting in set lengths, it is easy to manage the structure in an orderly and planned way and, given time is now available attention can be given to ensure installation standards are high.

Conveyor System Alignment

The key is firstly to have time, as above, to plan any activity such that installation standards are maintained at high standards. In addition however, the design of the extendable structure has the following self-aligning features:

- The system is chain hung from the roof using various chain configurations thus providing controlled flexibility within the monorail structure achieving a self aligning property.



- The conveyor frame can rotate around a central pivot point under the pipe trolley thus allowing the belt system to create its own self alignment as it suspends from the monorail pipe structure.

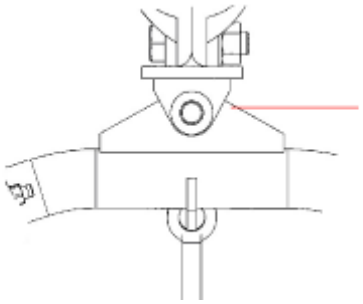


Figure 8~Schematic of the "self aligning" pivot point

Additionally the tail end assembly is re-designed to allow additional space also a crowned tail pulley is used to assist with centralizing the belt over the tail drum thus substantially reducing the problems associated with poor alignment. Crowned pulleys can be used for this purpose if, as described above, having only one clip joint in the conveyor system and this clip joint is renewed on every belt move. Such built in self-alignment will substantially reduce conveyor belt damage and increase conveyor belt life.

Cleaning and Spillage

By designing soft loading, modular transfer chutes at the head end, it gives easy access for installation and maintenance of the belt cleaners so that most spillage issues are addressed. Also, by not using so many clip joints, one of the key causes of scraper damage/mis-alignment is thus eliminated. Belt clip detectors could also be used to lift the cleaners over the few joints in the system.

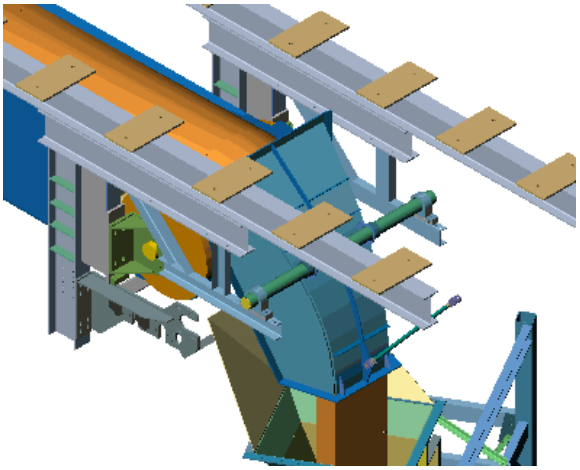


Figure 9 ~ - View showing ease of accessibility to transfer chute components like scrapers

Summary

Use of Handling Equipment

- Hydraulic belt reelers and clamping systems manage the addition/subtraction of belting from the system with efficiency and less manual handling by the workers.
- Use of trailer mounted installation/removal cassettes for the structure and idlers removes the need for manual handling and thus reduces both injury to personnel and damage to conveyor components
- Use of existing cut-throughs to insert/remove structure means that all parts of the system are accessible.

By taking the above holistic approach, it is easy to see how this whole process of longwall development panel to production panel can be made not only for more productive and safer, but also much less costly to run for the mine operator. The increase in some component costs would be more than offset by:

- Longer component life.
- Greater component reliability.
- Less worker related injury.

It is also worth mentioning that it is ideally suited for optimizing the belt specification for a longer wear life rather than the current philosophy of using cheaper belt in anticipation it will be damaged before it is worn out.

It is further acknowledged that the future of all conveyor system management is not only having a more planned approach but also having the time and the technology to plan. This paper illustrates the enormous savings to be had by such an approach.

References

(1) Benjamin, and Nemeth, J.: Transfer Chute Design for modern materials handling operations Bulk Solids Handling Vol 21 Number 1 January/February 2001 Trans Tech Publications Germany.