

The Redigrip PSM (Precision Steel Manipulator)

Redpath Australia Pty Limited

The Problem or Initiative

Working with suspended loads remains an identified significant risk within the mining industry, which can be compounded by cramped spaces and tight clearances in underground work areas.

During the tender process for the disassembly and re-construction of an overhead workshop gantry crane, at an underground mine, Redpath identified during a pre-project risk assessment, an opportunity to improve the safety of the work by eliminating the need for the slinging of beams and columns during construction, by way of the design and use of a fit for purpose Redigrip PSM (Precision Steel Manipulator).

The use of the Redigrip PSM also reduces the risk from limited headroom above the gantry structure and removed personnel from the hazardous areas adjacent to slinging and carrying of beams.

The Solution

Through the combined efforts of Redpath, Mecad Engineering, Doherty's and M&J Hydraulics, the concept advanced into a hydraulically controlled beam manipulator which was able to grab "I Beams" up to SWL 1.2 tonnes and manipulate them with: 360 degree rotation; 40 degree side tilt left and right; 140 mm side shift; 180 degree primary tilt; 600mm of telescopic extension; and provide a reach of over 8 meters. This was achieved by being attached to and powered by a Volvo L120 front end loader (FEL).



The Redigrip PSM

The major components of the Redigrip are an "Engcon" rotatilt 15 tonne excavator attachment, with specifically designed telescopic jib in conjunction with a hydraulic gripping clamp developed to suit I beams.

The machine was assembled in Redpath's Brisbane workshop and extensive testing was undertaken. The machine was load tested to 2.4 tonnes, with the restricting factor being the L120 FEL. Once the SWL and associated certification had been obtained, a comprehensive risk assessment was completed for use and the L120 FEL and Redigrip were sent to site.

Further testing and training was undertaken on the surface at the project site, with operators certified in the use of the Redigrip and it was then put to work on the underground workshop crane structure installation.

The first significant task was the erection of the vertical columns which were fabricated from 460UB67 beams at up to 8 meters in length. The first column took over 3 hours to install while educating the team on the construction technique. However installation time per column by the end was just 25 minutes, this was a full cycle which included tramping to the preparation area, securing the column with the Redigrip, tramping the column back to installation location, aligning and bolting down. Whilst there were several issues which impacted on the construction programme, the erection of the steel frame work was achieved in less time than programmed. The heaviest section of steel handled on this project was a 350WC197 beam at 5.6m long with a weight of 1.1 tonnes, which the Redigrip handled with ease.



I-Beam installation on site

During the design risk assessment, it was identified that dropping a hydraulically controlled beam was a significant risk, as hydraulic pressure could be lost due to:

1. Engine failure
2. Hydraulic system failure, including blown hose.
3. Unintended release of clamp (operator error) or
4. Electrical or control failure.

Contingencies were included in the design to prevent beam movement in the event of any of these failures.

The following controls were put in place to mitigate these risks:

- The clamp has inbuilt load check valves which are attached directly to the clamp body;
- The clamp control valve is 2 way normally open valve, meaning that with loss of electrical power, hydraulic pressure is still directed to the clamp;
- The controls for clamping / unclamping are safety latched, requiring two separate movements in sequence by the operator to open the clamp. Which was also accompanied by a time delay;
- The clamping circuit is fed from the main system hydraulics of the L120 through a check valve. The circuit has 2 accumulators and a pressure switch. The result is that if the L120 suffers hydraulic system pressure loss, the check valve will not allow clamp pressure to be drained back through the L120 system, while the accumulators will account for any leakage in the clamp circuit itself;
- The pressure switch is attached to a warning light in the cabin and red and green lights outside on the front of the cabin. The light in the cabin warns the operator if clamp circuit pressure is below optimum. The red and green lights on the front of the cabin above the windscreen are controlled by the pressure switch and also by a manual switch in the cab. The red light would be turned on by the operator whenever he is operating the Redigrip. Once the beam is positioned ready for riggers to install the bolts the green light is turned on and the red light is turned off. In this way the crew knows when it is safe to approach the clamped beam.

Underground workshop crane structure installation



Benefits

The Redigrip PSM had numerous benefits to the safety of the project and an efficient construction program, including:

1. Eliminating the use of a conventional crane in a confined space with very little headroom;
2. Eliminating the use of slings for moving horizontal and vertical beams;
3. Eliminating personnel from the traveling areas of suspended loads;
4. Positively controlling the fine degree movements which reduced the risks associated with adjusting or manoeuvring a load to align bolt holes;
5. Eliminate damage to the painted and prepared surfaces of the steel structure with the use of a non-slip rubber seat and neoprene gripper finger pads.
6. Minimising personnel exposed to potential manual handling, nip-point, and crush type injuries.
7. Reduced personnel required for the project, thereby reducing costs and potential for injury;
8. An efficient installation cycle due to positive beam control and minute adjustment ability, for trouble-free bolt hole alignment; and
9. Equipment flexibility, whereby the utilised L120 FEL was also a project forklift, loader, man basket and the specialised steel work installation tool. The L120 FEL used was able to be returned to other duties within 15 minutes on this project, where it worked with the dayshift service crew performing normal duties and installing steelwork on nightshift with the installation crew.

The use of the Redigrip PSM ensured the new 10 tonne gantry crane structure was assembled without incident and within program, to the satisfaction of the both the customer and Redpath, whilst offering the lowest construction risk solution possible.

Transferability

The Redigrip has many safety and productivity benefits that are not just restricted to the underground mining environment. With minor modifications this unit could be used for ground support steel-set erection, installation of large rising main pipes and paste fill delivery lines.

There is also the option to use the Redigrip in sheds and fixed plant installations on the surface. This can be done with minimal modifications for safe, flexible and rapid steel structure erection. The Redigrip could also be suited for use with a Telehandler, which would allow greater flexibility with potentially larger sections and greater lifting heights achievable.

Innovation

The principle innovation in the Redigrip PSM is in the unusual combinations of components and systems. As previously mentioned the primary component is an Engcon rotatilt 15 tonne excavator attachment, which gave the main range of movements. However the beam grab component was actually a forest industry product that was engineered to attach where an excavator bucket would typically sit. These two elements were then fitted to a manufactured beam which was designed to fit inside the OEM jib attachment on the Volvo and be hydraulically controlled to slide, which gave the additional telescopic movement.

Two additional hydraulic functions (the machine as a standard has two) were also added to the Volvo L120, which now gave boom slide and attachment tilt to the already raise/lower and bucket tip functions.

The Redigrip was controlled by an added Joystick and PLC which allowed fine adjustments via proportional solenoid valves. However, the rotatilt was designed for open centre hydraulics common with an excavator axillary circuit, not the load sensing hydraulics of the FEL. This was overcome by the innovative addition of a proportional solenoid valve controlled by the PLC which electronically manipulated the load sensing hydraulics to be able to operate all the movements necessary.

The combination of components and systems then allowed the Redigrip a 360 degree rotation; 40 degree side tilt left and right; 140 mm side shift; 180 degree primary tilt and 600mm of telescopic extension, to a height in excess of 8 meters.

Cost

The approximate cost to design, develop, and manufacture the total Redigrip PSM package, including the additions of purpose fitting the control systems to the FEL, was \$124,000.