RailKonsult

Office of Rail Regulation

Review of European Renewal and Maintenance Methodologies Technical Appendix Number 5

High Output Stressing

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Executive Summary

This paper is one of a series commissioned by the Office of Rail Regulation in order to gain an improved understanding of the maintenance renewal techniques used outside Great Britain. These reports have been produced as part of the PR08 process.

The CP4 settlement will require the industry to achieve further efficiency savings in the delivery of track renewal items. These will be achieved by working smarter, better, faster and safer, using process flow and production line techniques.

This report focuses on the use of rail heaters to provide the required rail stress, in combination with mobile flash butt welding equipment. This approach is an example of production line techniques adopted in Europe.

The process involves the use of rail trolleys fitted with gas heaters. These are passed over the rail at a suitable speed such that the rail is heated up to the required temperature. This can be determined by the use of suitably marked tell-tales on the rails.

The benefits identified through the use of this system include:

- Stressing and welding activities can be undertaken in parallel, reducing the time required for the overall operation;
- Mechanisation of the process reduces the resource requirements, particularly manpower; and
- Standardised approach within a production line environment facilitates the use of dedicated resources, leading to improvements in productivity, quality and safety;

Adoption of heater stressing process also facilitates the use of the mobile flash butt welding technique. This also provides benefits such as improved weld quality, welds that can be inspected using standard non-destructive testing methods and reduced unit costs where a significant number of welds are required.

In addition to the need to progress through the normal approval processes for new plant and processes, the main implementation issues are concerned with culture. High performance, dedicated teams need to be formed that have a regular work-bank of stressing items to deliver.

Cost savings achievable in connection with the stressing operation of a track renewal item, where re-railing forms part of the specified work package, are estimated to be approximately £10k per item. If this is applied to a yearly program of work where re-railing was part of the specification, savings approaching £9 million per annum could be achievable by introducing this process.

Acknowledgements

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1.0 HEATER STRESSING

1.1 Rail Stressing

All continuous welded rail (CWR) installed on a railway infrastructure is subject to internal stresses caused by seasonal variations in temperature. In order to prevent the possibility of track buckles due to expansion, or rail breaks due to contraction, all CWR on the rail network needs to be stressed to a "stress free temperature" (SFT). This is defined in Britain as being within the range of 21° to 27° centigrade. (27°C to 32°C for crimp ended steel sleepers).

Network Rail standard NR/SP/TRK/011, issue 5, June 2006, defines the requirements for design, installation and maintenance of CWR and specifies the methods to be used when stressing CWR in both plain line and switch and crossings.

These methods are:

- Tensor stressing;

  This is a process whereby the CWR is stretched with hydraulic tensors, so that the stress free temperature of the rails is at the upper permitted limit of SFT.
- Natural stressing;

  This involves clipping down the CWR, without tensors being used, when the rail temperature is within the permitted limits for SFT.
- Thermal stressing;

  In this process the rails are heated to the upper permitted limit for SFT and secured.
- Stress restoration.

  This method involves stretching the CWR back to the same length it was, so that the SFT of the rails is the same as is was before it was disturbed (this approach is used predominantly when replacing short sections of rail).

Whilst references are made to specific products and systems that are in use in particular countries, there may be other products available that provide a similar functionality. The report does not review available alternatives, or their comparative merits. The case studies are included as being indicative of alternative approaches in asset management.

1.2 Extent of Methodology

Whilst thermal stressing is mentioned in the Network Rail Standard, it is certainly not commonplace in Great Britain. However, it is widely used across Europe in conjunction with mobile flash butt welding. Here it is seen as a high productivity, low cost method of undertaking stressing of CWR.

The heater stressing process, combined with the flash butt welding, is routinely used in Switzerland and Germany as the prime method of stressing rails. Other countries that use the process, although not as the preferred method, include the Netherlands, Spain, Italy, Turkey, Greece, Denmark, Norway, Sweden and France.

1.3 Applicability

Thermal, or heater stressing, is predominantly a renewal system.

Stressing undertaken under maintenance is usually restricted to when short sections of new rail are installed for rail defect removal. This would entail using the stress restoration method as detailed above. However, it is applicable to maintenance situations where long lengths of rail require stress restoration as a consequence of a track disturbance.

2.0 EUROPEAN APPROACH

2.1 Method Deployed

Stressing of CWR is carried out as a subsequent operation after the new track has been laid, stoned up and tamped to its final height. This ensures that there is no significant change in stress due to changes in track position and that there is less likelihood of alignment problems during the welding process.

Generally, the rails are not welded during the core renewal possession and are left clamped ready for stressing and welding in strings in follow up possessions.

To commence the heater stressing process the rails are unclipped, rail clamps removed and the rail end web areas ground for effective electrode contact by the flash butt welding head.

The first new pair of rails are flash butt welded to the existing rails, this creates a fixed point for the stressing to commence from to enable expansion of the rail to move in one direction away from the fixed point.

Heat is then applied to the first pair of rails by means of purpose built heater trolleys. Heat is applied in order to expand the rails to the upper limit of the SFT.

Picture: Rail heater trolley in action

Once the required extension has been achieved on the first pair of rails, they are clipped down and the next the pair of rails flash butt-welded. This creates the next fixed point from which to commence stressing.

This cycle continues until all the new rails have been stressed to the upper limit of the SFT, with the final two welds are installed using the thermic welding process with hydraulic stressing equipment to hold the rails in tension. This process is required for the final two welds because most of the existing European flash butt welding machines do not have the capability to hold the rails in tension while flash butt welding takes place.

The development of super pullers incorporated within the flash butt welding equipment is currently being investigated. Super pullers would allow the final two welds to be flash butt welded by means of holding the rail in tension while the flash butt welding takes place, this would eliminate the need for the final two welds to be completed by the thermic welding process.

A process flow diagram is attached as appendix A, this shows that a typical site in Europe uses a total of 8 track operatives for clipping and unclipping, 1 team of 2 welders to prepare the rail ends and undertake the final thermic weld, I member of technical staff to calculate the rail extension, 2 staff to operate the heater trolleys and 2 operators for the MFBW to undertake the welding and grinding operations. Total = 15 staff.

2.2 Management Approach

Dedicated teams are used to deliver the process resulting in high productivity, high quality and low unit costs. Stressing rates in excess of 300 metres/hour are achieved using this approach. This means that up to 2 kilometres of track can be stressed and welded within an 8-hour possession.

2.3 Technology Involved

In essence the technology concerning the heater stressing element of the process is very simple. Mechanised trolleys apply heat to the rails by means of a gas powered flame that can be controlled by the operator. Tell tale marks, that detail the extension required to achieve the stress free temperature, are placed on the rail at 50 metre intervals. The technical engineer monitors these to ensure that the extension is achieved before the rails are clipped down.

3.0 CURRENT BRITISH APPROACH

3.1 Construction Methodology

The most commonly used method of stressing in Great Britain currently is tensor stressing. The rails are:

- Unclipped;
- Placed on rollers to assist movement;
- Pulled using hydraulic tensors to a calculated extension (equivalent to the upper SFT limit);
- The rails are then held in place with the hydraulic tensors whilst they are welded using the thermic welding process;
- Rollers are then removed; and
- Rails clipped down.

The emphasis on this approach being to utilise large numbers of labour (24 men per shift) to undertake the clipping / unclipping process due to the fact that the whole site has to be prepared before the stressing and welding operation can take place

3.2 Management Approach

Stressing of rails on renewals sites is most commonly planned and undertaken in subsequent possessions, as a follow up activity to the core possession. It cannot be used on the core possession as a parallel activity as all but the last two stressing welds need to be completed before tensor stressing can take place. Therefore the stressing operation would have to wait until all these welds are complete before the process can begin.

3.3 Technology Involved

As noted above, the use of existing hydraulic tensor equipment combined with the thermic welding technique is extensively used. MBFW is gradually starting to develop in GB, albeit to a far lesser extent than is currently used in Europe.

4.0 BENEFITS

4.1 Asset Management

As noted below, the mobile flash butt welding process produces higher quality welds more reliably. This reduces the number of potential broken welds that occur as a consequence of the thermic welding process.

Additionally, flash butt welds are formed using the parent metal of the rail. This makes them capable of being inspected by standard ultrasonic techniques. Thus, the risk of undetected flaws within welds is reduced.

The heater stressing process provides an improved distribution of extension within the rails, giving a better equalisation of stress, when compared with the tensor technique.

Undertaking renewal work, that includes replacing the rail, is done all year round. During warmer weather periods speed restrictions have to be applied if the rail has not been stressed due to the rail reaching a calculated critical rail temperature (CRT). If the stressing operation is undertaken at the same time as the core renewal work, (particularly re-railing work) it would eliminate these types of speed restrictions completely.

High output stressing could be used to follow the high output track relaying systems currently being used by Network Rail, thus preventing TSR's or ESR's being imposed.

The system fits into Network Rail's 7-day railway strategy with the ability to undertake 2 kilometres of stressing and welding in an 8-hour possession.

4.2 Efficiency Savings

This section is not intended to provide a rigorous business case assessment. For example, capital investment requirements are excluded and no discounted cashflows have been considered. It is, however, included to provide an indicative view of the potential operational opportunity available if similar approaches were adopted in Britain.

A standardised approach using a dedicated team to undertake the process is proven to bring about excellent production rates and lower costs. The process is an efficient production line technique due to the way the work flows through a logical sequence of activities

It would be possible to double the current British output for stressing activities by using the high output heater stressing methodology. For example, it would take 8 hours to undertake 1,000 metres of tensor stressing, whereas 2000 metres of heater stressing could be done in the same time. This increase in production together with a reduction in manpower due to a mechanised, production line process will lead to excellent efficiencies.

Cost savings achievable in connection with the stressing operation of a track renewal item are estimated to be approximately £10k per item. These savings will be achieved from:

- Reduction in manpower;
- Removal of the need for welders in the core possession; and
- Reduction in the number of follow up shifts required.

The methodology would not be suitable for all category of renewals work as its efficiency gain is on sites where re-railing has formed part of the specified package of work. In other words it could be used on:

Category 2 – Re-rail both rails
Category 4 – Steel sleeper relay
Category 6 – Re-rail, reballast (by traxcavation)
Category 10 – Reballast, resleeper, rerail (using ballast cleaner)
Category 11 – Reballast, resleeper, rerail (by traxcavation)
Category 14 – Formation, reballast, resleeper, rerail (by traxcavation)
Category 16 – Rerail, resleeper (concrete)

Table of savings

Work category	Estimated number of jobs per annum	Savings per annum (£k)
2	222	2220
4	202	2020
6	6	60
10	140	1400
11	245	2450
14	34	340
16	29	290
	Total	8780

When undertaking re-railing work (Category 2), the process can be used as a parallel activity that will allow stressing to be undertaken within the core work possession. This will eliminate the need for any follow-up possessions.

The heater stressing system would also complement the 8-200 Project by means of undertaking stressing in one shift following a number of weeknights relaying.

4.3 Life Cycle Costs

The mobile flash butt weld is effectively a quality factory weld performed on site using the parent material to perform a bond. This will enhance the life of the rail compared to the cast thermic welding process that introduces different material into the rail section.

Even stress distribution via the heater stressing process will remove the possibility of short sections of rail being subject to higher stresses, which could result in internal defect growth.

5.0 SAFETY ISSUES

The production line process will result in far less staff on site thus reducing the risk of accidents.

As already discussed, better quality welds are installed by using the flash butt welding process. This will reduce the likelihood of rail breaks due to the inferior cast thermic welding process.

6.0 IMPLEMENTATION INTO GREAT BRITAIN

6.1 Estimated Implementation Duration

As thermal stressing is already covered in the Network Rail standard, it should not be too difficult to introduce the thermal stressing methodology into Britain.

Mobile flash butt welders are already being used in the UK and Network Rail Engineers proactively back their use, as it is a technique that produces a better quality weld than the thermic welding process.

Heater stressing has already been tried by a number of contractors, with varying degrees of success to date (see section 6.2 below).

6.2 Constraints and Dependencies

Heater stressing as a technique is not new to the British rail industry, as it has been used in the past. However, it is not seen currently as best practice by staff currently undertaking stressing activities.

As such, there will be a cultural factor involved in its introduction into Great Britain. As with all changes, the benefits of the revised process will need to be proved to the delivery teams before it successfully adopted.

The process also requires dedicated teams, delivering this activity on a regular basis. Initial trials to date have already indicated the extent of the learning curve that such a team needs to climb. These teams need to be able to persevere to achieve the proven productivity rates, which require a regular work-bank of jobs and a consistent roster of team members. The current British track renewals environment does not routinely provide these opportunities to individual teams.

Since short-term efficiency is a key driver in the rail industry today, initial trial and set up costs of training and additional equipment may be seen as inhibitive to the introduction of heater stressing.

The current product approval process may slow down the introduction of items such as the mechanised heater trolleys, although manual trolleys already have trial approval status.

6.3 Investment Requirements

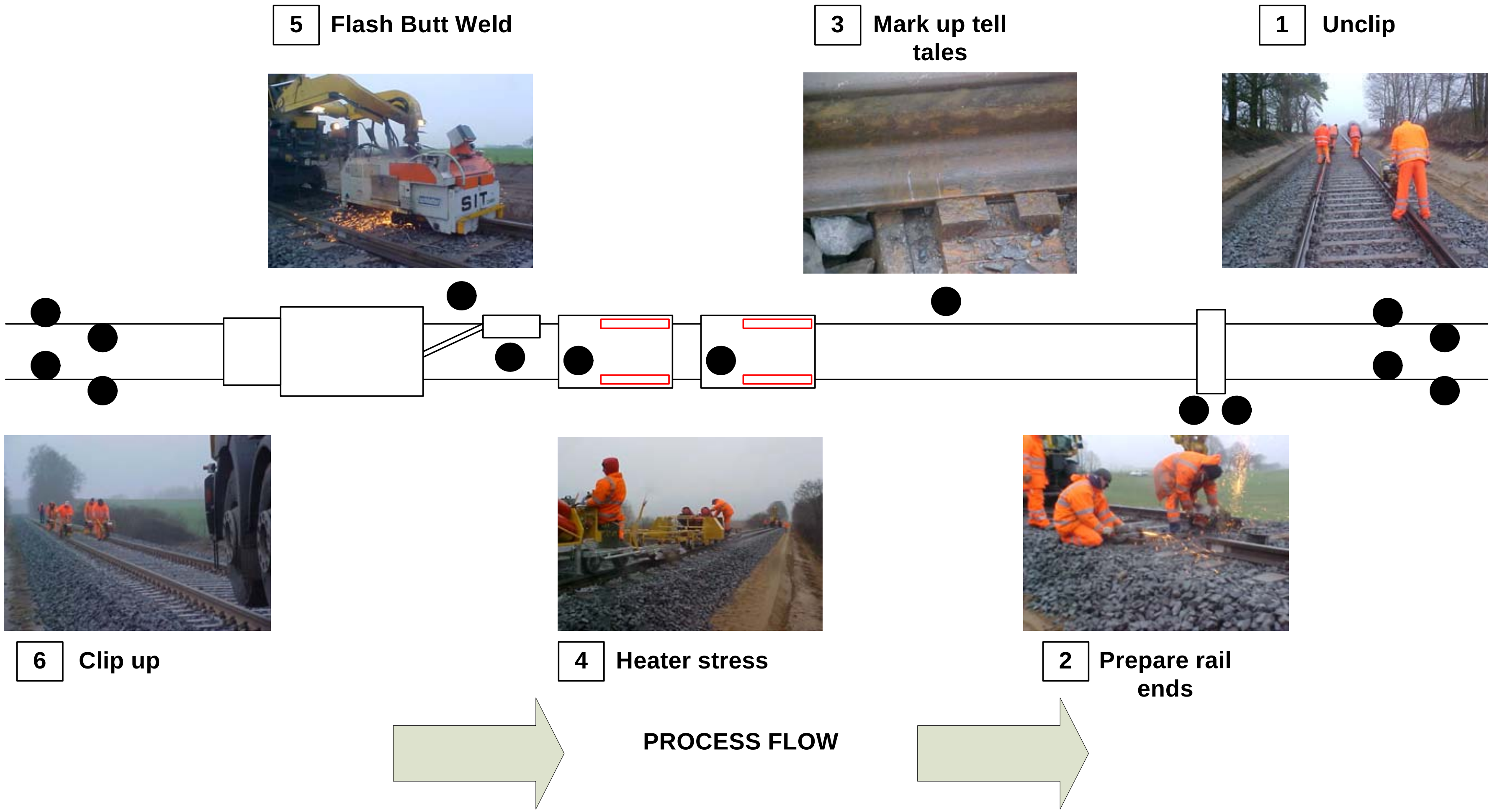
There will be minimal investment requirements needed in order to introduce heater stressing into Britain. There are already a number of mobile flash butt welders available in the country and the cost of mechanised heater trolleys is low in comparison with the prospective efficiency gains that could be gained by utilising the heater stressing process. It would be envisaged that the equipment would be purchased by suppliers and then hired in as part of the package, this hire in rate has been taken into account when calculating the shift savings.

7.0 RECOMMENDATIONS FOR FURTHER WORK

The following particular approaches are proposed as potential areas for further study:

- Efficiencies gained in Germany and Switzerland from using high output heater stressing;
- Scheutzer high output re-railing system that incorporates MFBW and induction stressing;
- Proposed thermal regulation process being developed by Mermec in Italy.

APPENDIX 1: HEATER STRESSING PROCESS FLOW DIAGRAM



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