RailKonsult

Office of Rail Regulation

Review of European Renewal and Maintenance Methodologies
Technical Appendix Number 3

Partial Renewal Process for Switch and Crossings

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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 maintenance and renewal techniques used outside Great Britain. These reports have been produced as part of the PR08 process.

This report focuses on the use of partial renewal techniques elsewhere in Europe, particularly the Swiss approach.

Partial renewal of switch and crossing layouts generally focuses on the life extension of two components: ballast and timber bearers. Periodic replacement of the ironwork is a standard maintenance activity.

A method of rehabilitating timber bearers has been developed that enables vertical and horizontal alignment to be returned to construction tolerances. Vacuum technology has been developed to efficiently replace life expired ballast in Scandinavia. Under-pinning both processes is a philosophy of achieving an extended life through targeted renewal of life expired components to eliminate vibration and movement.

The benefits identified through the adoption of partial renewal techniques include:

- Postponing need to undertake an expensive complete renewal;
- Reduction in plant, materials and manpower requirements (compared to complete renewal);
- An excavation technique that does not damage buried services; and
- Avoiding premature renewal of individual components.

The required technology is already available and in trial use within Britain, although issues with respect to the reduced loading gauge restrict the use of the current vacuum plant.

However, in order to adopt this philosophy there is a need to develop a suitable work-bank of jobs and convert this into a work programme for delivery. A prerequisite of this will be the development of engineering tools to determine the suitability of each site. This knowledge is available and experience can also be transferred from Europe.

It is anticipated that the partial renewal techniques discussed in this report would provide savings on S&C renewal costs in the order of 13% through deferring full renewals. Further savings would also be obtained from reduced maintenance activity.

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1.0 PARTIAL RENEWALS

1.1 Partial Renewal of S&C

The complete renewal of switch and crossing layouts is expensive and requires extensive track access in order to complete. Network Rail is already addressing this issue with the introduction of the modular S&C concept. This will go a long way towards achieving the efficiencies required and enabling the work to be done in shorter possessions, as well as delivering higher quality.

However, the complete renewal of the switch and crossing assets can result in the replacement of components that are not life expired. Partial renewal is one process that would extend the life of these assets and introduce more efficient ways of dealing with the infrastructure.

Network Rail's 2005 Business Plan indicated that in the year 2006/07 a target of 83 switch and crossing units would receive partial renewal treatment. However, the actual number of units achieved was significantly less.

The term "heavy maintenance" has been used in the past where switch and crossing work has needed attention to prevent speeds from being imposed, i.e. when some components are close to being life expired. This work traditionally consists of activities such as changing timbers, replacing discrete items of ironwork and welding up jointed crossings in order to achieve better track quality.

However, without proper engineering input, there is a risk that this work only addresses the symptoms of poor track quality and not the root cause. The major reason for deterioration of switch and crossing components is the condition of the ballast supporting the structure resulting in increasing vibration, movement and wear of the components.

Elsewhere in Europe there are items of plant in general use that can reballast switch and crossing assets with the track remaining insitu. This provides a cost effective solution to the support problems.

There is also a system used extensively in Europe that addresses the problem of wear and tear of wood sleepers and timber bearers by means of a re-sinification process of the screw holes. This system effectively breaths life into the wood of the sleepers or timbers by means of a new screw insert and the placement of resin to reinforce the screw hold. The track is returned to within construction standards thus improving track quality and extending the life of the ironwork through less wear.

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

The two case studies described in this report are specific to the localities mentioned, i.e. Scandinavia for use of vacuum technology for ballast replacement and northern Europe for the treatment of timber bearers. However, both techniques are specific examples of an overall philosophy to maximise the life of a system by paying attention to the life-expired sub-system elements.

1.3 Applicability

Partial renewal falls into a category of its own. It is generally not extensive enough to be considered a renewal item, but the scope of work undertaken extends beyond the normal limits of maintenance activities.

It is believed that it is because of this dilemma that it tends to be considered as neither a maintenance nor renewal activity, thus suffering from lack of budget availability.

2.0 EUROPEAN APPROACH

2.1 Method Deployed

2.1.1 Ballast Cleaning

Reballasting of switch and crossings using a high-powered rail mounted vacuum machine is common practice in Scandinavia and other parts of Europe.

This methodology allows for re-ballasting to take place whilst the track remains insitu, thus negating the need for expensive plant for track removal and other necessary follow up work such as stressing and welding. It also removes the need for any S&T disconnections as the machine can excavate around obstructions without causing any damage.

A single lead can be re-ballasted in 12 hours and the methodology also allows for formation stiffening such as geo grid to be installed whilst the re-ballasting is taking place.

2.1.2 Timber Sleepers / Bearers

Re-sinification of screw holes on wood timbered switch and crossing layouts, better known as the “second life system” (SLS) or “timber life extension”, is currently undertaken in Germany and Switzerland. It addresses gauge and alignment variations caused by problems such as indentation, base plate shuffle and screw hole elongation. Similar systems are also in use in other countries such as the Netherlands, Austria, Denmark, Sweden and Norway. The system has also been recently introduced into Italy, Spain and France.

Using this system, layouts can be returned to construction track quality standards, whilst reducing the need for expensive timber replacement. This is achieved by means of re-drilling base plate screw holes so that the ironwork can be reset to correct gauge and alignment. New screws are then inserted and held in place by means of a special screw insert and a fast setting resin added.

Vertical problems caused by base plate indentation of the timbers are corrected by means of varying depth lupolin pads that are inserted beneath the affected base plates. This method can also be used to correct out of plane situations in switch and crossings caused by bowed timbers.

A complete lead can be treated in an 8-hour possession with 6 men, without the need for the imposition of any speed restrictions.

2.2 Management Approach

Taking Switzerland as an example, the decision on whether to undertake partial renewal or complete renewal commences with the local SBB track engineer. If the asset has deteriorated below the relevant safety and quality standard then a request is made to the central SBB technical engineering department for work to take place.

It is important to note at this point that there is no differentiation between maintenance and construction standards in Switzerland. There are only two issues to be considered. These are safety and track quality levels, both of which are clearly defined by SBB.

The request is verified by the central technical engineering department and a decision is made on whether to undertake complete or partial renewal of the asset.

The life cycle of switch and crossing assets in Switzerland is expected to be between 20 and 50 years, dependant on line speed and tonnage. Partial renewal is undertaken to ensure that the asset achieves its design life cycle. The second life system is used to give a further 5 to 10 years life of the switch and crossing units. This will normally be accompanied by some ironwork replacement.

Partial renewal is not restricted to lower category routes in Switzerland. If a switch and crossing asset on a high-speed route requires partial renewal in order to achieve its life cycle, then the process is applied.

In the Netherlands, partial renewal is not undertaken on primary routes but they have a policy to always undertake partial renewal on switch and crossings in lower category lines up to speeds of 40 km/hour, rather than renew.

For both the SLS process and the vacuum reballasting technique, specialist dedicated teams are used to deliver the work. This approach provides high levels of productivity and quality levels (see separate report on the benefits of using dedicated teams).

2.3 Technology Involved

High powered vacuum equipment, developed by a Swedish company, is used on a rail mounted vehicle for the reballasting process.

The SLS system is a very simple system that incorporates the use of small low cost plant in the form of tie bars, jacks, drilling machines and screw removal and replacement equipment. All parts of the process are mechanised as far as possible in order to speed up the process.

3.0 CURRENT BRITISH APPROACH

3.1 Construction Methodology

Switch and crossing reballasting has previously been undertaken in Britain using specialist ballast cleaners or track gophers. These items of plant are no longer in use and the specification of reballasting only on switch and crossing is rarely used. The preferred option now is to undertake complete renewal, even if the timbers and ironwork are not fully life expired.

Heavy maintenance is often undertaken, but this type of work does not always solve the underlying problem. Replacing various timbers and sections of ironwork will stiffen up the switch and crossing unit but will not address the gauge, alignment and voiding problems that are likely to be inherent in the layout.

Thus there is very little long-term improvement in track quality and the work undertaken will not prevent the rapid deterioration of the new and existing components.

3.2 Management Approach

Heavy maintenance work is generally programmed and carried out by Network Rail maintenance teams and the work tends to be location specific, rather than campaign-led.

Partial renewal has only recently been identified as a possible solution for inclusion within the renewals budget. As with any work bank, identification of suitable sites and specification of work takes time to develop

3.3 Technology Involved

The limited life extension work undertaken in Britain is generally delivered by manual means, with the support of multi-purpose road rail machines where appropriate. However, trials of the technology and methods discussed in this report have been undertaken on Network Rail's infrastructure (see section 6).

4.0 BENEFITS

4.1 Asset Management

The rail mounted vacuum machine is ideal for undertaking half-life re-ballasting, thus extending the life of switch and crossing by solving the support problem caused by degraded and sub standard ballast conditions. This can be achieved on both timber and concrete bearer layouts.

Leaving the layout insitu means that there is no requirement for any S&T disconnections or follow up welding and stressing. Any unidentified cable or utilities buried underneath the track will not be damaged or cut when using this methodology.

This method can be used in much reduced possession access time, thus lending itself to the 7-day railway concept.

The second life system provides the capability to return timber bearer switch and crossing layouts to construction standards with respect to gauge and alignment. This will have the affect of improving track quality, reducing any excessive wear of the ironwork that could lead to premature replacement and hence reducing the need for maintenance intervention.

If half-life re-ballasting is combined with second life system on wood timber layouts, it will further enhance the life of the switch and crossing and reduce the maintenance requirements.

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.

Half-life reballasting of switch and crossing units with the rail mounted vacuum equipment has been shown to be approximately 60% of the cost of conventional reballasting methods.

Where utilised, the second life system removes the need for expensive timber replacement and removes the need for premature replacement of ironwork and associated components due to improved wide quality through the switch and crossing layout following reinstatement of good track geometry with respect to gauge and alignment.

Both systems are partial renewal methodologies that would give potential savings if they were applied at set levels of intervention in the life of the switch and crossing unit.

For example, on a switch and crossing unit with an expected life of 30 years, if reballasting using the vacuum equipment was undertaken after 20 years life, it is expected that the unit will last 10 years longer. This will have the effect of undertaking one less renewal over a 120 year period (see chart below). Note that the extended timescale used is solely to return to a point where full renewal is required whichever model is adopted.

Years	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120
Renew only	R						R						R						R						R
Reballast & Renew	R				B				R				B				R				B				R

On the basis that a complete unit renewal costs £450k, whereas vacuum re-ballast of a unit is only £70k, a simple life cycle cost comparison over 120 years is:

Cost of renewal only [4 at £450k] is £1,800k;
Cost of renewal and “half life” reballast [3 at £450k and 3 at £70k] is £1,560k.

Therefore partial renewal by reballasting gives 13% saving on renewal costs

Applying the second life system after 25 years will give a minimum 5 years life extension, by applying the same model to a switch and crossing unit with same life expectancy of 30 years, the following chart will apply. Note that, as above, the extended timescale is solely to enable the two approaches to be compared.

Years	0	10	20	25	30	35	40	50	60	65	70	80	90	95	105	120	130	140	150	165	175	180	190	200	210
Renew only	R				R				R				R			R			R			R			R
SLS & Renew	R			S		R			S		R			S	R		S	R		S	R			S	R

On the same basis as above, i.e. that a complete unit renewal costs £450k, whereas SLS treatment of a unit is only £30k, a simple life cycle cost comparison over 210 years is:

Cost of renewal only [7 at £450k] £3,150k
Cost of renewal and SLS treatment [6 at £450k and 6 at £30k] is £2880k

Therefore partial renewal by SLS treatment gives 8.5% saving on renewal costs

The costs used for the partial renewal processes are based on recent European supplier's prices, i.e. they do not include any allowance for overhead costs from the infrastructure manager for management of the works.

If reballasting using the rail mounted vacuum machines were to be combined with SLS treatment to give a comprehensive partial renewal it is envisaged that the quality of the switch and crossing unit would be substantially improved at relatively low cost. This would also give further cost savings, as maintenance would reduce due to the improved quality. However, the report's authors are not aware of any sites where this approach has been adopted to date.

4.3 Life Cycle Costs

Using the two methods discussed in this report will undoubtedly reduce life cycle costs as they prevent switch and crossing components from being prematurely renewed. Maintenance costs would also be reduced as the track quality is returned to construction standards thus reducing the wear and tear experienced by lower quality infrastructure.

5.0 SAFETY ISSUES

Reballasting of switch and crossing layouts using the rail mounted vacuum equipment provides significant safety benefits. The track remains insitu, removing the need for heavy lifting equipment. The machine is one man operated, thus reducing the amount of manpower required on site.

As already noted above in section 4, the method of excavation using vacuum technology also removes the risk of cable strikes or other damage to unexpected utility services.

The second life system removes the requirement for heavy manual handling techniques that have to be used when removing and replacing timbers and any necessary ironwork.

6.0 IMPLEMENTATION INTO GREAT BRITAIN

6.1 Estimated Implementation Duration

Vacuum reballasting has already been trialled in the UK with successful results with respect to productivity and cost efficiencies. However, a UIC gauge machine from Sweden has undertaken this work. As a consequence it has been restricted to sites where access is readily available.

Introduction of a W6A gauge machine to the UK will allow the machine to work and travel anywhere on the British railway infrastructure. The lead-time for construction of a new machine to this specification is understood to be 15 months.

The second life system has also been used in Britain. It was first trialled in August 2004 and has subsequently been going through the product approval process on further trial sites. Therefore implementation of this system in to Britain is believed to be imminent.

From the information available, there is currently very little in the renewals work bank for partial renewal of switch and crossing units. It will require a new approach to firstly identify and specify sites for partial renewal and, secondly, to allocate the budget to enable the work to take place.

6.2 Constraints and Dependencies

Some form of commitment to undertake this type of work is vital in order to give confidence to specialist suppliers before they are willing to invest in such equipment. Dedicated, specialist teams need to be set up to undertake the work in order to ensure that it is delivered efficiently and to the highest quality.

There may be a concern when undertaking reballasting using the vacuum technology that track quality will suffer due to a lack of compaction of the newly inserted ballast. Whilst this has been an issue, the use of crib compacters or a dynamic track stabiliser in conjunction with a tamper will overcome this problem.

As has already been stated, the second life process has been going through the product approval process since its first trial in August 2004. The slow implementation of the product approval process will delay the system being used to its full potential on partial renewal sites.

6.3 Investment Requirements

The initial investment for a new W6A vacuum rail mounted machine would cost in the region or £1.1 to £1.6 million depending on the complexity of the vehicle. If the machine is based on the currently used Swedish UIC machine, the cost would be in the region of £1.1 million. However, there are rail mounted vacuum machines used in the United States that have a conveyor system incorporated for emptying the spoil. The conveyor system would enable a further reduction in costs incurred by avoiding the need for additional road rail excavators to remove the spoil. It would also reduce the environmental problems caused by double handling of contaminated spoil. As such, it is believed that this design of machine would be the preferred option for Britain at a cost of £1.6 million.

The machine can also be used on other types of work such as wet bed removal, drainage replacement and reballasting level crossings to name but a few of its many versatile applications. Hence, the capital cost need not be solely supported by partial renewal schemes.

There will be minimal investment costs required to introduce the second life system. Suitable equipment for commencing a work programme is already available in Britain and the consumables, such as the resin, are also already available locally.

7.0 RECOMMENDATIONS FOR FURTHER WORK

It is recommended that the following additional studies are undertaken:

- Further understand the number of partial renewals undertaken in Europe compared with the British activity level, including an improved understanding of the work scopes;
- Review other partial renewal techniques undertaken in Europe; and
- Review the cost benefit analysis of work already undertaken in Europe.

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