An optimised take-up trolley design

With the resources market under pressure worldwide, companies are looking for ways to reduce construction and operational costs in this sector. Solutions that were accepted as standard practice a few years ago because they are known to work, are now being looked from every angle to reduce costs. An alternative to a well-known conveyor take-up arrangement is discussed here.

Bulk material handling conveyors require a take-up in order to ensure the required belt tension, compensate for permanent belt elongation, and to provide extra belt length during splicing operations.

This article provides an overview of important aspects that govern the mechanical and structural design of horizontal take-up trolleys, and explores the simplification of a current take-up trolley design, to arrive at an alternative, optimised solution.

Existing take-up trolley design

Figure 1 show a typical horizontal take-up trolley layout, which is often used for conveyor designs.

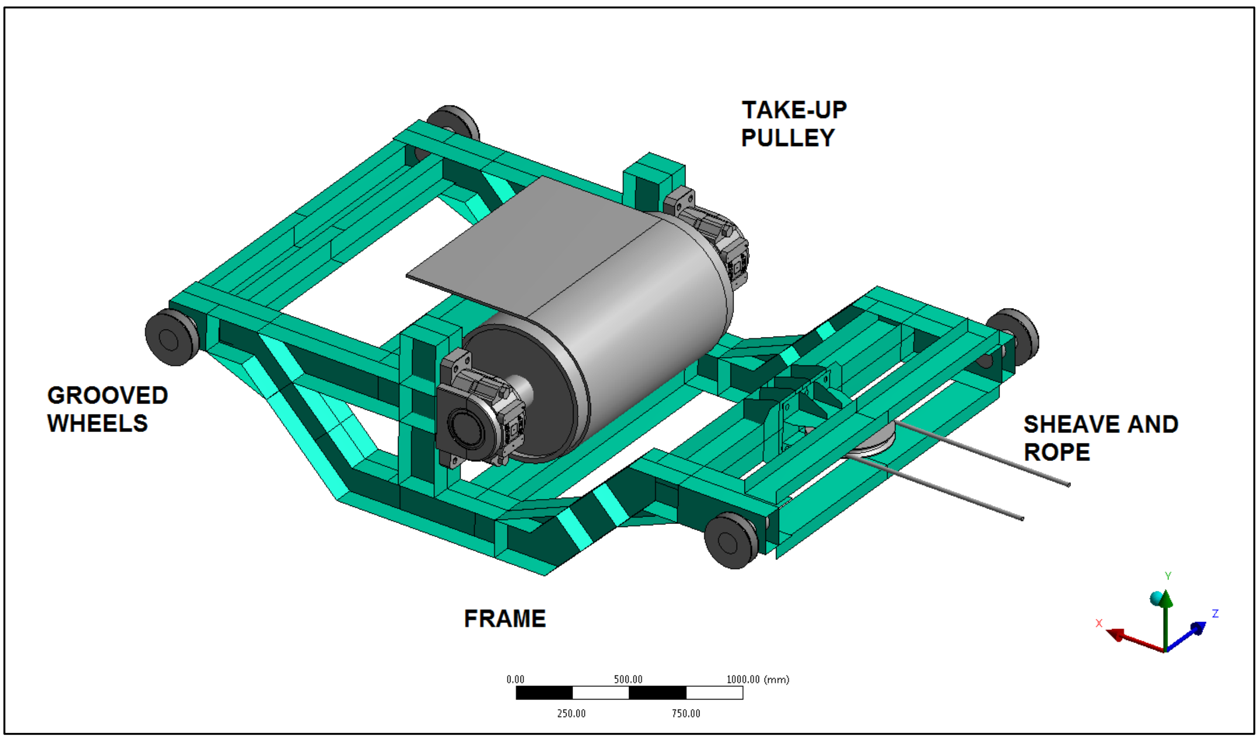

Figure 1: Well-known horizontal take-up trolley design

The typical horizontal take-up trolley consists of:

A pulley that transfers the belt tension loads to the take-up trolley.

Belt tension acting on the **take-up trolley structure** are transferred via the sheave wheel to the ropes.

Grooved **wheels** are used to support the trolley vertically and laterally, and allow the trolley to travel in the take-up frame.

The current design

The layout of the structure is such that the tensile force is transferred through the structure below the take-up pulley. The offset in the force path creates a bending moment (M) in the bottom member and welded moment connection as shown in Figure 2, requiring an increase in the member size, compared to that required for a pure tensile load. This moment governs the section selection.

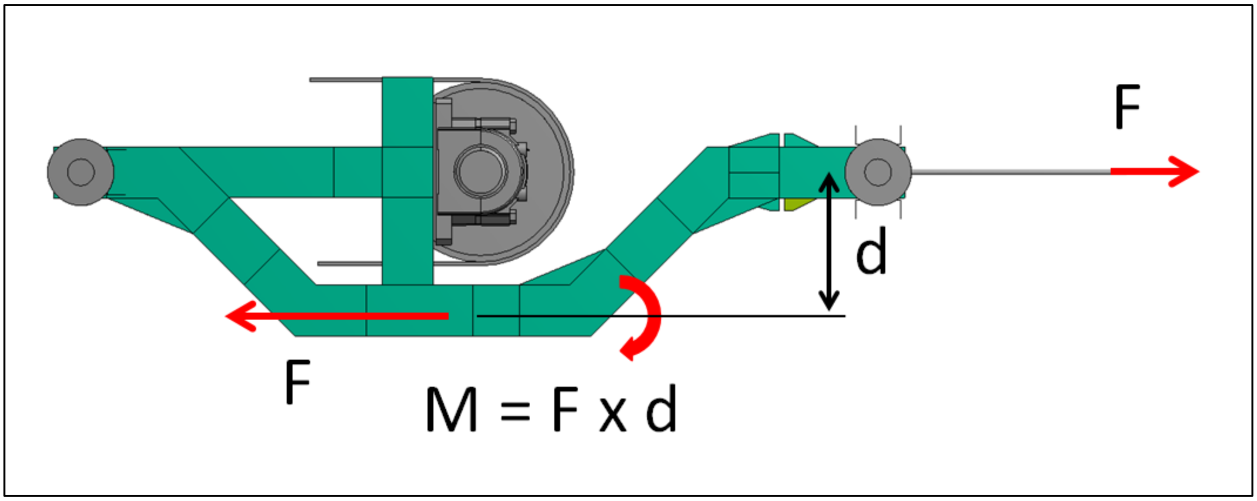

Figure 2: Transfer of forces

The layout of the sheave arrangement is such that the sheave connection bolts are subjected to tensile loads. A more ideal configuration would be to have the connection in compression or shear. The design requires a large amount of welding. Additionally, high quality of welding and quality control is needed, as full penetration welds are required to resist the combination of tensile forces and bending moments at the welded moment connection. With the take-up trolley supported by grooved wheels on both sides, a rule of thumb of the wheel base of 1.5 times the width of the trolley should be applied, to prevent the trolley lodging.

Optimised take-up trolley design

The re-design of the trolley focused on improving on the current shortcomings. Various concepts were evaluated to arrive at the simplified solution. Improvements were made to optimise the structural layout, sheave arrangement and use of welding in order to reduce mass and manufacturing costs. The structure was analysed using Prokon and Ansys structural design software.

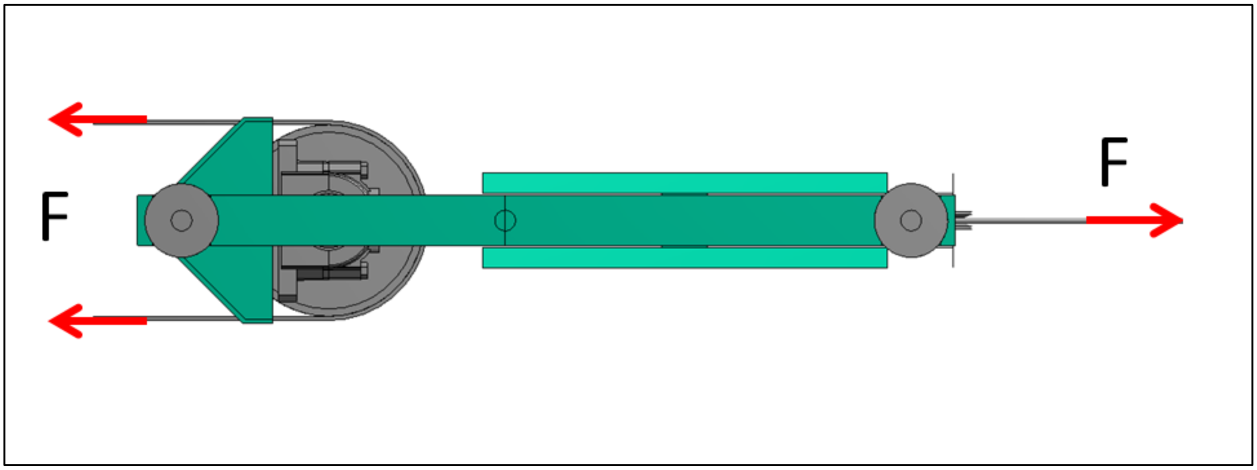

Figure 3: Side view of optimised trolley

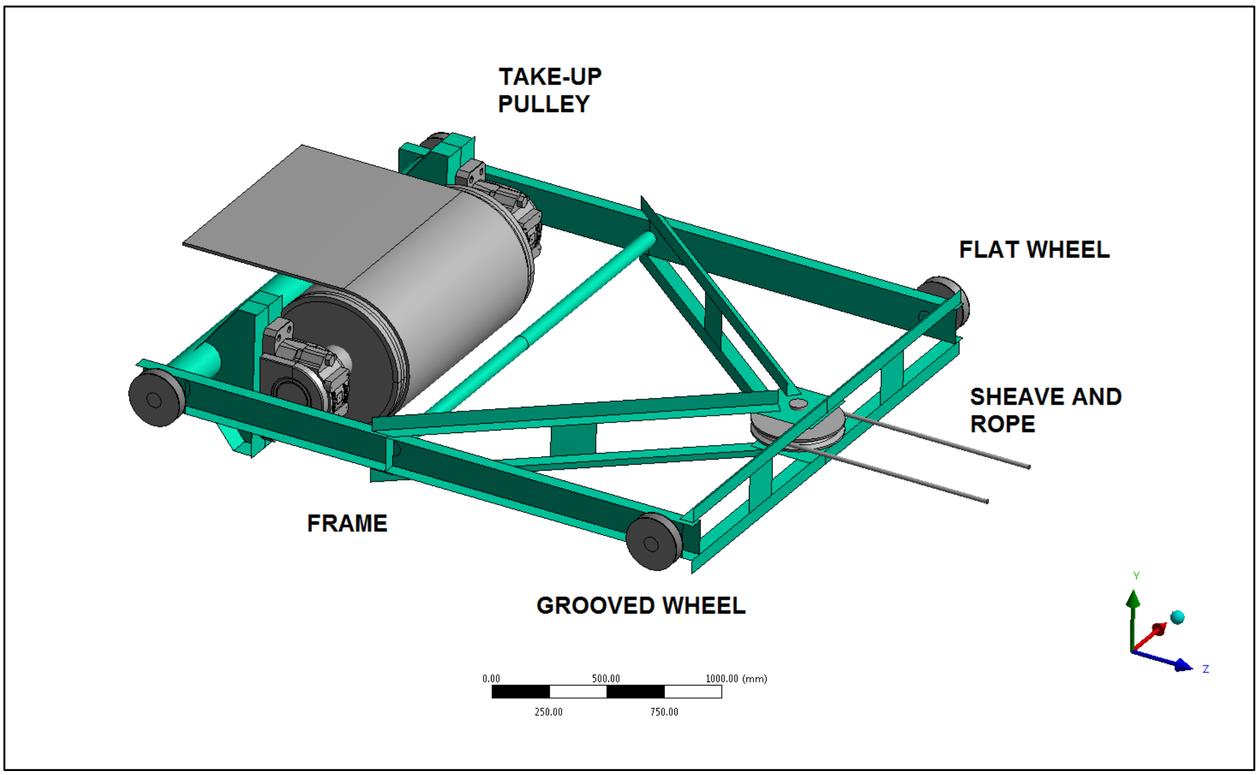

Figure 4: Isometric view of optimised trolley

The proposed layout is such that most structural members are subjected to tension or compression only; eliminating bending moments created by the offset of members transferring operation loads. This enables the use of much lighter sections. A circular hollow section is used to support the combination of torsional loads due to the take-up pulley mass and moments as a result of belt tension.
The sheave arrangement is improved by removing the bolted connection. The connection layout also allows for a much lighter design.

The cost of manufacturing is reduced by mostly making use of fillet welds loaded in shear, eliminating the need for full penetration welds, and associated quality control costs. The alternative arrangement also results in a much lighter frame, again reducing manufacturing costs. The overall **trolley length** is reduced, by using a grooved wheel-flat wheel arrangement, eliminating the need for a length to width ratio of 1.5.

The optimised design reduces the amount of welding and structural mass of the take-up trolley significantly. A limit analysis of both designs shows the optimised design to have a load capacity to mass ratio 3.2 times that of the original design.

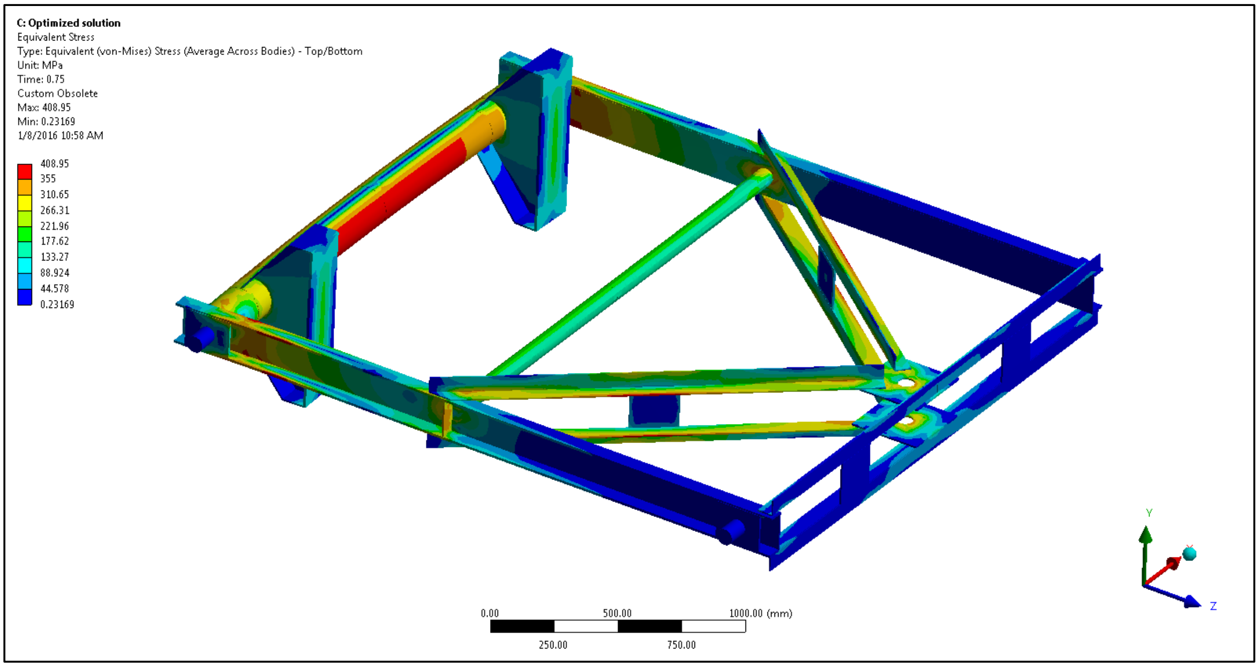

Figure 5: Nonlinear limit analysis of optimised design

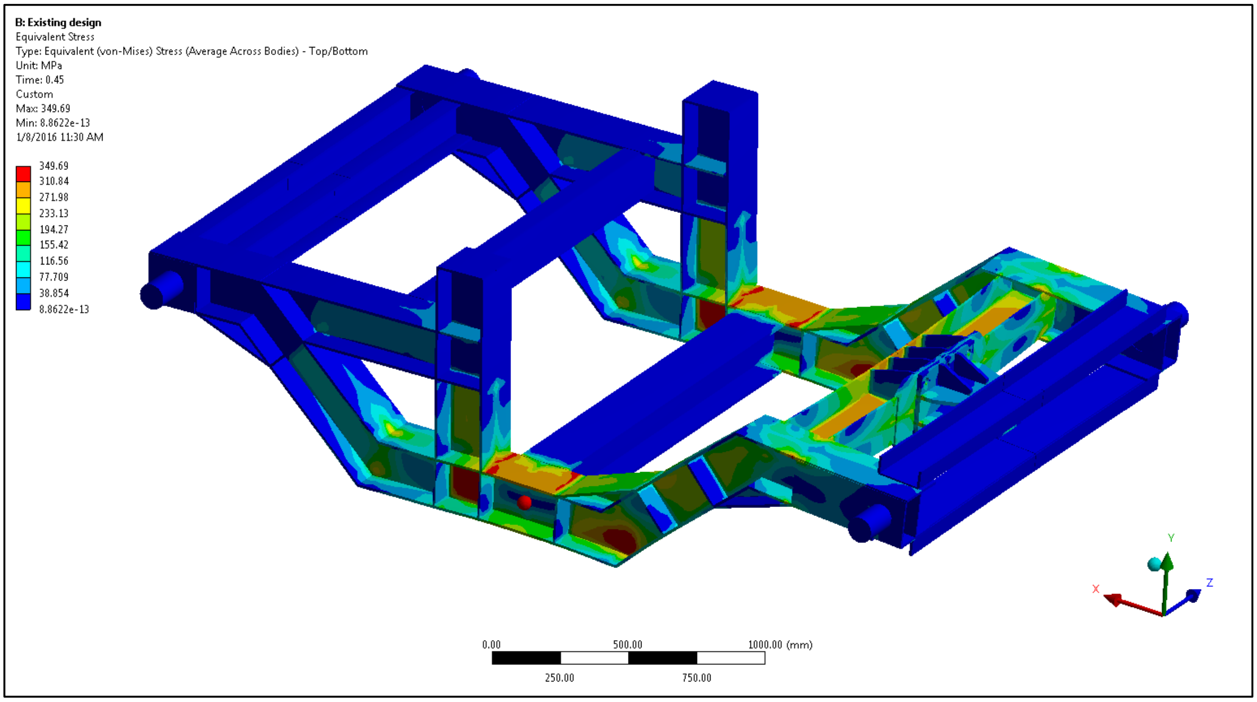

Figure 6: Nonlinear limit analysis of existing design

Table1: Summary of measurable improvements

	Existing design	Optimised design	Ratio
Structural mass (kg)	968	395	0.4 of existing
Total weld length (m)	23.2	15.6	0.67 of existing
Capacity to mass ratio	413 KN/kg	1329 KN/kg	3.2

Conclusion

With the resources market under pressure worldwide, companies are looking for ways to reduce construction and operational costs in this sector. The optimisation study completed by WorleyParsons RSA's Advanced Analysis consulting practice has shown that savings can be achieved in components and areas that are often overlooked, and accepted as standard practice.