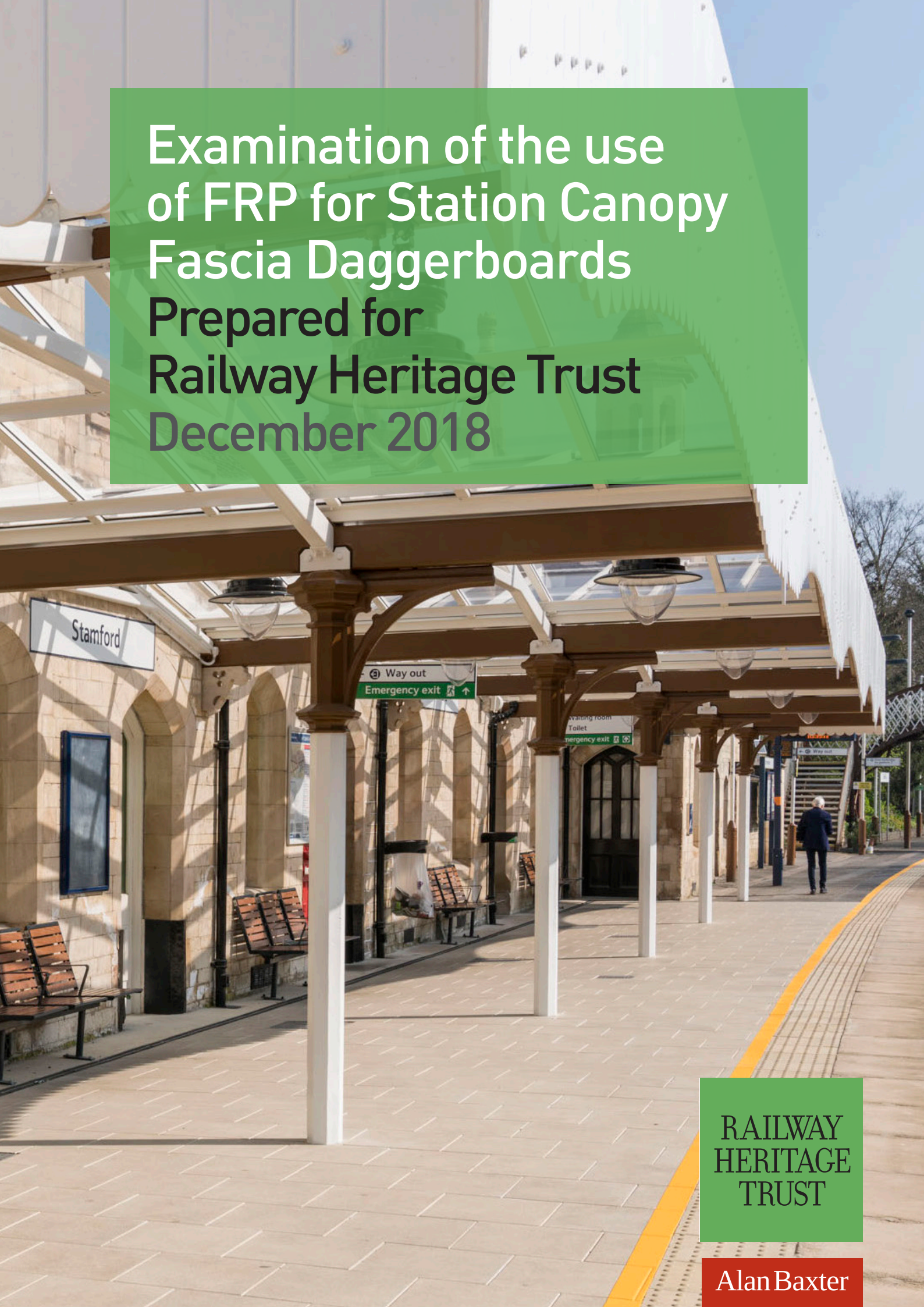
Examination of the use of FRP for Station Canopy Fascia Daggerboards

Prepared for Railway Heritage Trust

December 2018



RAILWAY HERITAGE TRUST

Alan Baxter

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Contents

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Executive summary

This report has been produced by Alan Baxter for the Railway Heritage Trust to investigate the suitability of Fibre Reinforced Polymer (FRP) as a replacement material for timber daggerboards on railway station canopy fascias. The Railway Heritage Trust has commissioned the report in order to provide guidance to the railway industry.

The origins of railway station canopy fascia daggerboards are inextricably linked to the technological development and industrialisation of Britain in the nineteenth century. They performed an important role in the canopy structures which were developed to serve the increasing number of passengers on the railways. Becoming an established component of Britain's station canopies between the late 1850s and 1930s, daggerboards primarily served the important practical function of removing water from the canopy, tempering weather-inflicted damage such as rot and by extension the structural deterioration of the canopy itself. In addition to their practical functions, daggerboards were recognised as having positive aesthetic qualities and were designed in a variety of patterns, contributing to the role of daggerboards in the imagination of an archetypal British railway station. This acceptance of the traditional of aesthetic of daggerboards can, however, lead to a neglect of their primary, technical functions.

Currently two thirds of canopy valancing at railway stations on the network are still constructed in timber. Timber was historically an obvious choice for daggerboards, but its extensive maintenance requirements as well as its associated structural and aesthetic deterioration pose significant issues for the railway today. The ongoing modernisation and electrification of Britain's railway network makes it pertinent to question the continued suitability of timber daggerboards at railway stations. Exposure to weathering results in the appearance of timber daggerboards degrading over time. It can also lead to timber rotting, which in turn can result in individual boards falling away, posing a health and safety risk to both trains and the public. Maintenance work on timber daggerboards requires track "possessions", incurring considerable costs and increasing the health and safety risks to which staff are exposed, both from working at heights and from electrocution. Timely maintenance and repainting work is recommended to take place every five years but it is understood that due to cost and time implications, such work is frequently deferred, resulting in continued deterioration.

Fibre Reinforced Polymer (FRP) is a viable alternative to timber, offering considerable benefits from longevity, minimal maintenance requirements and being non-conductive. The last of these characteristics is an important consideration as electrification continues on Britain's railways. FRP can be manufactured to higher levels of fire resistance, decreasing safety concerns. The minor maintenance requirements of FRP minimise the time spent working at heights, sometimes in the vicinity of overhead conductors, reducing the health and safety risks to which staff are exposed. FRP panels can be manufactured to replicate the design of timber daggerboards and imitate the appearance of multiple individual boards without the health and safety concerns associated with timber equivalents.

The primary function of daggerboards is their practical role in removing water from the canopy structure. FRP achieves this at lower cost, increased safety and greater functionality without altering the appearance of the original timber valancing. The aesthetic role which daggerboards play within railway station design is significant. As such, it is recommended that FRP daggerboards, particularly at listed stations, should replicate the historic design and detailing.

1.0
Introduction and purpose of the report

1.1 Purpose and structure

This report has been produced by Alan Baxter for the Railway Heritage Trust to investigate the suitability of Fibre Reinforced Polymer (FRP) as a replacement material for timber daggerboards on railway station canopy fascias. The Railway Heritage Trust has commissioned the report in order to provide guidance to the railway industry.

There are more than one thousand stations on the Network Rail network with canopy fascias, more than one third of which are listed. Traditionally constructed in timber, these daggerboards deteriorate with weathering and are costly to maintain and repair. Additionally, the electrification of the railway lines can result in timber daggerboards posing new health and safety issues, with maintenance works exposing staff to the risk of both working at heights and electrocution.

There is currently an inconsistent approach towards the replacement of timber daggerboards. Informed by an understanding of the history and significance of railway station canopy fascia valancing, this report assesses the practical benefits and acceptability of using FRP to replace timber daggerboards at both listed and non-listed stations. The acceptability of FRP as a material replacement for timber is subject to high quality design and detailing, and the criteria considered necessary for its use at listed stations are outlined in Section 7.

The report is divided into eight parts:

- The preceding Executive summary;
- Introduction (1.0);
- the role and history of canopy valancing and daggerboards (2.0);
- an analysis of the data pertaining to canopy valancing at stations on the Network Rail network today (3.0);
- the practicalities of maintenance for both timber and FRP daggerboards (4.0);
- Case studies (5.0);
- Conclusion and recommendations (6.0);
- Checklist for making a listed building consent application for replacement of timber valancing with FRP (7.0);
- Sources (8.0);
- Appendix A: brief history of station canopies; and
- Appendix B: cost calculations.

1.2 Scope of report

This report is limited to those stations on the Network Rail network. Though beyond the scope of this report, it should be noted that in addition to those stations on the Network Rail network, there are other stations in the United Kingdom to whom the same principles apply regarding the maintenance and repair of timber daggerboards. These include those stations overseen by Transport for London, other metro stations such as Tyne and Wear, Northern Ireland or private heritage railways

Statistical data for the report has been provided by Network Rail, with cost figures provided by BAM Nuttall.

Fig. 1: Timber station canopy valancing at Finchley Central Underground Station (1867), pictured in 2016

1.3 Methodology and limitations

This report is based on desktop research and the analysis of statistical data provided by Network Rail.

Alan Baxter would like to thank the professionals at Dura Composites Ltd. and BAM Nuttall, correspondence with whom has informed the understanding of FRP specifications and material costs in this report.

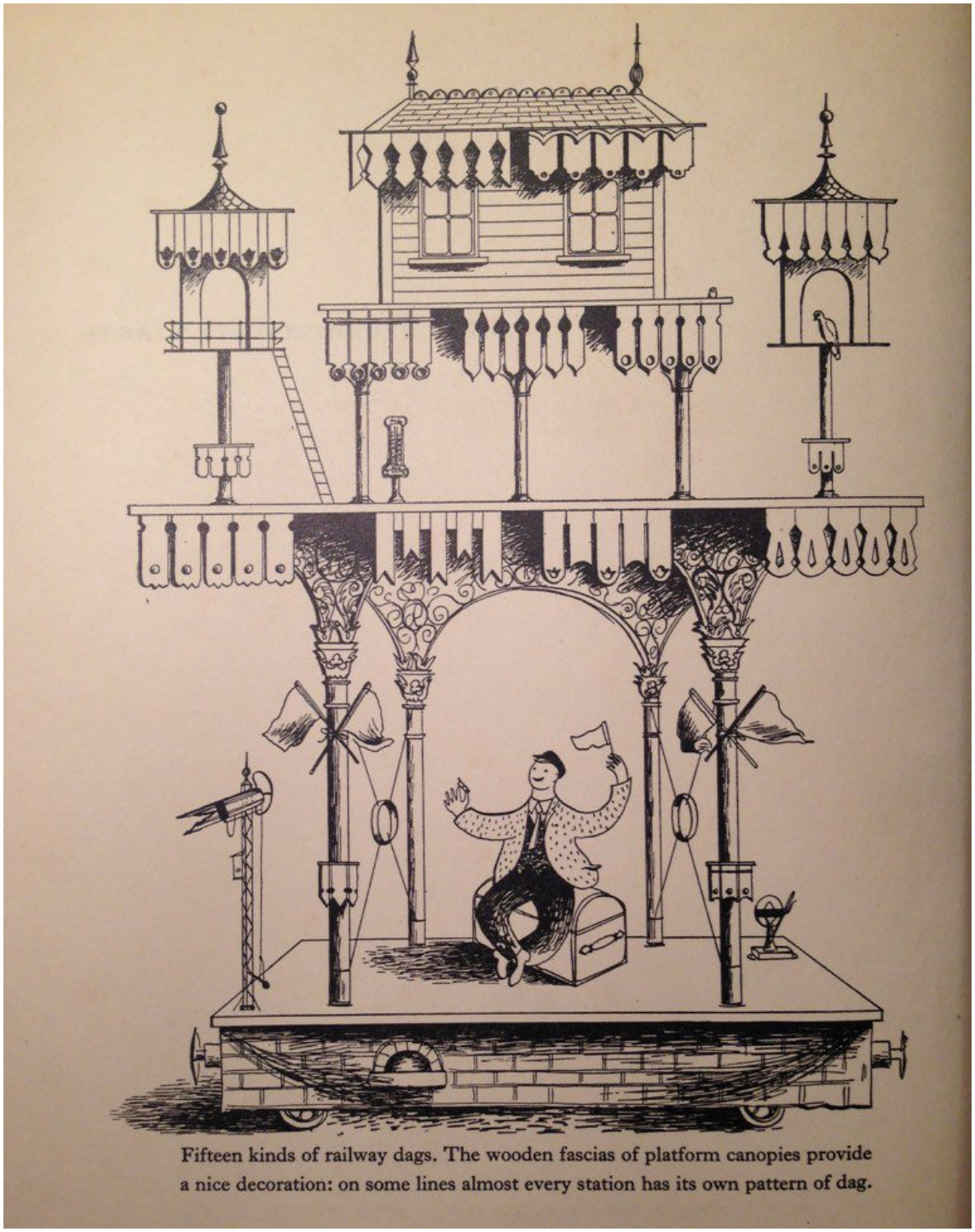


Fig. 2: An illustration from Barbara Jone's 1951 book, *The Unsophisticated Arts*

2.0
Valancing and daggerboards

2.1 Overview

From the late 1850s to the 1930s, canopies were often embellished with valancing (Bradley 2015). A brief history of canopies and the evolution of their use at railway stations is provided in Appendix A. Valancing involves the creation of vertical slats, or daggerboards, which are affixed to the canopy edge. Daggerboards perform the important, practical function of carrying run-off rainwater away from the canopy structure itself, as well as improving ventilation inside the canopy. Their ornamental potential was quickly recognised, and they can now be considered one of the archetypal features in the imagination of a traditional British railway station. This acceptance of the traditional of aesthetic of daggerboards can often lead to a neglect of their primary, technical functions.

2.2 The functional use of daggerboards

The practical functions of fascia daggerboards are critical and precede their adoption as decorative additions to railway structures. Canopy fascia daggerboards help temper weather-inflicted damage, such as rot and rust, and by extension the deterioration of the canopy.

Fascia daggerboards serve the canopy structure, whose purpose is to protect railway passengers from the elements (a brief history of the canopy typology is appended to this report). The primary function of fascia daggerboards themselves is that of carrying run-off rainwater away from the canopy structure itself in the absence of collecting gutters.

A straight-edged fascia does not control where water falls from the canopy, meaning that rainwater blows off randomly and may drip on passengers. Furthermore, water tends to cling to the underside of a flat edge, and thus be absorbed into the grain of the timber. To avoid this and the resultant rot, daggerboards are often painted and shaped at their end to create a pronounced drip-point for water runoff. Pointed or scalloped daggerboards, therefore, reduce the chances of rot developing.

In addition to protecting both the canopy structure and railway passengers from the weather, daggerboards contribute a structural function. A cantilevering flat or sloping roof has a tendency to blow off upwards in strong winds. A downstand board (fascia) at the roof edge may reduce damaging uplift. The daggerboards along the fascia edge are therefore subject to intense impact from wind and rain.

Historically, canopy fascias also played a crucial role by acting as screens reducing the amount of steam and smoke getting under the canopy from trains' funnels. Though it is difficult to imagine today just how unpleasant such quantities of smoke would have been for those on the platform, this may have been a major reason for the popularity of valences.

The images below illustrate some of the functional uses of daggerboards.

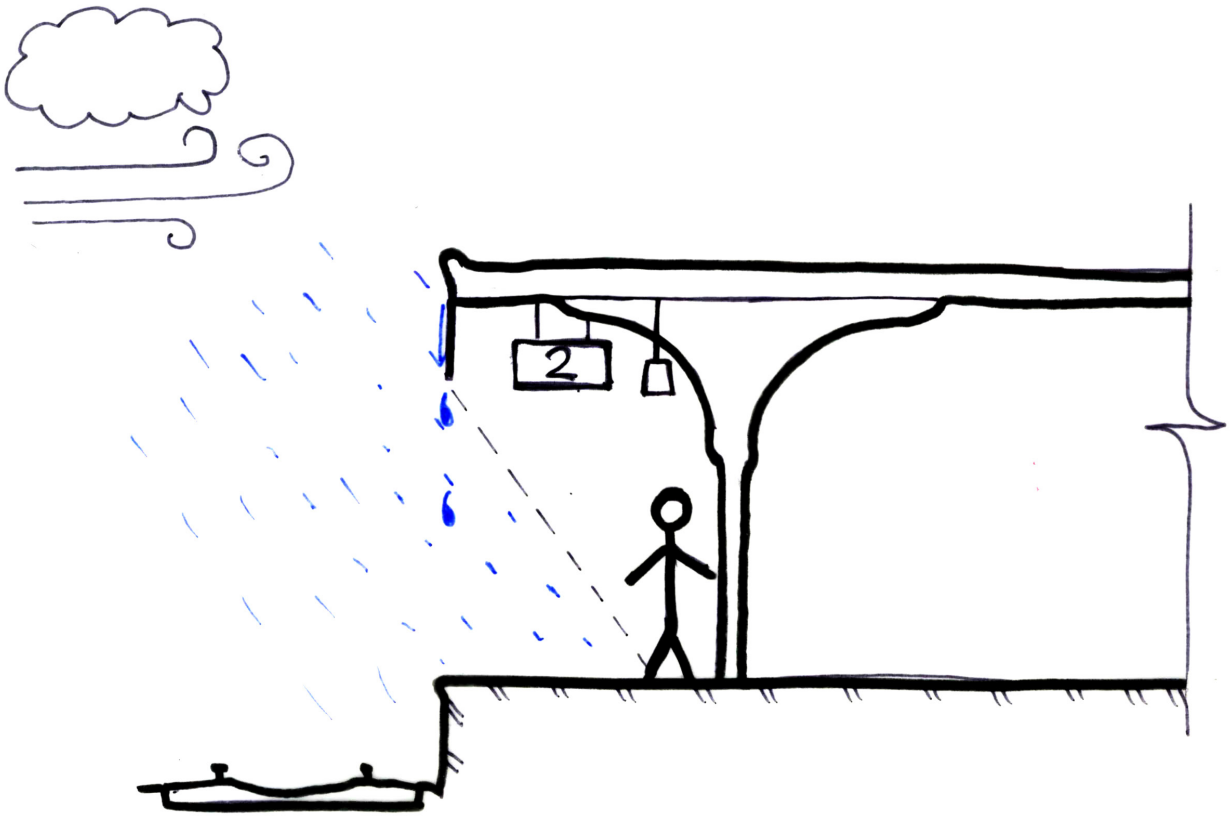


Fig. 3: Daggerboards help to protect railway passengers from the elements

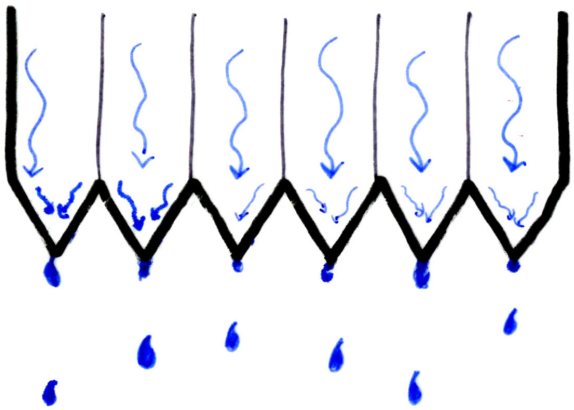


Fig. 4: Daggerboards create a drip-point for water runoff

2.3 The decorative use of valancing

The practical function played by daggerboards makes them a necessary component of station canopy structures, but their decorative potential was quickly recognised and a variety of designs were created. Valancing provided an inexpensive means of decorating these otherwise simple utilitarian railway structures as the daggerboard ends could be machine-cut.

Brunel is credited with the earliest use of decorated valancing, with his stations at Ealing and Maidenhead likely being the first to which he applied the dog-tooth valancing, which can be considered a signature of his early station designs (Burman 1979). Individual railway companies had distinctive styles of valancing, some of which were unique to a company, others which were common to more than one. It has been suggested that this became diluted and confused overtime as alterations were made and extensions constructed (Wikeley and Middleton 1971).

Daggerboards are fundamental to the imagination of an archetypal train station in Britain and whilst a typical daggerboad is either shingled or scalloped at its end, more detailed designs can be found. Daggerboards can also be arranged in various lengths, allowing for a range of ornamental effects to be achieved.

2.3.1 Decorative ends

The ends of daggerboards are often decoratively shaped, and broadly this is used to create two types of effect. The first involves each daggerboard being cut identically, to varying levels of complexity, creating a regular rhythm along the canopy border. The second arranges boards of different shaped ends to create a larger scale pattern overall. Daggerboards ends are designed in a multitude of shapes, ranging from perforated edges to decorative cut-outs; in 1977 there were thought to be over two hundred different patterns in the southern region of Britain alone (Reynolds 1977).

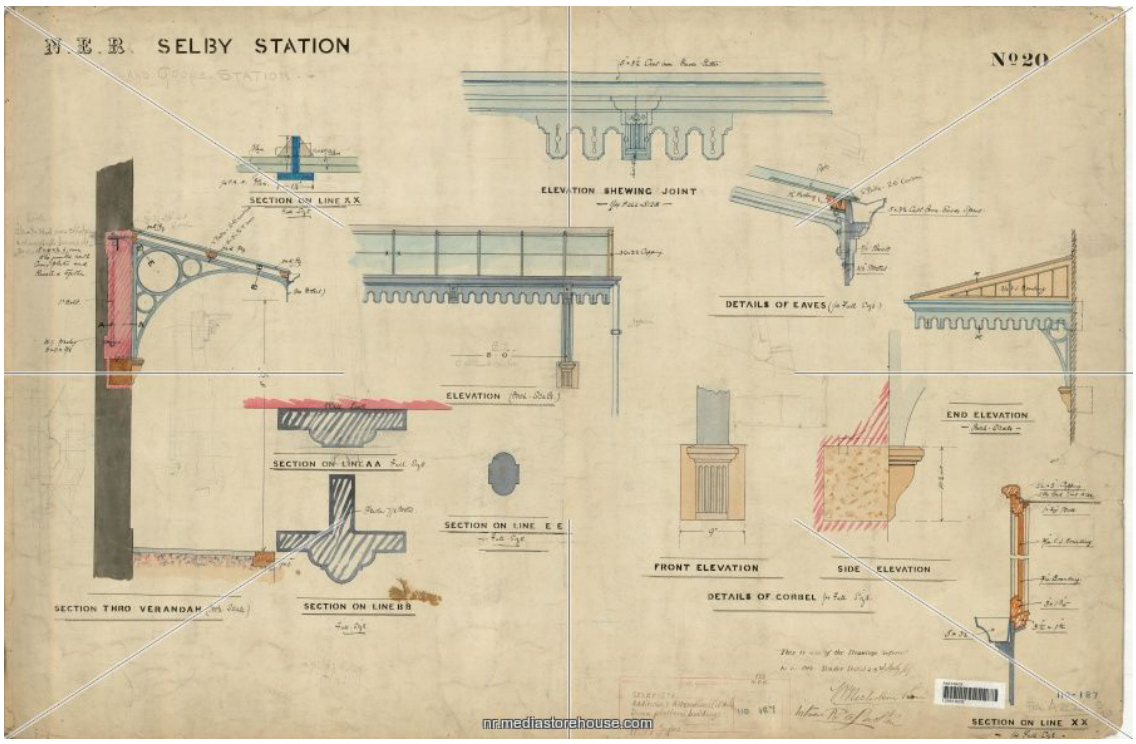


Fig. 5: This 1889 drawing shows details for a station canopy at Selby station, North Eastern Railway, 1871. The valancing comprises uniform scalloped daggerboards with decorative ironwork to the bracket

3.0
Station canopy fascias today: analysis of statistical data

3.1 Stations on Network Rail network

3.1.1 Total number of stations with canopy valancing

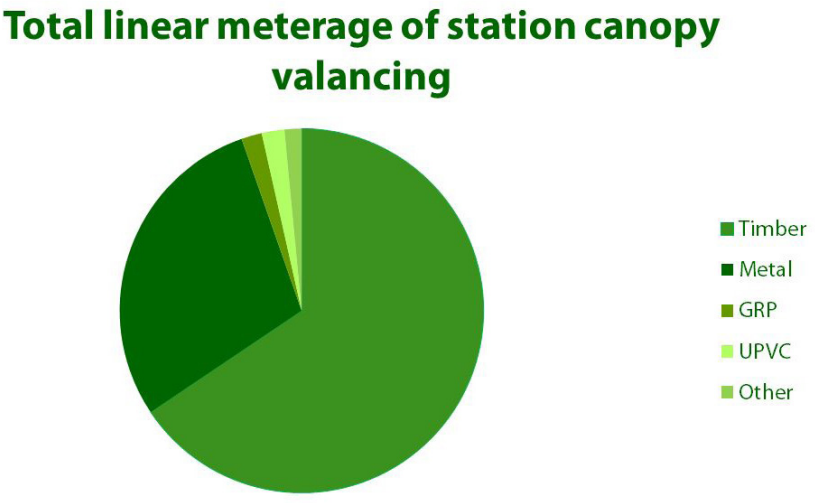
Based on statistical data provided by Network Rail, there are 1142 stations on the Network Rail network with canopy valancing.

3.1.2 Total linear meterage of station canopy valancing

The table below shows a breakdown of meterage of canopy valancing at stations on the Network Rail network. The data and its subdivision are provided by Network Rail.

Area	timber	metal	upvc	FRP	other	Total canopy valancing/m (to the nearest ten)
Anglia	20,044	11,378	555	91	337	**32,410m**
East Midlands	3,220	2,608	111		282	**6,220m**
Kent	29,158	17,367	66	623	260	**47,480m**
London North Eastern	13,366	12,547	4,610	802	94	**31,420m**
London North Western	35,103	17,297	454	1,236	2,773	**56,860m**
Scotland	15,114	4,012	25	8	304	**19,460m**
Sussex	23,120	12,053	65	1,423	301	**36,960m**
Wales	11,866	3,330	230	677		**16,100m**
Wessex	35,638	5,442	28	596	323	**42,030m**
Western	23,776	7,230	292	384	209	**31,890m**
Total (to the nearest ten)	210,410	93,260	6,440	5,840	4,880	**320,830m**

This data demonstrates the high proportion of station canopy valancing is timber. Of the total linear meterage across the Network Rail network, two thirds is timber.



The table below breaks down this data in terms of its geographical distribution.

Country	Total canopy valancing/m	Total timber canopy valancing/m	Percentage of canopy valancing made of timber
England	285,270	183,430	**64%**
Scotland	19,460	15,110	**78%**
Wales	16,100	11,870	**74%**
Total (to the nearest ten)	**320,830**	**210,410**	**66%**

3.1.3 Total number of listed stations

Of the 1142 stations on the Network Rail network with canopy valancing, 291 are listed structures. Listed stations therefore amount to 26% of the total number of stations with valences.

3.1.4 Geographical distribution of these stations

England

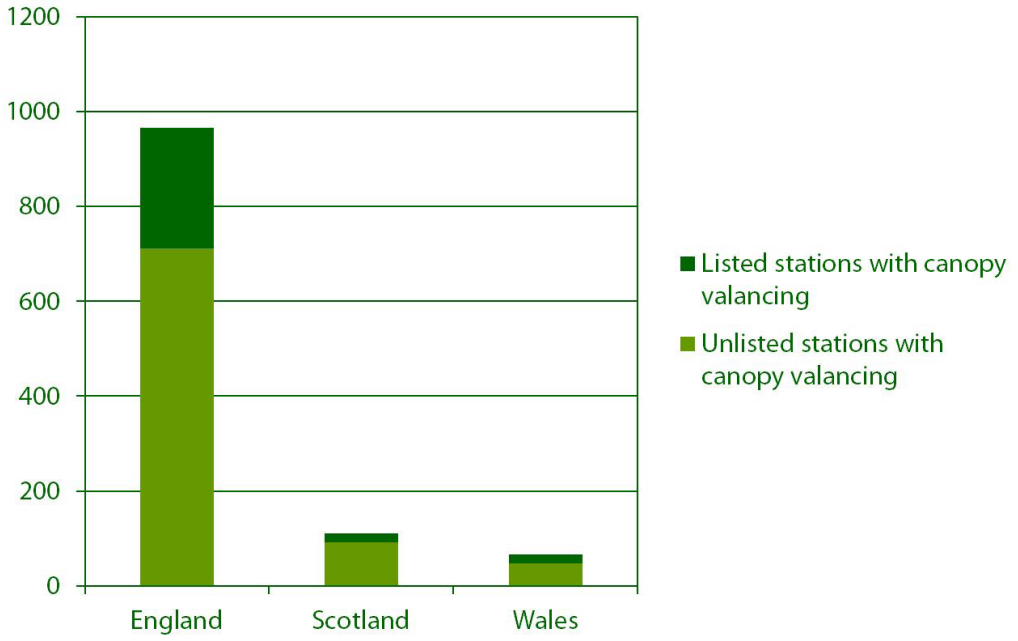
There are 965 stations in England with canopy valancing. Of these 965 stations, 253 are listed, amounting to 26% of the stations in England on the Network Rail network with valences.

Scotland

There are 111 stations in Scotland with canopy valancing. Of these 111 stations, 19 are listed, amounting to 17% of the stations in Scotland on the Network Rail network with valences.

Wales

There are 66 stations in Wales with canopy valancing. Of these 66 stations, 19 are listed, amounting to 29% of stations in Wales on the Network Rail network with valences.



4.0
Practicalities of maintenance

4.1 Timber daggerboards

4.1.1 Lifespan

Timber daggerboards have an estimated lifespan of thirty years. According to Network Rail, repair and maintenance of these is needed every ten to twelve years, but it is understood that due to cost and time implications, such work is frequently deferred, resulting in continued deterioration. Based on these assumptions, it is unlikely that any nineteenth century timber survives in canopy valancing. This is an important consideration when exploring the options for timber daggerboard renewal.

4.1.2 Aesthetic and structural deterioration

Both the body and paint coating of traditional timber daggerboards are prone to weather damage. Rain penetration can also affect the appearance of timber daggerboards, causing the paint coat to flake and peel away, leaving the daggerboard further exposed. This cycle can be the result of leaking gutters as well as direct rain penetration. Both can cause the daggerboards to rot, making them structurally unsound. The aesthetic deterioration of unmaintained timber daggerboards, as seen in Fig.6, gives the railway station an appearance of neglect and is visually unappealing to passengers using the railway.

In addition to the aesthetic problems associated with timber daggerboards rot poses a health and safety risk as individual boards can be dislodged from the fascia and fall onto the platform below. The vibrations caused by passing freight and passenger trains can trigger the boards to break off or slip.

Fig. 6: The Grade II listed Bury St Edmunds station platform showing the timber platform canopy daggerboards in a poor state of repair before their replacement in FRP in 2016

4.1.3 Intensification and electrification of railways

Whilst timber was originally an appropriate construction material for railway station canopy valancing, being lightweight and easy to shape, as railways modernise it has become clear that this is no longer the case. As the intensity of railway use continues to grow, the frequency and speed of trains is ever-increasing. This combination places a physical strain on the daggerboards of station canopy valancing because the increased frequency and intensity of reverberation can dislodge timber daggerboards.

The intensity of railway use also poses a maintenance problem, as the increased number of trains reduces the opportunities to close lines for maintenance. Formal possessions are required, meaning the closure of the section of railway, in order to repair or clean the timber valancing. This is expensive, disruptive to passengers and freight, and demanding on health and safety requirements.

Fig. 7: Newport Station platform canopy pictured in 2016. The canopies required cutting back due to the electrification of sections of the Great Western mainline route

4.1.4 Practicalities of repair and renewal in timber

Repair

It is understood from correspondence with professionals at BAM Nuttall and Network Rail that the aesthetic and structural deterioration of timber daggerboards means that repainting and repair should be carried out every five years, with replacement usually necessary after fifteen years. The repair process for timber daggerboards involves several stages:

1. Where deterioration is only aesthetic, existing paint layers should be removed and the daggerboards repainted in situ.

2. Painting and paint-stripping in situ requires track possessions for access, incurring additional costs to those of the practical repair work itself.

3. Where deterioration is structural, existing paint layers must be removed in order to assess the full extent of the damage.

4. Damaged and deteriorated sections of valancing must then be removed and replaced.

It is understood from Network Rail that a typical canopy takes between five and eight eight-hour shifts of four men working at heights to undertake basic repair work to a typical station platform canopy.

Whilst repair and maintenance is acknowledged as desirable practice at listed stations, it is understood that due to cost and time implications such work is frequently deferred. Network Rail has advised that it is difficult to quantify the cost of repairing timber daggerboards and that it is often preferable and more cost effective to replace the full length of station canopy valancing rather than repair specific sections.

An additional consideration is the role of the train operating companies (TOCs) where they are the station facility owners and are responsible for the repair of canopy daggerboards at their stations. The relatively short timescales of TOC franchises (up to a maximum of fifteen years), combined with the long life of timber daggerboards (around thirty years), is understood to discourage TOCs from carrying out the necessary maintenance work to their canopy daggerboards where they have such a responsibility.

Renewal

The process of renewing deteriorated timber daggerboards in timber can be broken down as follows:

1. Stripping of existing valancing, including the removal of nails and top trimming. This can be carried out at an average rate of 10m per eight-hour shift.

2. Replacing the valancing with like-for-like tongue and groove or flat-finish panels. These panels are painted off-site. This can be carried out at a rate of 7-10m per eight-hour shift.

3. Nail holes must be filled and paintwork touched up. This requires two eight-hour shifts per platform.

Health and safety

Installation and repair works to station canopy fascia daggerboards exposes staff to health and safety risks. Both maintenance and installation work involves working at heights, risks that NR are required by law to minimise (Health and Safety Act 1974 Sections 2 and 3). These statutory requirements are detailed further in section 4.2.4 of this report.

Where railways are electrified, working at heights also brings the risk of electrocution from working next to electrical conductors. The need to repair of timber daggerboards in order to maintain their appearance and condition exposes staff to these health and safety risks at greater frequency.

4.2 FRP daggerboards

4.2.1 Nature and lifespan

Fibre Reinforced Polymer (FRP) is a composite material formed of a polymer matrix reinforced with Fibres. Manufacturers state that FRP has an average lifespan of fifty years and its material qualities are appropriate and desirable for station canopy valancing. These qualities are listed below:

- Durable and impact-resistant
- Corrosion-resistant
- Non-conductive
- Low maintenance
- Long lifespan
- Quick and easy to fabricate
- Fully water-resistant
- Non- expanding
- Can be manufactured to different specifications of resistance as required
- High level UV resistance reduces colour fading
- Can be manufactured to replicate existing daggerboard designs
- Can be manufactured in a range of finishes and colours

Fig. 8: FRP fascia daggerboards at the Grade II listed Bury St Edmunds Station

4.2.2 Size and weight

FRP daggerboards can be manufactured in a variety of sizes and thicknesses. The specifications below are provided by Dura Composites, a supplier whose products meet Network Rail's requirements for replacing existing timber daggerboards and have been installed at a number of stations on the Network Rail network:

- FRP panels are generally between 1400mm and 1500mm in width
- Each FRP panel usually consists of 9 – 15 daggerboards
- FRP panels have a maximum drop of 1800mm
- FRP panels can be manufactured in a range of thicknesses, starting at 6mm

FRP is heavier like-for-like than timber, but can deliver the practical functions of daggerboards at a greater thinness. The weight of FRP bears consideration at listed stations, since replicating the thickness of timber daggerboards can result in a FRP product that places too heavy a load on the canopy structure. FRP continues to evolve and, looking ahead, lighter weight foam-filled matrices are being developed.

The table below offers a guide to the weight corresponding to the different thicknesses of FRP panels:

Thickness (mm)	(kg/m^2)
8mm	11.4
10mm	14.5
12mm	17.4
15mm	21.75

4.2.3 Maintenance and installation

The lightweight nature of FRP when produced in a thinner thickness than timber makes it easier to handle than those timber equivalents. This generally makes the installation of FRP daggerboards quicker, reducing associated labour costs and the amount of time spent working at heights.

Since FRP does not degrade overtime, maintenance is minimal and intervention is rarely required over its fifty year lifespan. This significantly reduces lifecycle costs and related health and safety risks.

Regarding aesthetic upkeep, FRP daggerboards can be cleaned with the simple solution of soapy water and their durability means that they can be sprayed or cleaned with poles from the ground. Deep-cleaning is understood to be advised to take place every five years (see 4.2.8). Looking forward, it is understood that FRP is being developed with self-cleaning properties.

4.2.4 Health and safety

In accordance with the Health and Safety at Work Act 1974 (HSW Act 1974) Network Rail has a statutory legal obligation to both its employees and to passengers of the railways on its network. Under Section 2 of the HSW Act 1974, Network Rail is required, as an employer, to ensure, so far as is reasonably practicable, the health and safety of its employees. Under Section 3 of the HSW Act 1974, Network Rail is required to conduct its undertaking so as not to expose those outside its employment, such as passengers on the railway, to health and safety risks. Working at heights poses some of the greatest health and safety risks to those working on the railways across the UK, and in accordance with these regulations should therefore be kept to a minimum.

Additionally, The Work at Height Regulations 2005 stipulates in paragraph 6.2 that 'Every employer shall ensure that work is not carried out at height where it is reasonably practicable to carry out the work safely otherwise than at height'. This bears particular consideration when assessing the respective merits of timber and FRP for use at railway station canopies.

The low maintenance requirements of FRP greatly reduce the health and safety risks to which staff are exposed. Installation necessarily involves working at heights and the risks associated with this, but removing the need to maintain FRP daggerboards means that the frequency of this risk is greatly reduced. The use of FRP for station canopy fascia daggerboards therefore represents a significant health and safety benefit.

Furthermore, as an employer, Network Rail is obliged to observe the Regulations contained in the Electricity at Work Regulations 1989. Part 2 of the Regulations stipulates that employers must ensure that employees are not engaged in any work on or near a live conductor in such a manner that danger might arise unless it is considered reasonable in accordance with the three criteria set out in point 14 (Electricity at Work Regulations 1989). Where railways have been electrified, working on canopy daggerboards places employees in the vicinity of conductors. Therefore, in observation of the Electricity at Work Regulations 1989 Network Rail should minimise the time employees spend working in these conditions. This should be considered when assessing the respective merits of timber and FRP for use at railway station canopies.

4.2.5 Aesthetic benefits

The material qualities of FRP offer aesthetic benefits. FRP is a highly durable material, being both impact and corrosion-resistant. This greatly reduces the chances of structural damage to daggerboards constructed in FRP. Being water-resistant, FRP daggerboards can be sprayed clean without the fear of incurring structural damage, making the cleaning process easier.

In addition to their physical resilience, FRP panels are designed to create the appearance of individual daggerboards and can be produced with a range of finishes and in a selection of colours. As such they do not require painting and by extension do not suffer the same aesthetic deterioration of flaking as timber equivalents. FRP offers a high level of UV resistance, with earlier issues with UV degradation having been largely addressed.

Fig. 9: FRP valancing was used on the canopy at Porthmadog Harbour, on the Ffestiniog Railway, more than thirty years ago. Though this level of installation is not acceptable today, it serves as an example of the structural and aesthetic durability of FRP in an aggressive seaside environment

4.2.6 Practicalities of replacing timber daggerboards with FRP

Renewing existing timber daggerboards with FRP replacements involves two stages:

1. Stripping of existing valancing, including the removal of nails and top trimming. This can be carried out at an average rate of 10m per eight-hour shift.

2. Replacing the valancing with FRP panels of the same design as the existing timber daggerboards. This can be carried out at a rate of 9-12m per eight-hour shift.

The cost of FRP panels varies depending on the design and size required to replace existing timber daggerboards.

Because FRP is heavier than timber for any given thickness, replicating the thickness of existing timber daggerboards in FRP can place an additional structural load on some canopies. FRP can be produced to a visible thickness to maintain the appearance of the canopy valancing.

4.3 Comparing timber and FRP

4.3.1 Installation specifics

Material	Metres of existing valancing stripped/8hr shift	Metres replaced/8hr shift	Additional processes
Timber	10	7 – 10	Filling nail holes and touching up paintwork- 2 x 8hr/shift per platform
FRP	10	9 – 12	None

Maintenance and installation of canopy daggerboards necessarily involves working at heights and, in the case of those stations where electrification has taken place, working in the vicinity of overhead conductors. These are additional health and safety concerns which bear consideration.

4.3.2 Material and upkeep specifics

It is understood from correspondence with professionals at BAM Nuttall and Network Rail that the aesthetic and structural deterioration of timber daggerboards means that repainting and repair should be carried out every five years, with replacement usually necessary after fifteen years.

FRP daggerboards are understood to require deep cleaning at every five years or so. This is the only intervention necessary over their estimated lifespan of fifty years.

4.3.3 Cost comparison

To illustrate the comparative costs of replacing existing timber daggerboards in timber and FRP, hypothetical canopy dimensions have been used. The dimensions assume a canopy length of 100 metres, with daggerboards 0.5 metres in depth.

The costs relate to the first fifteen years following installation and do not include the labour cost of upkeep. It is understood that timber is normally required to be replaced after this period of time, incurring a fresh set of material costs (see 4.3.4). FRP can continue to be deep cleaned at a cost of £30 per square metre for at least another thirty years.

Figures for labour costs have been provided by Network Rail. Figures for material and upkeep costs have been provided by BAM Nuttall. Full details of the figures and calculations can be found in Appendix B.

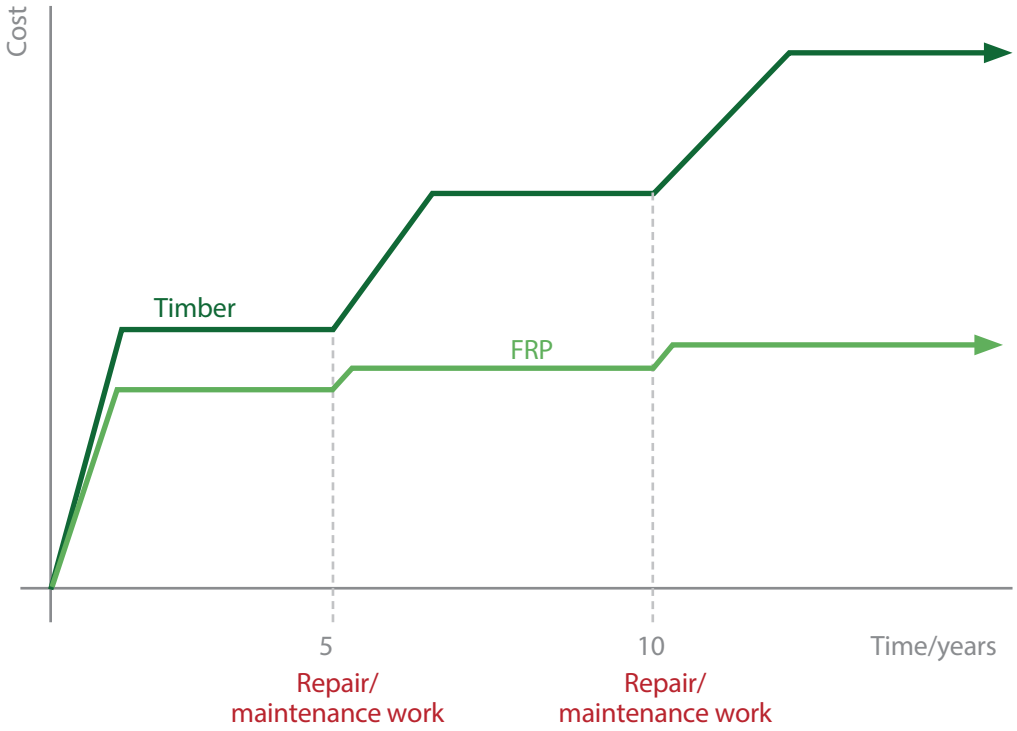
	Labour cost of stripping and replacing	**Initial material costs**	**Upkeep costs Year 5 to 15**	**Total cost over 15 years (to nearest £1000)**
Softwood treated timber	£80,800	£15,000	£15,000	**£111,000**
Class 2 FRP	£66,400	£20,500	£3,000	**£90,000**

Observations:

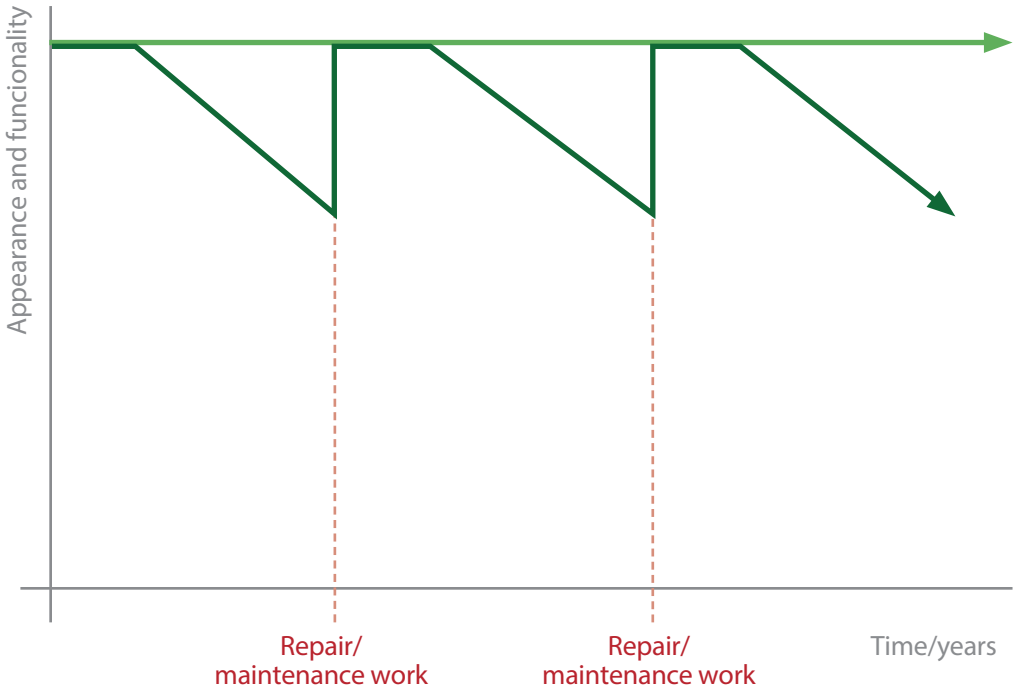
- The initial material cost of Grade 2 FRP is greater than timber, but this is off set by the significantly lower upkeep costs.
- Timber daggerboards are five times more expensive to upkeep than FRP equivalents.
- The capital cost of Class 2 FRP is £110 greater per square metre than for timber. It is understood that this figure would be reduced to £20 per square metre with the use of general purpose FRP.
- The minimal upkeep costs of FRP means that over a 15 year period it is more cost effective than timber.
- The long lifespan of FRP in comparison to timber makes FRP even more cost effective in the longer term, beyond the 15 year span of this example.

4.3.4 Long term performance comparison

It is understood from correspondence with professionals at BAM Nuttall and Network Rail that the aesthetic and structural deterioration of timber daggerboards means that repainting and repair should be carried out every five years, with replacement usually necessary after fifteen years. This creates additional costs at these intervals. The low-maintenance nature of FRP means that other than the minor costs of deep cleaning there are not further costs after installation. The graph below provides a visual representation of this comparison, but is not based on specific figures.



Over time the appearance and functionality of timber daggerboards degrade, requiring maintenance and repair work to return them to optimum performance. The graph below provides a visual illustration of the comparison of the fluctuating standards of timber with the constant of FRP.



5.0
Case studies

5.1 Timber daggerboards in good condition

5.1.1 Hanwell Station

© ABA

Fig. 10: Platform canopy fascias at the Grade II listed Hanwell Station, GWR 1877

Hanwell Station in West London is Grade II listed and has platform canopies and ironwork which are of historical importance as examples of those characteristic of the general station rebuilding which took place in the 1870s. The station has been subject to improvement works since 2016, in anticipation of the arrival of CrossRail in 2019. Works approved at the time of writing will see the station's existing timber canopy daggerboards replicated in timber.

Hanwell Station is included on Historic England's Heritage at Risk List under Category C, the underuse of its buildings creating concerns of slow decay. The arrival of CrossRail will remedy underuse, but slow decay of timber daggerboards remains a concern.

5.2 FRP daggerboards

5.2.1 Bury St Edmunds

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Fig. 11: Bury St Edmunds station platform pictured in 2018 after the timber canopy daggerboards (Fig 4) were replaced with FRP

The Grade II listed Bury St Edmunds Station in Suffolk is a fine example of Victorian station design, with canopy valancing along the lengths of its long platforms. With its annual footfall amounting to around half a million passengers, the station was subject to large-scale refurbishment in 2016, the station remaining in service throughout this period. Part of the renovation works involved the removal of all the station's existing timber daggerboards, many of which were degraded (Fig. 6), and the installation of FRP replacements. These replacements were manufactured in a matching FRP profile with a wood grain effect to both sides.

5.2.2 Stamford

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Fig. 12: The Grade II listed Stamford Station shown after the installation of FRP canopy valancing in 2017

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Fig. 13: A closer view of Stamford Station's FRP canopy valancing

FRP panels were installed at the Grade II listed Stamford Station in Lincolnshire during refurbishment works in 2017. These works involved the removal of the station building's existing twentieth century canopy and its replacement with a more traditional design, corresponding to the station's historic canopy which featured daggered valancing. The valancing on the station's new platform canopy was successfully executed in FRP.

6.0
Conclusion and recommendations

The conclusions reached in this report are informed by an examination of the history and typology of railway station canopy fascia valancing. This research shows that the canopy daggerboards have historically been both functional and ornamental, and continue to be so today. This duality of use should be appreciated when considering the replacement of existing timber daggerboards in order that neither the decorative nor functional qualities are neglected.

Daggerboards are an essential to platform canopy design, removing water from the main structure to prevent its degrading, and are therefore subject to greater exposure to deteriorating elements such as rainwater. As with other aspects of the operational railway, the challenge is to balance the reasonable demands of operating and maintaining a busy network whilst conserving historic significance.

Historically, timber was the obvious material choice for daggerboards. It is understood, however, that due to cost and time implications, the repair work required to maintain the appearance and quality of timber daggerboards is frequently deferred, resulting in continued deterioration. Today, FRP presents an alternative choice which offers practical, aesthetic and cost benefits when compared with timber as well as significantly reducing the health and safety risks to which staff are exposed. FRP has an estimated lifespan of fifty years and does not degrade over time. FRP requires minimal maintenance and can be easily cleaned. These benefits, paired with the ability for FRP to be manufactured to resemble existing timber daggerboards in pattern, colour and finish, are deemed to offset the possible heritage impact of using a new material. This conclusion is further reinforced by the fact that the estimated lifespan of timber is around thirty years, meaning that it is unlikely that any nineteenth century timber survives in canopy valancing.

The primary function of daggerboards is their practical role in removing water from the canopy structure. Using FRP for station canopy daggerboards allows a high aesthetic and structural standard to be maintained over a longer period of time whilst also greatly reducing maintenance costs and health and safety risks. As such, FRP is deemed an acceptable material replacement at both listed and non-listed railway stations, but its design and detailing must be of high quality. It is recommended that FRP daggerboards, particularly at listed stations, should replicate the historic design and detailing and be produced to a visible thickness. The criteria that FRP daggerboards should meet in order to constitute an appropriate replacement for timber at listed stations are detailed in Section 7 of this report.

7.0
Checklist for making a listed building consent application for replacement of timber valancing with FRP

In order for FRP to constitute an acceptable material replacement for timber daggerboards at listed stations certain criteria must be met. These are primarily concerned with the design and detail of the FRP panels, which should seek to replicate as closely as possible that of the existing timber daggerboards. A checklist of these criteria is provided below:

Removing timber daggerboards

- When considering the removal and replacement of existing timber daggerboards, the local authority conservation officer should be consulted at an early stage in the process.
- Where a railway station is listed Grade II*,I, A or B the appropriate national heritage body (Historic England, Historic Environment Scotland or Cadw) should be consulted in addition to the local conservation officer. Where timber daggerboards exist, the design and detail of these should be accurately recorded and photographed before removal.
- Sample sections of the existing timber daggerboards should be taken in order to accurately inform the design of the FRP replacement panels.

Design of FRP panels

- Replacement FRP panels should be designed to reproduce the design of the existing timber daggerboards.
- Where more than one style of daggerboard is present at a particular station, each of these designs should be recorded and replicated in FRP in their given location.
- Attention should be paid to the details of the existing timber daggerboards, such as carvings, and these should be reproduced accurately in FRP.
- If there are suggested changes to the daggerboard design, these should be discussed with and agreed to by the local authority (and Historic England, Cadw or Historic Environment Scotland if Grade II*,I, A or B listed)
- The colour of the FRP should be agreed prior to manufacture with the local authority (and Historic England, Cadw or Historic Environment Scotland if Grade II*,I, A or B listed)
- FRP daggerboards should be produced at a visible thickness.
- Network Rail should provide the specifications for the design and construction quality of FRP panels.
- Network Rail and train operating companies should employ the same standard of care for station canopy valancing at both listed and unlisted stations.

8.0 Sources

8.1 Primary sources

Statistical data relating to the volume of station canopy valancing at stations on the Network Rail network are supplied by Network Rail.

Data relating to the number of listed structures on the Network Rail network and their geographic distribution are supplied by Network Rail.

Figures for the respective labour costs of replacing existing daggerboards with timber or FRP are supplied by Network Rail.

The specifications of FRP are supplied by Dura Composites.

Material cost figures are provided by BAM Nuttall.

8.2 Secondary sources

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Appendix A:
Brief history of canopies

Pioneering phase

Generally, on the earliest passenger-carrying railways, passengers were at designated points along the route, tickets having been purchased from a nearby inn or office. As railways spread across Britain, station building design quickly evolved and station structures were developed to protect both trains and passengers from the elements. At large termini, these sheds were often grand feats of engineering. Isambard K. Brunel's station shed at Bristol Temple Meads, 1841, and W. H. Barlow and R. M. Ordish's shed at St Pancras, 1868, are notable examples of this celebration of the arrival and departure of trains.

Smaller stations during the pioneering phase were sometimes equipped with a sheltered area on the platform, their station buildings themselves not being sufficiently large to provide waiting rooms for passengers. In the earliest examples, shelter was provided by extending the roof of the station building over the platform and enclosing this projection on either side with panel walls. David Mocatta (Simmons 1991) designed such platform shelters for thirteen of the stations along the London & Brighton Railway 1839–41, none of which survive (Bradley 2015). Following the gradient of the station building roof, however, limited the distance that the shelter could extend. This created only a confined area of covered space and left a gap between the shelter and the edge of the platform. These issues were ameliorated with the construction of canopies which projected from the station building or waiting room, allowing greater outdoor areas to be covered.

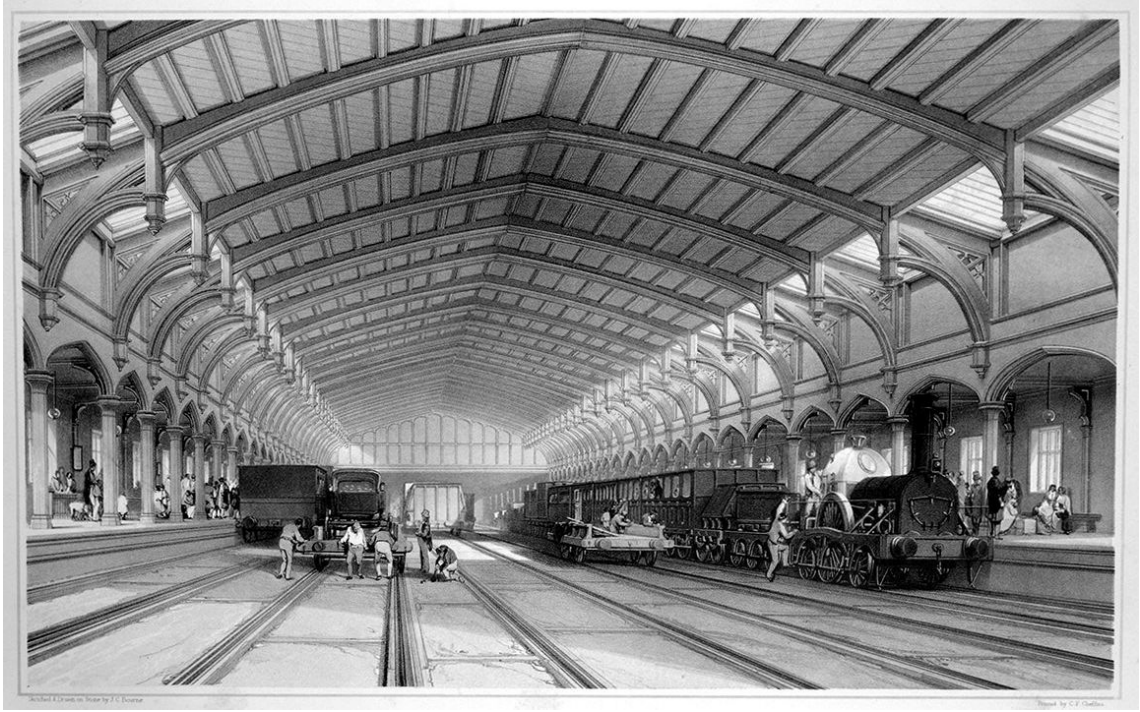

Fig. 14: Engraving of Brunel's passenger engine shed at Bristol Temple Meads Station, c.1841

The history of the canopy

Whilst there has not been a comprehensive study of the history of structurally independent canopies, their origins in the tradition of fabric awnings can be traced to the ancient world, where they were employed to provide shade at large outdoor spectacles, and the nomadic tradition of material tents. These relied on guy ropes to stand freely. The recorded presence of tents in Britain dates to at least the medieval period. Valancing on these structures was commonplace, as can be seen from a depiction of an encampment of tents in fourteenth century Italy (Fig.2) which displays a variety of valance designs.

Fabric canopies in Britain were employed as temporary, often ceremonial, structures or as supplementary awnings to traditional buildings until the industrial revolution of the nineteenth century transformed the potential of canopy design. Outdoor entertainment and leisure activities benefitted from these innovations, and metal-framed canopies were incorporated into the design of bandstands, seaside piers and sports grandstands towards the middle of the nineteenth century and some such canopied structures featured daggerboard valancing. It has been suggested that these designs were influenced by the traditional tents seen during the British occupation of India (Rabbitts 2018). Railways and their associated designers imagined some of the most elaborate canopy structures, as well as some of the most utilitarian.

Fig. 15: Italian encampment depicted in 'Roman du Roy Meliadus de Leonnoys' c. 1360

Fig. 16: The canopy roof of the Grade II listed grandstand at Lincoln Racecourse (1897) has charming daggerboard valancing

Brunel's 'chalet' structures

Brunel was attentive to a need for shelter and devised two types of canopy design which are both now commonly referred to as his 'chalet' style. One model exaggerates the hipped roof of the station building by elongating the eaves to form supports, the other is a horizontal projection supported by deep brackets extending from the base of the roof; Charlbury Station (1853) and Culham Station (1844) respectively represent Brunel's two types of 'chalet' station building. Brunel built these structures at the smaller stations along the Great Western Railway and associated lines are some of the earliest examples of the incorporation of canopies to the design of station buildings. These approaches were used for numerous small station buildings thereafter. The recently restored Pantyffynnon Station (1857) demonstrates the adoption of Brunel's model more widely.

Similar to the 'chalet' style were the island platform shelters on a number of Scottish railways, including the Cathcart Circle and the West Highland Railway. These differed crucially in their use of materials, the structures usually timber-built and the canopies glazed.

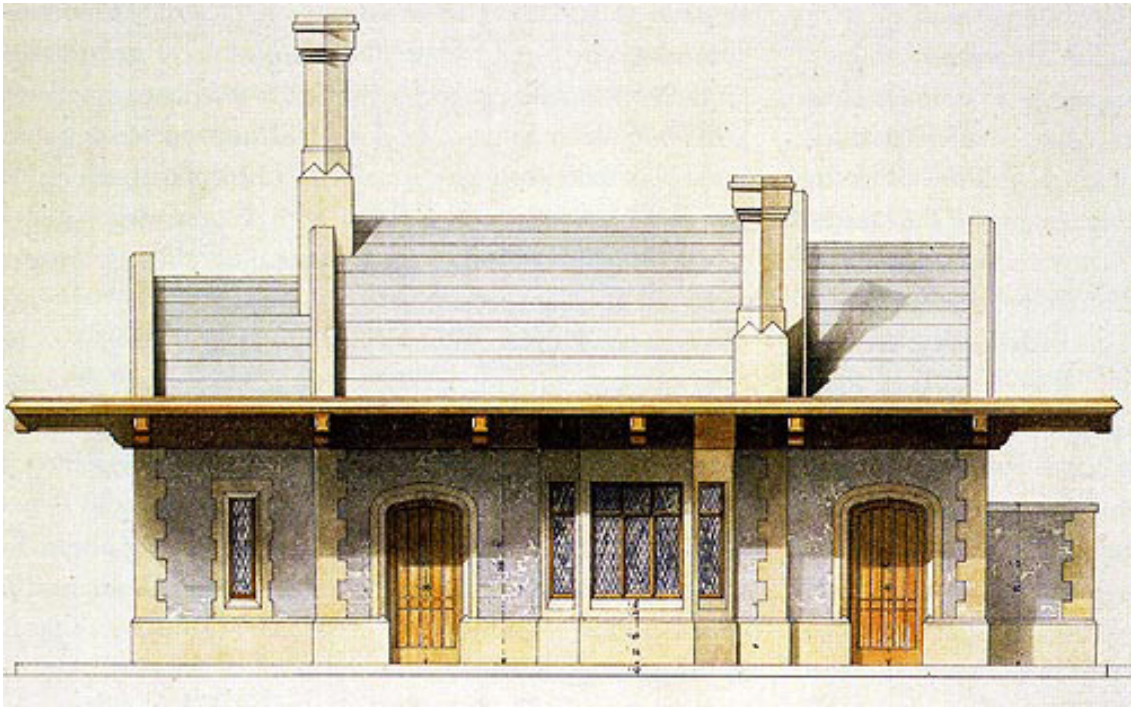

Fig. 17: Contract drawing showing Brunel's design for Culham Station. It is uncertain whether this represents the design as built but it nonetheless demonstrates the 'chalet' structure typology

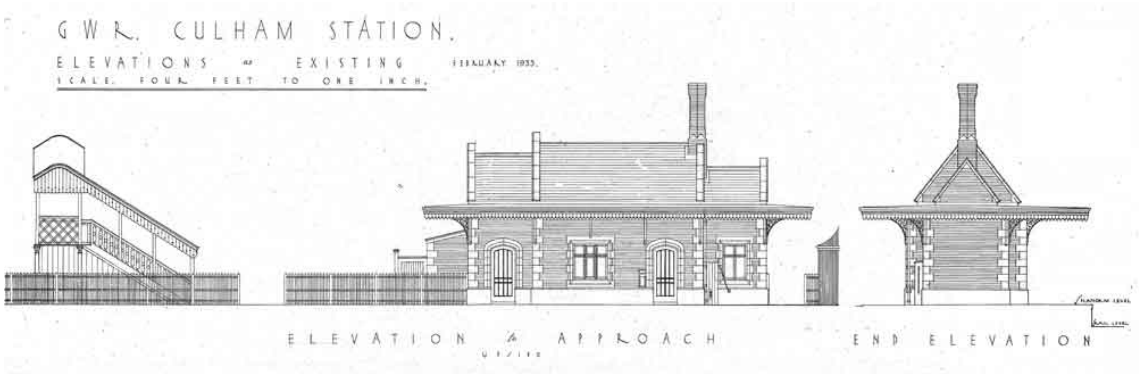

Fig. 18: Brunel's 1844 Culham Station 'chalet' structure drawn as it existed in 1935 and showing daggerboard valancing to the canopy

Fig. 19: Brunel's Charlbury Station is an example of the exaggerated roof model of 'chalet' style

Fig. 20: Restored in 2014, Pantyffynnon station is an example of the adoption of Brunel's 'chalet' style

Fig. 21: Mount Florida Station, Cathcart Circle 1886

Fig. 22: Glazed canopy on the island platform at Queens Park Station, Cathcart Circle 1886

Structurally independent canopies

Brunel's 'chalet' structures were well suited for the small station buildings initially required along Britain's new railway lines, but they did not provide sufficient shelter for the expanding stations and number of passengers using them as the railways rapidly developed. The result was the introduction of structurally independent canopies supported by iron or timber columns.

Canopy structures were built adjoining or separate to the station building along the platforms and over elevated footbridges. On island platforms these were free-standing but where platforms had wall backings, canopies were bracketed from these walls and from iron columns on the platforms. The ironwork brackets provided opportunity for decorative schemes to be employed, and this was often extended to the columns (Lloyd 1979).The materials for the canopies themselves vary depending on the date they were designed and constructed; timber, iron, steel, glass and glazing were used in various combinations. The majority of Britain's medium-sized stations had individual platform canopies, as did many of the smaller stations and a few of the larger ones. The old Midland Railway main line retains platform canopies at a large number of its stations, as do former GWR stations and many of the suburban stations on the way out of London such as the eight at Clapham Junction (Bradley 2015).

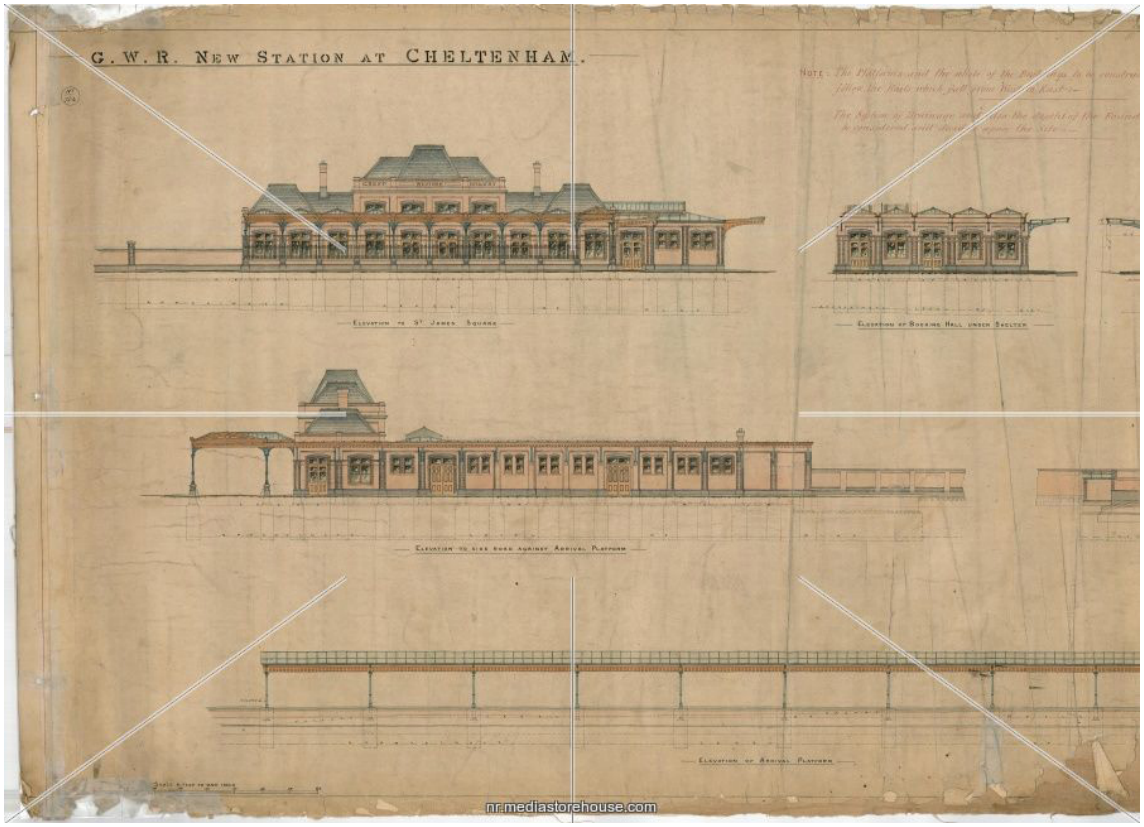

Fig. 23: These 1892 designs for Cheltenham station provide examples of a wall-bracketed canopy (middle) and a large platform canopy structure supported by columns (bottom)

Practicalities of canopies today

To keep passengers dry, canopies extend beyond the platform edge, over the track. Water runoff functions differently depending on whether there is a train at the station:

In the absence of a train, rain water runs off onto the tracks, and is carried away by track drainage. This saves on the cost and maintenance burden of gutters.

When there is a train in platform, rainwater runs off onto the roof of the carriage, and is diverted to the end of the carriage and down to the track. This creates a sheltered zone for passengers to get on and off the train without getting wet.

Appendix B: Cost calculations

Labour cost of replacing timber daggerboards with FRP

The cost calculations in this section concern only the labour costs of renewal in FRP; the cost of materials is contained in the following section of the report.

For the purposes of this report, hypothetical canopy dimensions have been used for ease of illustration. Figures relating to rate of renewal and cost have been supplied by Network Rail.

- Canopy length: 100m
- Average labour cost of an eight-hour shift: £3,400
- Average rate of replacement with FRP: 10.5m per eight-hour shift

Cost of stripping the existing canopy valancing at a rate of 10m/shift: £34,000
Cost of replacing with FRP at a rate of 10.5m/shift: £32,400
Total average labour cost of renewing existing timber canopy valancing with FRP replacement: **£66,400**

Material and upkeep cost of replacing timber daggerboards with FRP

For the purposes of this report, hypothetical canopy dimensions have been used for ease of illustration. Figures relating to material costs have been supplied by BAM Nuttall. It is understood that using purpose FRP further reduces the cost by around £90 per square metre.

- Canopy length: 100 metres
- Depth of fascia daggerboards: 0.5 metres
- Total canopy square meterage: 50 square metres
- Class 2 FRP: £410 per square metre
- Year 5 to 10 deep cleaning costs: £30 per square metre
- Year 10 to 15 deep cleaning costs: £30 per square metre

Cost of replacement FRP daggerboards: £20,500
Year 5 to 10 deep cleaning costs: £1,500
Year 10 to 15 deep cleaning costs: £1,500
Total material cost over 15 year lifespan: **£23,500**

8.2.1 Labour cost of renewing timber daggerboards in timber

The cost calculations in this section concern only the labour costs of renewal in timber; the cost of materials is contained in the following section of the report.

For the purposes of this report, hypothetical canopy dimensions have been used for ease of illustration. Figures relating to rate of renewal and cost have been supplied by Network Rail.

- Number of platforms: 1
- Canopy length: 100 metres
- Depth of fascia daggerboards: 0.5 metres
- Average rate of renewal in timber: 8.5 metres per eight-hour shift
- Average labour cost of an eight-hour shift: £3,400

Cost of stripping the existing canopy valancing at a rate of 10m/shift: £34,000
Cost of the renewal in timber at a rate of 8.5m/shift: £40,000
Cost of filling nail holes and touching up paintwork at a rate of two shifts/platform: £6,800
Total average labour cost of renewing existing timber canopy valancing in timber: **£80,800**

Material and upkeep cost of replacing timber daggerboards in timber

For the purposes of this report, hypothetical canopy dimensions have been used for ease of illustration. Figures relating to material costs have been supplied by BAM Nuttall.

- Canopy length: 100 metres
- Depth of fascia daggerboards: 0.5 metres
- Total canopy square meterage: 50 square metres
- Softwood treated tongue and groove timber: £50 per square metre
- Painting in possession: £150 per square metre
- Uplift for piecemeal installation: £100 per square metre
- Year 5 to 10 repainting costs: £150 per square metre
- Year 10 to 15 repainting costs: £150 per square metre

Cost of replacement timber daggerboards, painting in possession and uplift for installation: £12,500
Year 5 to 10 repainting costs: £7,500
Year 10 to 15 repainting costs: £7,500
Total material cost over 15 year lifespan: **£27,500**

Labour cost comparison

For the purposes of this report, hypothetical canopy dimensions have been used for ease of illustration.

The table below shows the average labour cost estimates of replacing existing timber daggerboards. The labour cost estimates are calculated from the statistical figures provided by Network Rail.

- The labour cost is constant at £3,400 per eight-hour shift
- Calculations refer to one platform with 100 metres of existing timber canopy valancing

Material	Metres stripped/8hr shift	Cost of stripping	Metres replaced/8hr shift	Cost of replacing	Cost of additional processes	Total labour cost
Timber average	10	£34,000	8.5	£40,000	£6,800	**£80,800**
FRP average	10	£34,000	10.5	£32,400	n/a	**£66,400**

Observations:

- The average labour cost of replacing existing timber canopy valancing with FRP is 18% less than renewing in timber.

Material and upkeep cost comparison

Timber daggerboards require repainting in order to maintain a high aesthetic standard. This is understood to take place roughly every 5 years. FRP daggerboards are understood to require deep cleaning at similar intervals. The figures below are provided by BAM Nuttall and do not include the associated labour costs.

Material cost comparison

- Softwood treated tongue and groove timber: £50 per square metre
- Painting in possession: £150 per square metre
- Uplift for piecemeal installation: £50 per square metre
- Total initial material costs for timber: £300 per square metre

	Softwood treated tongue and groove timber	Class 2 FRP
Basic material / square metre	£50	£410
Painting in possession/ square metre	£150	n/a
Uplift for piecemeal installation/ square metre	£100	n/a
Total initial material cost/ square metre	**£300**	**£410**

Upkeep cost comparison

	Softwood treated tongue and groove timber	Class 2 FRP
Year 5 to 10 repainting/deep cleaning costs/ square metre	£150	£30
Year 10 to 15 repainting/deep cleaning costs/ square metre	£150	£30
Total upkeep costs over 15 years/ square metre	**£300**	**£60**

Total material and upkeep cost comparison

For the purposes of this report, hypothetical canopy dimensions have been used for ease of illustration. The dimensions assume a canopy length of 100 metres, with daggerboards 0.5 metres in depth. The figures below are provided by BAM Nuttall and do not include the associated labour costs.

	Initial material cost	Upkeep costs Year 5 to 10	Upkeep costs Year 10 to 15	Total material costs over 15 years
Softwood treated timber	£15,000	£7,500	£7,500	**£30,000**
Class 2 FRP	£20,500	£1,500	£1,500	**£23,500**

RAILWAY HERITAGE TRUST

The Railway Heritage Trust has operated since April 1985. It is an independent not-for-profit company, owned by its Directors and limited by guarantee. The Trust is not a charity.

The Trust is supported by grants from Network Rail and Highways England (Historical Railway Estate) so that it is able to award grants of some £2 million a year. The Trust makes these grants to encourage the conservation and enhancement of railway buildings and structures which are listed or scheduled, or are of special architectural or historical interest. It also acts as a catalyst between outside parties and owners in the conservation and alternative use of non-operational railway property, including the transfer of responsibility to local trusts or other interested organisations. The Trust's scope of operations is the property of Network Rail and Highways England (Historical Railways Estate). As well as its grants, the Trust also offers an advice service for built heritage matters within its scope.

Further details of the Trust's activities can be found at www.railwayheritagetrust.co.uk

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