RailKonsult

Office of Rail Regulation

Review of European Renewal and Maintenance Methodologies
Technical Appendix Number 6

Lightweight Platforms

Reference BBRT-2012-RP-0006

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.

This report focuses on the use of modular, lightweight polystyrene units to form station platforms.

The proposed enhancement programme includes a forecast of in excess of 20,000m of new or extended platforms. A lightweight modular system has been developed that has been fully product approved and is currently being used in the Netherlands.

The product consists of preformed polystyrene units with Poly Urea coating on the external sides, bedded on sand and typically finished with a tile or slab layer. Each of the platform units typically weighs 300kg.

The benefits identified through the use of this system include:

- Lightweight modules eliminate need for extensive foundation works;
- Modular approach enables quick installation times to be achieved;
- Use of standard units, rather than bespoke solutions, accelerates both design and procurement processes;
- Use of standard approach increases construction consistency and reduces construction risk;

The result of these benefits is a reduction in possession time requirements and construction costs.

Subject to confirmation that the Dutch approval process has addressed all the issues relevant to product approval in this country, it is anticipated that the system could undergo a British trial immediately.

An initial assessment of the reduction in cost compared to traditional platform construction method indicates a saving of approximately £1,100 per metre.

Acknowledgements

RailKonsult wish to acknowledge the support and assistance received from the following organisations in compiling this report:

- ProRail
- Compa Tech bv

Contents

Page

1.0 CP4 PLATFORM WORK

The proposed future enhancement programme includes an extensive work-bank that involves either the construction of new platforms or lengthening existing platforms, primarily to address capacity issues through the introduction of longer trains. This work-bank is estimated to equate to approximately 20,000 metres of new construction.

Platform construction work using current methods is expensive and generally requires a significant amount of track access to undertake.

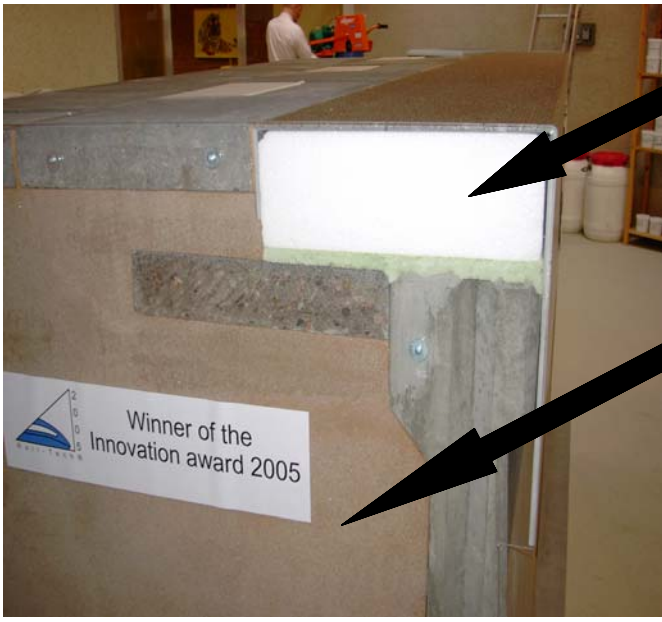
Whilst references are made to specific products and systems that are in use in particular countries, there may be other products available that provide a similar functionality. The report does not review available alternatives, or their comparative merits. The case studies are included as being indicative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

1.1 Lightweight Platforms

In the Netherlands, trials of a lightweight modular system (Comparon modular platforms) were undertaken several years ago. This system is now being used to increase the length of existing platforms.

A platform edging system has also been developed to enable platform coping stones to be replaced. This facilitates the easy adjustment of platform heights at lower cost and with significantly less possession time required (Comparand platform edging system).

The picture below illustrates the two systems both of which are patented.



Comparand (edging)

Comparon (platform)

Comparon formed platforms can have either have an edging system flush to the platform face (as shown above) or with an overhang.

1.2 Extent of Methodology

The example described in this paper represents an example of best practice observed in the Netherlands.

1.3 Applicability

These products are primarily used in connection with 'enhancement' works (i.e. for platform extension & lifting). The system also has applicability for maintenance operations such as the replacement of platform edges.

2.0 EUROPEAN APPROACH

2.1 Comparon Platforms

Platforms are constructed from a combination of modular EPS formed sections and the edging system. It is used to extend existing structures.

Each modular section is faced with a polyurea concrete finish and the platform surface is produced from tiles, slabs or any other finish required. The modular sections are bedded on a layer of sand, usually some 150mm depth. A base of EPS slabs is used to provide strength when extending platforms on particularly steep embankments.

Each modular section is usually transported to site by lorry and lifted into position with a road rail type or small excavating machine. The standard weight of a four metre by three-metre section is 300kg. A small team prepares the sand layer formation and position the units with gauges. This ensures correct alignment and compliance with the relevant structural gauge tolerances. A high production rate of is attainable, typically 10m per hour.

Obstructions, such as lighting columns or signals, are easily worked around as the units can be simply shaped with a saw.

Once the modules are in the correct position, the sections are glued together and services can be installed along the top of the units. The edging system is then applied with glue and positioning devices. Finally a sand layer is installed and a tile surface typically completes the construction.

Key to the success of the system is that the construction weight (around 500 kg/m^2) is equal to the weight of the excavated material. Thus, the necessity for extensive foundations is avoided.

The picture below shows the segments being positioned on a sand layer base. The work is being undertaken in conjunction with a platform extension.

2.2 Compa-rand Edging Systems

Compa-rand is a fibre-strengthened synthetic profile. It is used to provide the platform edge for platforms and it can also be mounted on an existing platform and provides an adjustable system. This adjustable system is designed to provide flexibility, enabling the rectification of platform construction heights or track clearances

After achieving the correct position, the edging is supported with high-grade EPS and glued to the existing platform. Experience has shown that in a short track access period, an installation rate of 12 to 18 metres of platform can be achieved. Platform surfacing can then be applied to the required height. This is the most labour-intensive operation and drives the overall time required for each project.

The picture below shows a Comparand edge being applied to an existing platform in conjunction with a lifting scheme. Work is being undertaken between trains.

Thirteen platform extensions have been constructed in Holland since 2001. Over 2,000 metres of platform edging have also been installed.

2.3 Management Approach

In the Netherlands, designs for platforms and the materials for construction are provided by the specialist supplier. Approved contractors install the system, making use of the specialist supplier as an advisor on the construction works as required.

ProRail have approved the system for use on Dutch Railways. However, they do not directly contract with the specialist supplier of the product.

2.4 Technology Involved

The design life of these platform extensions and the edging systems has been assessed as in excess of 50 years. The basis of this assessment is:

- The polystyrene used in the platform modules is of very high density and does not decay, thus it will be very durable;
- The edging system is also anticipated to be of long life with the exception of the non skid layer that needs renewing approximately every five years, which is simply accomplished;
- The side of the platform is covered with a thin layer of poly-urea coating, which is a hard synthetic material that protects the platform against damage caused during track maintenance (additionally, graffiti will not adhere to this layer); and
- There are no subsidence issues as the lightweight construction provides a weight neutral construction solution.

The solution is very useful in areas having poor ground conditions such as clay and peat. In the Netherlands poor ground conditions exist in many locations. A platform extension project at Bodegraven was built on poor ground conditions. Independent consultants have monitored this site for subsidence. There was no extra subsidence to the platform extension when compared to subsidence of the traditionally built platform.

A number of tests were undertaken to prove the safety, strength and reliability of the product. The results from these tests, plus associated calculations made for ProRail, were provided as part of the Product Release Certification process. The test requirements were defined by the product acceptance department of ProRail in Utrecht. The Dutch product acceptance procedures are based on European standardisation. A summary of these tests is attached as Appendix A to this report.

ProRail Engineers have confirmed that the performance of the Comparon and Comparand products has been satisfactory since installation was started in 2001.

3.0 CURRENT BRITISH APPROACH

3.1 Construction Methodology

Platform construction techniques currently used in Great Britain demand significant track access to undertake the works. Works generally involve the construction of footings, platforms walls and surface construction, usually with the incorporation of services.

Several different types of platform construction are approved, including modular solutions offered by Corus Rail and Stepsafe. The Network Rail Chief Engineer, Professor Andrew McNaughton, has supported the concept of modular stations and platforms. The first modular station is being undertaken at Greenhithe (opening May 2008).

3.2 Management Approach

Contracts for platform extension or construction are usually let and managed by Network Rail and delivered by an approved contractor using an approved product, as specified by the design.

3.3 Technology Involved

Construction of platforms or extensions can be undertaken in Great Britain using several different approaches to construction. The materials used include the traditional brick, block, pre-cast concrete and modular steel construction.

4.0 BENEFITS OF LIGHTWEIGHT PLATFORMS (MODULAR CONSTRUCTION)

4.1 Asset Management

The key benefits of installing a platform or an extension through a modular construction include:

- A Simple and rapid procurement process using standardised components, allowing easier assembly with the opportunity for the exchange or addition of modules;
- Greater consistency of construction quality using teams specialised in the construction;
- Reduced site build time with associated reduction of work in high-risk environments;
- Improved programme certainty through standard build times and reduced lead times from standard components; and
- Less track access required as a consequence of employing quicker construction methods.

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.

Adopting a modular approach would lead to a quicker installation rate with reduced resources in comparison with traditional British construction practices. This will provide a more efficient construction process.

Based on experience from the Netherlands, the typical cost to deliver and install a 200-metre platform, with a width of 3 metres and an edging overhang of 250mm, are as follows:

Comparon model 1980 including edging	€175000 +25% Indirect costs	€218,750	
	Total	€218750	(£171,353)
Comparand edging only	€21000 +25% Indirect costs	€26,500	
	Total	€26500	

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.

A simple comparison has also been undertaken using data for platform extensions at Hitchin (from an Ove Arup Report "Engineering Advice on Network Rail's Enhancement Programme" for the ORR) and costs obtained for Comparon platform extensions from the Netherlands. This identifies a potential saving of 25% when the Dutch lightweight modular construction method is deployed. Details of this analysis are attached as Appendix B.

4.3 Life Cycle Costs

The following life cycle cost analysis was undertaken in the Netherlands. It identifies the life cycle costs based on a life of 50 years and a segment of platform 16 metres in length and 3 metres wide.

Date: 2008 Comparison analyses		Traditional			Comparon standard®		
		price per unit	freq. per 50 yr	project costs	price per unit	freq. in 50 yr	project costs
Building costs	m	€ 750,=	1x	€ 12000,=	€ 650,=	1x	€ 10400,=
New pavement	m^2	€ 35,=	2x	€ 3360,=	€ 35,=	2x	€ 3360,=
Replacing elements	m	€ 285,=	1x	€ 9975,=	€ 150 ,=	1x	€ 5425,=
Repaving	m^2	€ 26,=	4x	€ 4992,=	€ 26,=	2x	€ 2496,=

The conclusion is that the lightweight platform system has a better life cycle profile than traditional construction techniques

5.0 SAFETY ISSUES

Significant testing has been undertaken of these products in the Netherlands, including crash and fire resistance. As noted already, these are summarised in Appendix A. The Dutch Infrastructure Manager, ProRail, has approved the product.

6.0 IMPLEMENTATION INTO GREAT BRITAIN

6.1 Estimated Implementation Duration

Subject to meeting the British platform construction standards, a trial could be carried out within the next twelve months. Following appraisal of this trial, a production line approach to the implementation process would enable the process to be adopted as a standard practice within two years.

6.2 Constraints and Dependencies

No specific constraints have been identified, other than the need to gain the necessary skills and competency in its use. It is noted that it would be a further variation in platform construction methods and, as such, would need to prove its value in comparison with existing available options. The initial trial would need to confirm this value.

6.3 Investment Requirements

Initial investment would be required to assess and trial the system in Britain, although this would be negligible if incorporated into the development of an existing scheme.

Investment in a British manufacturing capability of the modular units might be required in the longer term.

7.0 RECOMMENDATIONS FOR FURTHER WORK

It would be advantageous to further develop the detail of a trial, including the overall approval programme, construction implementation plan and costs for a trial and subsequent roll out of the process to the British market.

This paper is based on currently identified European best practice. It would be beneficial to further review global construction techniques in order to identify any other best practice methods.

APPENDIX 1: SUMMARY OF PRODUCT TESTS

A number of tests were undertaken to prove the safety, strength and reliability of the product. The results from these tests, plus associated calculations made for ProRail, were provided as part of the Product Release Certification process. The following text identifies some of the tests and results achieved.

1. Strength

- Soil loads

  Due to the balance in weight taken away by excavating the foundation level and the Comparon structure's weight, there's no alteration in soil load hence no settlements are expected.
- Loads as a result of raising groundwater level

  The risk of floating: Due to the constructions weight, groundwater can raise up to the top of the rail. From that point the upward pressure caused by the (ground-) water starts to equal the downward force caused by the Comparon's weight.
- Structures weight applied to EPS core (polystyrene) caused by sand and concrete tiles

  Weight is 8 kPa, long-term strength EPS100 is 20 kPa.
- Spread loads of 5 kPa applied to the tiles don't cause problems due to the spread angle in the sand

  Spread loads of 5 kPa applied to the edge are also overcome by both Comparand and EPS, short-term strength EPS150 is 80 kPa.
- Concentrated forces of 7kN on an area of 0,01 m2 result in 700 kPa, if applied to the Compa-rand elastic deformations are measured

  If the force is taken away the edge and the EPS will retain to its original size.
- Similar test as above, but now with 10kN

  Similar results.
- Caterpillar crane resulting in a pressure of 58 kPa,

  Doesn't exceed short-term strength of 80 kPa.
- Thermal pressures in Compa-rand --> a dilatation of 0.5 cm is needed.
- Impact strength related to derailed trains

  Calculated and proven that the Comparon's strength exceeds the strength of platforms built in the Dutch traditional way (L-shaped concrete elements filled with sand and finished with concrete tiles).

2. Chemical resistance:

- To obtain required resistance the EPS core is sealed in LDPE (low density poly ethylene) foil

  The Compa-rand, which is made of polyester and glass fibre, is chemically resistant itself.

3. Water discharge capacity:

- Discharge capacity related to rainfall is calculated and proven.

4. Construction Tolerances:

- Level

  Differences in height of the pavement may be no bigger than 1 cm. Standard pavement is used, hence proven.
- Height and distance to the rail

  Building tolerances of max 1 cm are realistic and proven.

5. Safety:

- Against trains being derailed

  Requirements are proven in calculations worked out by independent third party Van Nuenen

- Fire resistance
  Tests have been carried out with the following results:
  - Construction doesn't add to fire as it doesn't burn itself;
  - Construction fails locally just after a long period exposure to extreme temperatures. No progressive collapse occurs;
  - Damaged parts have to be and can be replaced by new construction parts;
  - Local areas where damage occurs are not considered parts of an evacuation route, due to the extreme temperatures at this specific location (one would simply not evacuate straight through the middle of a fire).

6. Environmental conditions – Vibrations:

- Construction has to overcome vibrations caused by passing trains
  Information obtained in the field and historic information from deconstructed road constructions show that EPS is very well resistant to vibration.

APPENDIX 2: COST ANALYSIS SUMMARY

Analysis has been undertaken between the extension of a platform at Hitchin using data from the Ove Arup analysis for the ORR and costs obtained for Comparon platforms from Holland. This identifies a potential saving of circa 25% by using the Dutch modular construction.

Comparison Sheet
GB Enhancement (from Arup)
versus
Dutch Extension (from Compa Tech)

	Great Britain						*Basis of Comparison* [Assumptions]	*Holland*					
Platform lengthening 3m width per m run (assuming 50m extension)	Unit	Rates (£) Basic	Qty	Uplift	Total			Unit	Rates (£) Basic	Qty	Uplift	Total	
1.0 Site Clearance													
General Site Clearance	m²						Not included	m²					
2.0 Fencing													
Post and wire boundary fencing	m						Not included	m					
High security fencing	m						Not included	m					
3.0 Drainage and ductwork													
Drainage	m						Not included	m					
Chambers	no						Not included	no					
4.0 Railway Earthworks													
Topsoil Strip	m³	25.00	2.00		£50.00		Unchanged	m³	25.00	2.00		£50.00	
Excavation (Bulk)	m³	10.00	3.00	25%	£37.50		No foundations required	m³					
Disposal off site (contaminated)	m³	60.00	3.00		£180.00		No foundations required	m³	60.00	2.00		£120.00	
Imported fill	m³	18.00	3.00	25%	£67.50		No foundations required	m³					
						£335.00							£170.00
5.0 Platform Construction													
Break out ramp	no	1,080.00	0.02		£21.60		Unchanged	no	1,080.00	0.02		£21.60	
Box unit	m	1,496.00	1.00		£1,496.00		Equivalent to quoted €875/m run (assumed €0.79/£1 exchange rate)	m	1,108.00	1.00		£1,108.00	
Surfacing	m2	12.00	3.00		£36.00			m2					
Copings	m	52.00	1.00		£52.00			m					
Tactiles	m	20.00	1.00		£20.00			m					
Trough	m						Not included	m					
Downpipe	m						Not included	m					
Car Stop board	No						Not included	No					
Remove car stop board	No						Not included	No					
DOO mirror	No						Not included	No					
Monitor	No						Not included	No					
Lighting (column and Unit)	No						Not included	No					
Re-profile existing platform	m2	1,080.00	0.30		£324.00		Unchanged	m2	1,080.00	0.30		£324.00	
						£1,949.60							£1,453.60
6.0 Permanent Way													
Track - assume minor slew	m						Not included	m	300.00	0.50			
7.0 OHLE							Not included						
8.0 Structures							Not included						
9.0 Highway Works							Not included						
10.0 Signalling Works													
New signalling	No.						Not included	No.					
New LOC	No.						Not included	No.					
New TPWS	No.						Not included	No.					
New IBJ	No.						Not included	No.					
New RA Indicator	No.						Not included	No.					
11.0 Communications							Not included						
12.0 Services													
Services Protection - £20K for 1 in 10 locations	sum	10,000.00	0.02		£200.00	£200.00	Unchanged	sum	10,000.00	0.02		£200.00	£200.00
13.0 Net Construction Costs						£2,484.60							£1,823.60
14.0 Administration Costs													
Preliminaries & General Items					£571.15		Dutch assumed at 12%					£132.96	
Design					£114.23		Dutch assumed at 10%					£110.80	
Testing & Commissioning							Not included						
Consultancy Charges							Not included						
Training							Not included						
Spares							Not included						
Other						£685.38	Not included						£243.76
15.0 Ancillary Items													
Environmental Mitigation							Not included		2%				
Landscaping costs	sum						Not included	sum					
Abandonment of Roads and Railway routes	sum						Not included	sum					
Land and Property Acquisition Costs	sum						Not included	sum					
Archaelogical investigation	sum						Not included	sum					
16.0 Possessions													
Supplying protection staff & coordination													
<30 hours possession	No.	2,500	0.10		£250.00		Unchanged	No.	2,500	0.10		£250.00	
>30 hours possession	No.	6,000				£250.00	Unchanged	No.	6,000				£250.00
17.0 Total Construction Costs						£3,419.98							£2,317.36
18.0 Network Rail Costs													
Network Rail Project Management		8%			£273.60		Unchanged		8%			£273.60	
Possession / Isolation Management		2%			£68.40		Unchanged		2%			£68.40	
RIMINI Costs		2%			£68.40		Unchanged		2%			£68.40	
TOC Compensation/Schedule 4 Charges		10%			£342.00		Unchanged		10%			£342.00	
TWA Charges							Unchanged						
Site Supervision		3%			£102.60	£855.00	Unchanged		3%			£102.60	£855.00
19.0 Risk Allowance (50th Percentile Range)													
20.0 Total Cost including risk						£4,274.98							£3,172.36
21.0 HM Treasury "Green Book" optimism bias factor		15%							15%				
22.0 Escalation costs													
23.0 Estimated Total Cost						£4,274.98							£3,172.36

RailKonsult