Using Automated CAD Modelling to Meet Client Requirements

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Abstract

Aspec Engineering (ASPEC) was engaged to provide engineering support to a client that was upgrading part of their wharf-based rail infrastructure. ASPEC was responsible for the design of replacement rail support sole plates which had to interface with existing hold down bolts in the wharf. This required producing CAD models for roughly 1200 individual sole plates that were all unique. ASPEC opted to use an automated CAD solution where all the modelling and files were created by computer code that was written in-house. The code took 3D point cloud survey data of the existing hold down bolt locations and generated the CAD files for input into the manufacturing process. By leveraging several advantages provided by the automated process, the project engineering was completed on time with no errors.

1. Introduction

Aspec Engineering (ASPEC) recently completed a project assisting one of their clients to upgrade a section of their wharf-based rail infrastructure. The project involved the following items:

- the replacement of worn rails,
- the replacement of corroded sole plates and sole plate grout and
- the improvement of the rail realignment.

In addition to the replacement of rail components, the project also involved a redesign of the rail support system to improve the clearance envelope around the rail to allow the installation of long travel rail clamps on the wharf machinery. The major engineering component for the project was the design of a new set of sole plates. The sole plates are steel plates that bolt to the concrete structure beneath them and support the rail above. The sole plates are also fitted with weld-on rail clips that locate the rail horizontally and jacking bolts to aid with installation. A photo of the sole plates after their initial positioning is shown in Figure 1.

The new sole plate design was required to interface to the existing fastener infrastructure that was cast into the concrete structure below the rail. Here, the angle bolts, shown in Figure 1, were a particular challenge. The position of the rail clips was also carefully considered so that the new rail could be installed closer to its design alignment while also allowing adjustments to align the new rail with existing rails on adjacent wharves.

The 3D scan of the existing infrastructure showed that the design would be complicated by the irregular alignment of the existing fastener locations in the concrete wharf structure. This meant that the design of every one of the roughly 1200 sole plates would be unique. Thus, the potential for drafting errors was high and the sheer amount of work required to manually produce a set of models and files for profile cutting would have been excessive. Also, the short timeframe of the project would have precluded any changes or updates to the design if drafting had been carried out manually.

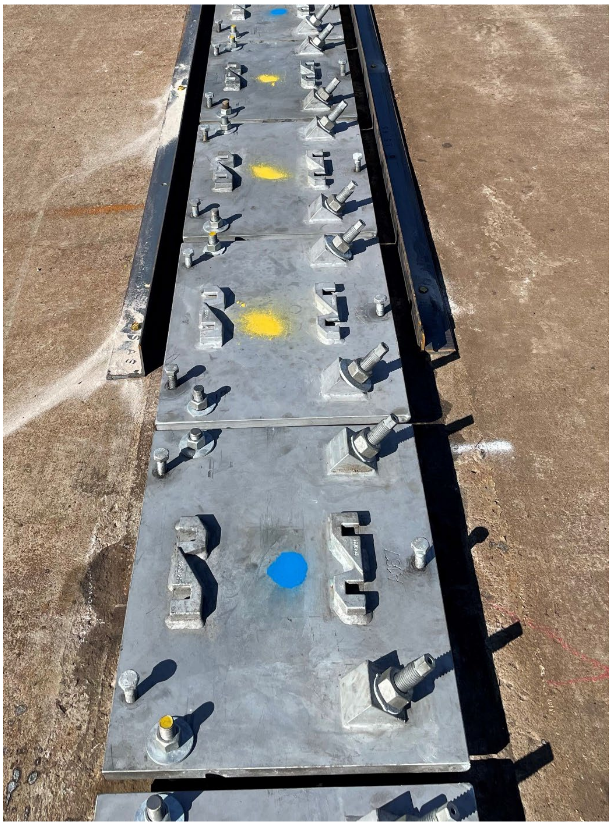

Figure 1. Rail sole plates during installation.

ASPEC had previous experience with wharf rail upgrade projects. These projects were conducted manually for smaller lengths of rail which also included the irregular fastener alignment of the current project. These projects took a great amount of time to produce the irregular sole plate design drawings and it was obvious that manual generation of roughly 20 times more sole plates for the new project would cause schedule issues. To relieve this problem, it was decided to employ automated CAD modelling – computer code – to draw the plates.

1.1 Automated CAD Design

The development of the sole plate profiles was part of an involved process which is simplified into four major steps shown in Figure 2. The process began by determining the location of the existing fasteners. This was carried out by surveyors via 3D laser scanner. The resulting point cloud was then manually manipulated to determine the centre locations for the vertical fasteners on one side of each rail and the angled fasteners on the other side as well as the alignment of the two rails. The coordinates were then read by a custom coded program that read the vertical fastener coordinates and plotted a circle at each point. The position of the angled bolts was then used to plot the location of the rectangular cut out. Finally, based on the location of the fasteners, the outside edge of each plate and the three jacking bolt locations were plotted along with the unique plate number and the rail clip position outline. These details can be seen in the drawing of plate A30 shown in Figure 3.

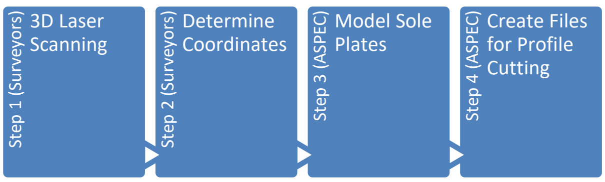

Figure 2. Key project steps.

The time savings in using automatically generated drawings are obvious, however, there were several other benefits presented by the process. Chief among these was the reduction, and ultimately elimination, of errors. Since all the files were created with the same code, once it was proven that a small number of plates had been drawn correctly, it could be relied upon that the remaining files would also be correct. This would not be true for hand drawn sole plates as each plate would require independent verification at each design iteration.

The DXF files produced for each plate were fed directly into the plate profiling process; however, details of each plate were required for quality assurance (QA) and future reference. The development of the QA data was made easy using automated CAD design. To verify the plates were cut and fabricated correctly, a table of dimensions was produced for each plate. The programming generated the required dimensions as part of the sole plate drawing process, and it was a simple matter to write these dimensions into a table that could be used by the profile cutters and fabricators to verify their work.

The automated CAD design solution also allowed the design to evolve as more information became available or when the design concept changed. After the programming was completed for the first iteration of the sole plate design, the design changed several times to optimise the project outcomes. The new designs were programmed over a few days and a complete set of sole plate files conforming to the new design became available. Minor changes were also possible, particularly the rectangular cut-outs which changed several times throughout the process. These changes were made in short time frames, with a new full set of part files being available immediately upon completion of programming.

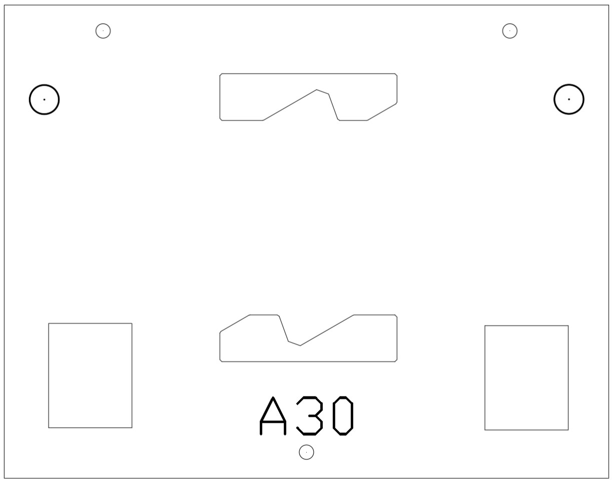

Figure 3. A typical sole plate profile.

The data that was generated by the automated CAD design program was useful for other parts of the project as well. For instance, the program data was used to quickly calculate the volume of grout based on the survey data and assisted with planning for the new rail alignment and rail transitions to the existing rail on adjacent wharves. Once the new rail alignment was decided, the program was used to add the rail clip outlines to each sole plate to assist with rail clip positioning during fabrication. Additionally, the program was used to determine the coordinate locations of each plate so that installation of the sole plates could be progressed from multiple points along the rail rather than from one end to the other in numerical order. New rail coordinates were also easily generated to assist the surveyors with the alignment of the new rail to the agreed alignment.

2. Conclusion

The rail upgrade project was ultimately completed several weeks ahead of schedule. This was in large part due to the ability to produce fast sole plate design updates with a high degree of accuracy which allowed refinement of the design to achieve optimised installation outcomes. The incorporation of automated CAD design programming techniques to produce the part files enabled the required design updates and the production of files before the deadline for fabrication of the sole plates. The availability of accurate QA data assisted the fabricators to verify the plate dimensions quickly and the procedurally generated sole plate coordinates and rail alignment assisted with the fast installation of the new sole plates and rails. A view of the completed installation of the sole plates is shown in Figure 4.

Figure 4. Completed sole plate installation after grouting and rail installation.

Ultimately, the use of automated CAD design procedures to generate the sole plate designs with computer code proved to be highly successful. Future rail upgrade projects and any other projects that lend themselves to creation of components using automated CAD design processes will benefit from using these design methods and lessons that were learnt during this project.

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