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# A study of timber frame repair and the case of Gunns Mill's old blast furnace

# Um estudo sobre o restauro de estruturas de madeira e o caso do antigo alto-forno de Gunns Mill, Reino Unido

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**Abstract**

This article provides a critical summary of repair techniques employed for timber frame and an analysis of factors which might determine the adoption of a particular approach, in this case, a brief analysis at Gunns Mill. Gunns Mill is a remaining blast furnace from the 17th century, located in the Forest of Dean, which was the leading iron-making area in the UK since the medieval ages. The 18th-century half-timbered paper drying house endured, however, it is in a dilapidated state. The knowledge from the first part is applied to an aspect of the paper house and discussed approaches for its repair. Repairing does not only depend upon structural considerations, historic value and visual appearance influences, but also on the conservation philosophy adopted, which might restrict the range of options of repair.

**KEYWORDS**
Forest of Dean
Timber frame repair
Blast furnace
Gunns Mill
Buildings at risk

**Resumo**

Este artigo fornece um resumo crítico das técnicas de restauro empregues para estruturas de madeira e uma análise dos fatores que podem definir a adoção de uma determinada abordagem, neste caso, uma análise sobre Gunns Mill. Gunns Mill é um alto-forno remanescente do século XVII, localizado na Forest of Dean, que foi a principal área de produção de ferro no Reino Unido desde a Idade Média. A casa de secagem de papel meio-enxaimel do século XVIII sobreviveu, no entanto, encontra-se num estado degradado. O conhecimento na primeira parte é aplicado a um aspecto da casa de papel e são discutidas as abordagens para o seu restauro. O restauro não depende apenas das considerações estruturais, do valor histórico e do aspeto visual, mas também da filosofia de conservação adotada, que pode restringir as opções.

**PALAVRAS-CHAVE**
Forest of Dean
Restauro de estruturas de madeira
Alto-forno
Gunns Mill
Edifícios em risco

## Introduction

A set of principles for historic building and timber frame conservation has been largely covered by the Society for the Protection of Ancient Buildings (SPAB) [1-2] as well as the ICOMOS International Wood Committee's document: *Principles for the Preservation of Historic Timber Structures* [3]. These principles emphasize repair over restoration, minimal and reversible intervention, and the use of traditional repair methods. The Burra Charter [4] also emphasizes the use of traditional materials and techniques, while acknowledging the potential for contemporary methods. To prevent or hinder decay without causing unnecessary damage to the historic fabric or altering the architectural or historical character of the building, Brereton and Pickard [5-6] suggest that repairs should be carried out.

A basic principle of repair for historic buildings is to understand the significance of a place to ensure that any proposed repairs will be beneficial and not harmful to its significance [7]. This article aims to consider Gunns Mill's paper drying house as a case study to the discussion of historic timber frame repair techniques. The text is divided in a critical study and repair techniques for timber frame and an analysis of factors that determine the adoption of a particular approach in a specific case study, and, secondly, the case study itself. The article will focus on the timber structure of the paper drying house, review its current state, then, apply understanding from the first part to be used as a reference to recommend an approach to be followed. It also includes background information on the study location and its historical significance.

Gunns Mill is a remaining blast furnace dating from 1625, situated 2.6 km North of Littledean, England [8-9]. The blast furnace was prominent in ironmaking in the United Kingdom, as this was the location which had more furnaces active. However, in 1740 the site was converted into a paper mill. The Former eighteenth-century timber charging house and half-timbered paper drying house impressively persisted, nonetheless, it is currently in a dilapidated state. Its importance as a historic building lies in both the typology and the relatively fair condition of the blast furnace itself.

In terms of methods of research, an extensive desktop study, literature review and documentary research were fundamental to write the first part of this article, and site visits, photographic and building surveys helped with the analysis of the case study.

According to Douglas Kent, technical secretary of the Society for the Protection of Ancient Buildings (SPAB), inappropriate maintenance or alterations are the main factors causing problems in historic timber buildings. These problems can be divided into two types: decay from beetle or fungal attack caused by dampness, and distortion from overloading or removal of frame members [1]. For this reason, this report will start discussing decay and infestation, its treatment, to later, considerations about assessing and surveying timberwork and repair techniques, weatherproofing and applied finishes.

As the first part of this article serves as the basis for the case study, it consists of a summary of types of decay and infestation most common. Due to space limitations, a detailed discussion of all possible types of beetle and fungi attacks is not included. The case study will cover Gunns Mill's background history and significance, a brief survey of the building, and focus on the half-timbered drying paper house to discuss possible repair methods for the south-east and west walls of the timber drying loft, while considering the advantages and drawbacks of intervening in a significant and historic structure. The proposed method will adhere to the conservation principles outlined in the first part of the report.

## Decay and infestation

For centuries, timber structures and elements, including windows and doors, have been widely used in Britain for their structural and aesthetic properties, as well as being an energy-efficient and renewable resource [10]. The way timber was shaped or arranged can aid in dating historic buildings, as different types of joints, carpentry, and framework design evolved over time [11]. However, timber also has a biological role and can be a food source for organisms such as fungi or beetles, which can attack and decay the wood if certain environmental conditions are present (moisture content and temperature) [12-13]. The most common beetle responsible for timber decay is *Anobium Punctatum*, also known as woodworm. *Xestobium rufovillosum*, known as death watch beetle, *Lyctus* spp., powder post beetle, and *Hylotrapes Bajalus*, house longhorn beetle, are also commonly found in historic buildings.

Fungi decay is different, as it degrades wood into simple edible material, resulting in loss of weight and strength. Mainly, there are two types of fungal attacks: wet rot and dry rot [12]. In the past, chemicals and biocides were commonly used to treat infestations, but this approach only treated the symptoms and not the underlying cause. If the problem is solved by removing the source of dampness, then, the timber will dry, and further decay will not be likely to happen again if environmental factors are controlled. Consequently, chemicals are unnecessary [14].

Remedial treatments frequently involve loss of structural fabric or irreplaceable details on floors and ceilings. In addition, they are expensive, not sustainable, and unsafe for the specialists that apply it and inhabitants of the building. Accordingly, during the last century conservators realized that biocides are not the answer for all infestation problems. Environmental control and preventative maintenance are the best alternative, as they are less destructive, retain more historic timber, and align with principles of historic conservation [12].

Systematically surveying and assessing the timberwork using non-destructive techniques is also important, as well as effectively discovering the cause and extent of dampness. British Standards [15, pp.22-23], reinforce the importance of this approach, stating that chemical treatment is unnecessary, and the best approach is to keep timber dry. A specialist consultant or surveyor should conduct an examination to effectively discover the cause and extent of dampness. In buildings, moisture can increase through penetrating or rising damp, condensation, leakages, or from mortars, concrete, and plaster. It is crucial to reduce the moisture content of all timber to below 16-18 %, which is the desired level not to benefit organisms to multiply. To accomplish this, it is necessary to isolate the timber from damp masonry using a damp proof membrane, ensure adequate ventilation, and provide air movement around walls and roofs. Additionally, other sources of water should also be removed, such as poor rainwater goods, gutters, leaking plumbing, condensation and rising or penetrating damp [12]. By following these guidelines, the future health of historic buildings can be ensured while retaining their unique character and historical significance.

**Woodboring beetles**

Most of woodboring beetles have similar life cycles, they vary in type of time attacked and the extent and damage caused, which is what helps to identifying them. Correct identification is extremely important to avoid mistreatment, since they are all commonly divided in three groups regarding treatment required. The first category may need insecticidal treatment. If active: few insects require it. Structural survey is necessary. If inactive: do not require treatment. Insects may have died of natural causes or eaten by parasites (spiders); as regards the second group, treatment necessary to control allied fungus, some beetles feed on wood rotted by fungi. Therefore, to prevent it, controlling wood rot first should solve the issue. Finally, the third, which requires no treatment, if beetles attacked green timber, they are likely to have been killed during drying process of wood, so no treatment is needed. These insects do not require pesticides [16, p. 52].

***Anobium punctatum* (woodworm)**

The furniture beetle, also known as *Anobium punctatum*, has been a significant cause of damage to timber in Britain for over a century. According to Hutton "at least 50 per cent of buildings in the UK have had some prior infection and decay by *Anobium punctatum*" [17]. Woodworm often attacks scarcely ventilated structures and, these types of infections are easy to assess. If the moisture content of the timber is below 12 %, then it is too dry for infestation to occur. However, if the moisture content falls between 16-30 %, it is likely to occur. If this level of moisture is present in the sapwood, it is recommended to investigate whether the moisture is likely to continue for over two years, if this is the case, eggs may be able to fully develop, and treatment should be considered [17].

To determine necessary repairs for damaged historic buildings, experts must assess the extent of damage using non-destructive imaging methods such as X-rays. Repairs may involve replacement or scarfed new timber. Preventing future decay requires ensuring moisture content stays below 16 % for longer than a year. Signs of previous woodworm attacks should not be a major concern, but dust and tunnel appearance can indicate active infestation, if the tunnels are dark and dirty, the attack is likely to be historic. Conversely, if the tunnels are clean or light-coloured, the attack is likely to be recent or active [14].

**Fungi infestation**

In summary, there are two types of infestation caused by fungi which infest timber structures: dry rot and wet rot. Wet rot fungi thrive in consistently moist environments, with an ideal moisture content range of 50-60 %. Therefore, wood-rotting fungi differ in their optimum temperature, between 20-30 °C. In contrast, dry rot occurs in minimum moisture content in timbers of about 20 %. Optimum growth occurs at 30-40 %. Spore germination requires wood moisture content of 30 %. The optimum temperature for growth in building is about 23 °C, maximum temperature for continued growth about 25 °C and the fungus is killed above 40 °C [12].

## Surveying timber and repair techniques

The deterioration of timber-framed buildings is not limited to biological decay and requires different repair techniques to address various causes. Some potential problems are caused by dampness and structural failures, such as overloading of lintels and beams due to excess weight or subsequent alterations, as well as the cutting of timbers during past interventions, can result in potential problems [11-12]. For instance, [14] cites a timber-framed house in Sussex that underwent an intervention in its infill panels, where original wattle and daub was replaced with flint and stone. This alteration, without proper consideration of weight, may lead to distortion of the historic frame. It is important to conduct detailed structural assessments to avoid any harm to the historic fabric. Another aspect of structural failure to be considered is the joints between timber elements, which are crucial to the performance of the structure and are connected through timber-to-timber mortise and tenon joints.

To identify timber construction issues and develop repair methods, expert surveys and assessments are crucial. Before intervention, honesty, minimal intervention, structural integrity, documentation, reversibility, and like-for-like repairs must be considered. Honesty means repairing without changing the historic building's appearance. Minimal intervention retains as much historic timber as possible and minimize the introduction of new elements, and conservation architects should consider moving timber for repair to avoid damage. Structural integrity depends on joint condition. Documentation records the condition of the fabric before intervention and document all alterations or repairs to ensure that future conservation or maintenance work is properly executed. Reversibility enables undoing repairs without harm to the original fabric [11]. Like-for-like repairs, as specified in the International Woods Committee principles for the preservation of historic timber by ICOMOS (1999), require using the same materials, construction, and jointing techniques as those used in the building's history [18].

After considering these conditions, then it is necessary to survey the historic timberwork and the information collected should aid in understanding the overall condition and strategy for conservation and a repair schedule. When assessing it, SPAB [1], Hunt and Suhr [14] and Boutwood [19] advise to test if timber is sound by poking with a penknife. However, there are alternative, non-intrusive methods for assessing the structure, such as infrared thermography, micro-drilling, fiber optic surveying, as noted by Brentnall and Wilson [10, 20]. Dendro-dating can also assist in dating when the wood fell and reviewing past carpentry or joinery. To create an effective repair schedule, a comprehensive understanding of the construction and condition of the building is necessary.

**Repair techniques**

Generally, repair techniques include replacement of a whole element, or a portion of it (generally its end), or if there are structural failures, reinforcing the structure with other materials, such as steel. The process of replacing a part of the timber involves removing a damaged section and joining a new piece to the old one, often through a scarf joint. The sill plate is the bottom component of the timber frame located near the ground. It is particularly susceptible to moisture and degradation and is therefore often in need of restoration. Regarding structural failures, such as cracking, bending, or crushing that occur against the direction of the wood grain, indicate overloaded structural members, which can be caused by decay, poor design, or excessive loads [11, 18]. This article divided timber repair techniques into the following: 1) timber to timber repairs; 2) repairs using resins; 3) use of metal in repair work; 4) repair of Sill plates; 5) repairing holes and shakes in historic timbers.

***Timber to timber repairs***

This method often uses traditional carpentry approaches or like-for-like replacements, but extensive decay may require cutting the original part to sound timber, resulting in loss of historic material. This should be taken into consideration when selecting a repair method. Scarfs typically have 75 % of the strength of a full timber, but in high-stress zones, they should be bolted or glued for best results. The type of joints used in historic structures can provide valuable information about their age and history, and the new scarf should mimic the original joint to preserve this information. Figure 1 illustrates two typical scarf joints, with the only drawback being the required size of timber. If the new scarf is likely to receive greater stress, all joints should be connected either with pegs or stainless-steel bolts [10, 19].

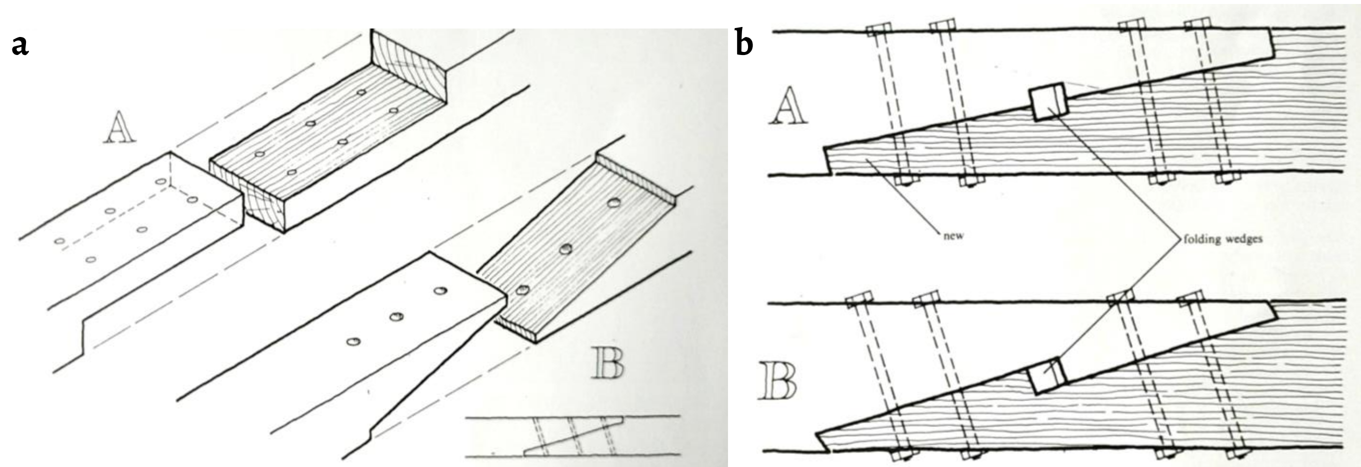


**Figure 1.** Typical scarf joints: *a)* two simple scarf joints for repairing horizontal elements, sill plates or wall plates, the size of joints should be 2.5 to 3 times the depth of the plate; *b)* the most common scarf used in tie beams, this type of joint is strong against curving upwards or downwards in the middle and sideways movements [19].

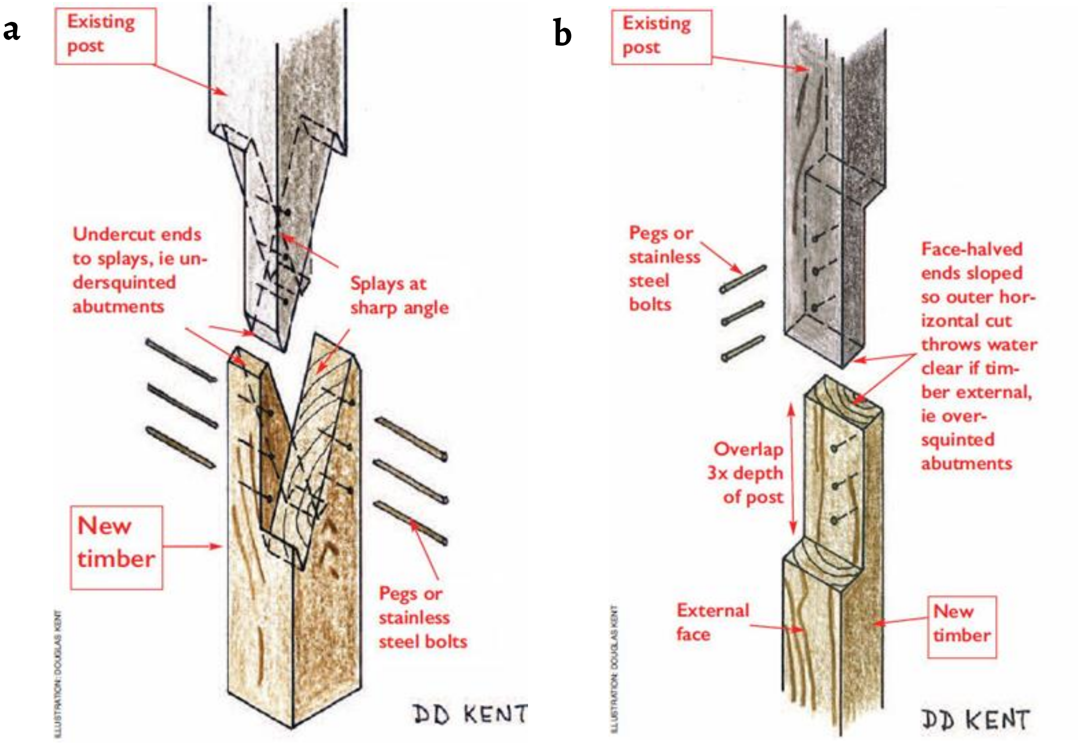


**Figure 2.** Drawings of: *a)*: scissors scarf repair to a post and *b)*: face halved scarf repair to a stud [1].

Figure 2 depicts repair to vertical members or in compression. The main difference from the horizontal scarfs is that the cuts are designed to guarantee that water is not guided into the direction of the joint.

***Repairs using resins***

Resin-based repair techniques face criticism due to their disadvantages, despite some companies promoting its use. While resin repairs offer advantages, such as minimal loss of historic fabric and gap-filling capabilities, their drawbacks may outweigh these benefits. Resins are not reversible and may fail when exposed to moisture, leading to potential issues. Figure 3 below depicts: in situ epoxy resin repair to the base of a post. A crack had occurred between the resin filling and the timber due to movement at the joint between the post and sill, besides, mould surrounding resin because of moisture.

**Figure 3.** The white arrow points out the location of crack which indicates that the bond between resin and the decaying end grain of the timber was not strong, failure because of poor design [2, p. 318].

***Use of metal in repair work***

Metal to repair timber has been used for centuries. Generally, they are reversible, it can be used to strengthen (Figure 4) a member that has insufficient load carrying capacity, supplementing it, and acting independently to provide support or acting together, even though it alters the frame structural behaviour. Besides, repairs can be at decayed or damaged joints or decayed end or face to be replaced. One advantage of using metal is that less historic material is lost, although the appearance of the repair may be noticeable. Despite its higher cost, steel is often a suitable choice due to its high strength-to-size ratio and resistance to corrosion when in contact with oak [21].

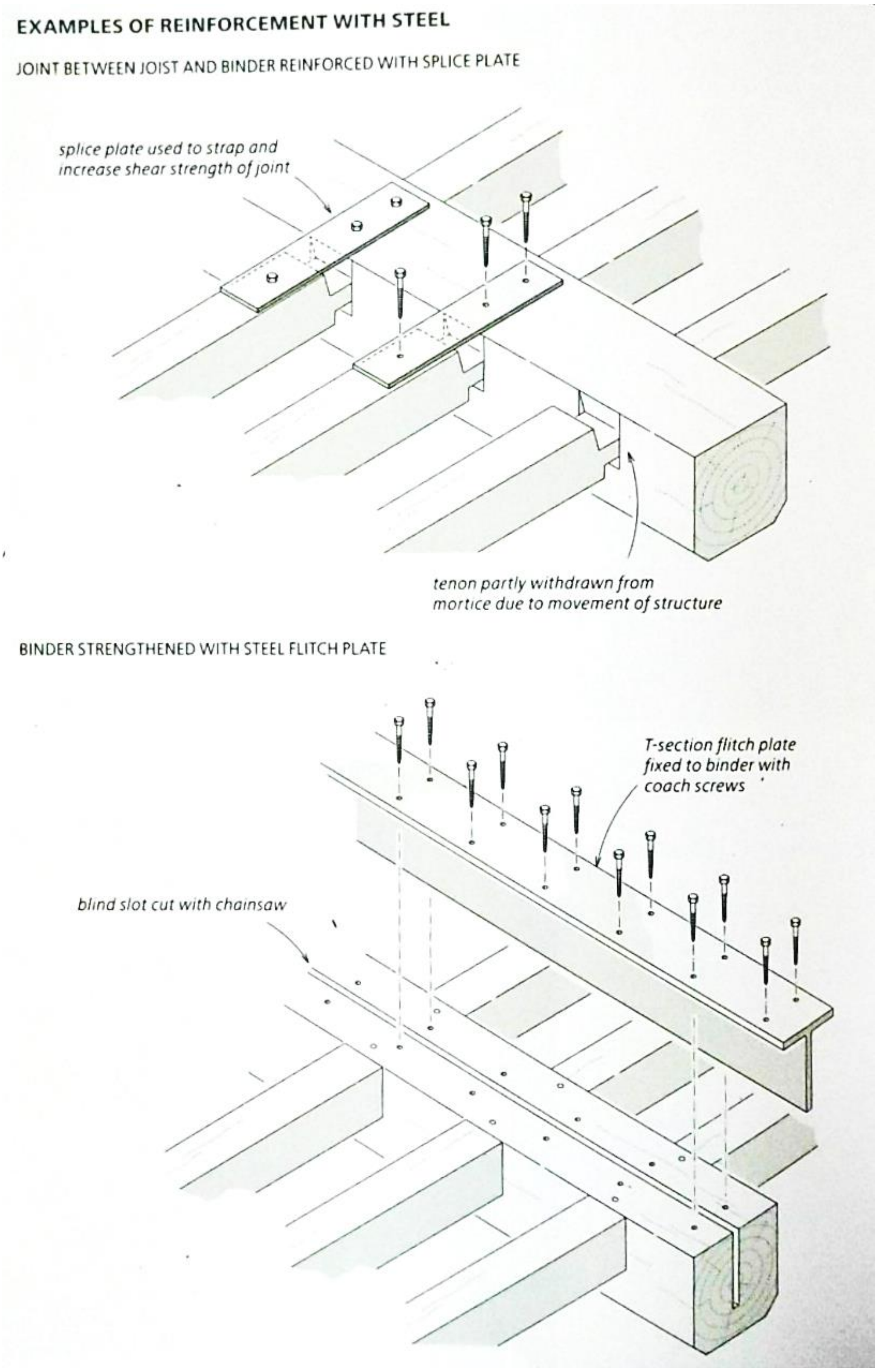


**Figure 4.** Timber strengthened with steel plates [2, p. 386].

***Repair of sill plates***

Sill plates are horizontal elements of a timber frame at the bottom that typically rest on masonry bases and are therefore susceptible to high moisture levels and decay. Therefore, it requires more attention, as partial or total renewal of the plate may be necessary. If replacement is needed, the supporting brick or stone plinth can be rebuilt, with an option to raise the plinth height to prevent future decay. If the masonry base is not being rebuilt, a solution is to create a new sill plate by cutting two halves and bolting them together with stainless-steel bolts [1]. Figure 5 illustrates different situations of repair techniques. The first (Figure 5a), if a sill beam has decayed and the supporting plinth must be redone, the new plate can be introduced from underneath with the mortices already cut to have the tenons on the studs as shown in A. "B" shows simple method of replacing in two sections so that the masonry is untouched. One half of the plate is cut to receive the tenons from the studs and the bolts must be located to avoid them. If tenons on the studs must be substituted, this can be done by cutting in a false tenon as shown in "C". [19, p. 11]. As regards the second situation Figure 5b shows in "A" how a new sill plate can be positioned horizontally and then held with infill parts, part "X" being put in from the front and "Y", then, from above. It requires a lot of time to be executed and is expensive. This repair can be used to putting new sections to plate in situ. "B" illustrates how infill pieces can repair a timber in situ [19, p. 11].

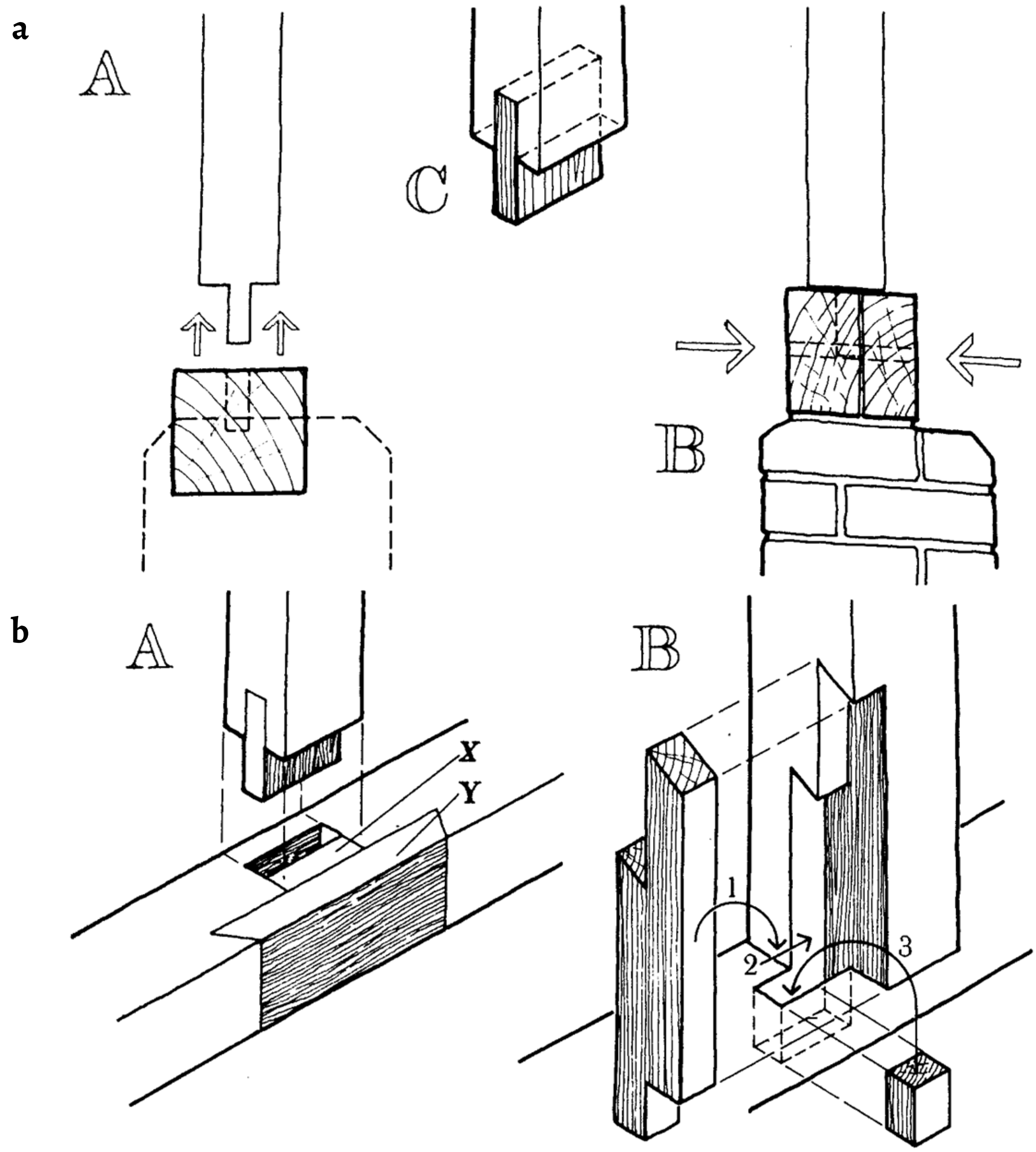


**Figure 5.** Repair of sill plates: *a)* Situation #1, *b)* Situation #2 [19, p. 11].

***Repairing holes and shakes in historic timbers***

There is no perfect method for dealing with holes or shakes, but it is possible to fill in shakes (splits) or holes in timbers. Splits are hardly of structural concern, even though might let rainwater penetrates from outside. A solution is to fill it with lime putty. The same concept is used for empty mortices or peg holes, they can either be filled with timber inserts or well-haired lime mortar and lime washed. Timber inserts can also be pieced in when part of a timber face has rotted away [1, 19].

## The case study of Gunns Mill

**Background history and significance**

The Gunns Mill site in Gloucestershire is home to a historically significant former charcoal blast furnace, considered to be one of the most well-preserved in England. This place has a long history of iron making, during the medieval ages it was the leading iron-making district in the United Kingdom, with more blast furnaces in the country [22]. Gunns Mill dates from the seventeenth century, the main structure was built in 1625 and the furnace's timber frame was re-constructed in the 1680s using oak beams for its superstructure. In 1625 the ironworker John Winter built a blast furnace close to a mill and the name was transferred to the iron works. A dendrochronology study dated the oak trees used for the beams of the superstructure attached to the furnace were chopped in 1681-1682 [23].

Cast iron was produced in the furnace until 1736, when it changed to producing paper. A timber structure was built on top of the furnace area to dry it. Production of paper was continued by Lloyd's family for over three generations until 1840. By the end of the nineteenth century, the building changed ownerships many times for agricultural purposes and eventually fell into neglect [9]. In 1955, the site was listed as Grade II* and Scheduled monument [22]. In 1968, a preservation order was made [24-25]. The closure of Gunn's Mill as a Blast Furnace is possibly linked to the depletion of woodland and its rising cost, as well as mid-eighteenth-century wars and foreign competition, leading to a general decline in the industry [26]. Abraham Darby's development of a coke-fired blast furnace in 1709 became the dominant method of iron production, further diminishing the significance of the charcoal blast furnace at Gunn's Mill as a rare historical survivor.

In 1986, the site was scheduled by English Heritage. William Parker saved the blast furnace from demolition in 1994 when he purchased the site with an Ancient Monument and Listed Building Consent for conversion to a two-bedroomed dwelling. The building was already in poor condition and internal and external scaffolding was erected to prevent collapse. The dating of the oak timbers has increased the historic value of the site from important to unique, but unfortunately, Gunns Mill Furnace has remained covered in scaffolding (Figure 6b) [9, 27]. In 2000, English Heritage increased the structural support and weatherproofed the building. In 2013, William Parker donated Gunn's Mill to the Forest of Dean Buildings Preservation Trust (FODBPT) due to funding concerns for its restoration.

The FODBPT is a charity established in 1996 to restore and preserve historic buildings in the Forest of Dean area. They have conducted extensive repair and restoration work on the site, including repairing the roof, stabilizing the walls, and restoring the millpond. The paper drying house, however, remains in a state of disrepair and requires significant attention. The FODBPT conducted investigations to determine the building's condition and is seeking Heritage Lottery Funding for preservation works. The original building is made of coursed, squared rubble walling with eighteenth-century timber-framed additions on the first floor. This case study will focus on the timber structure of the paper drying house, highlighting concerns and areas in need of attention, followed by a brief analysis of the defects and proposals for intervention. Due to years of neglect and alterations, the building is listed as "High Risk" on the *Buildings at Risk Register*.


**Figure 6**. Gunns Mill: *a)* in the 1990s [24]; *b)* current state, view from Southeast (2017).

**Current condition and brief survey on timberwork**

Caroe & Partners Architects [22] has thoroughly described the situation of the building for the last ten years, Gunns Mill stands at a height of 8 m, rising to 14.5 m when including the later added timber structure. Additionally, the building spans a length of 8 m (17.5 m with the roofed structure) and has a width of 10 m. The building was constructed into a slope, with the furnace being loaded at the upper ground level and the iron and slag being discharged at the lower level. Above the furnace is a half-timbered drying loft, which was used to dry materials, and its roof is slated. The southern gable end of the drying loft is made of wattle and daub, while its west and east sides have windows. Adjacent to the drying loft is the Charge House, which was used to store and prepare materials in the dry prior to being fed into the furnace. The Charge House has a slightly higher floor level than the drying loft. The construction of the Charge House can be dated back to 1681-1682, based on the felling dates of its timber trusses. Even though the furnace is largely structurally sound, the drying loft has become unstable due to the partial collapse of the east wall of the Charge House, which has accelerated the decay of the timber frame, particularly the trusses. The lack of support above the staircase holes has also caused local instability in the furnace.

In summary, the east wall of the Charge House is leant because of many issues: failure of masonry underneath, movement of decayed roof, possible lateral force below floor level in the anticipated destabilized fill, also as an effect in the east drying loft wall is leant too. The roof structure and east wall of drying loft decayed severely because of lack of covering. It requires complex in situ repairs (Figure 7) [22].

The focus is the east and west walls of the drying loft, Figure 8 represent the survey carried out. The floor plan was drawn based on-site visits, photos taken and through analysis of drawings included in Cotswold Archaeology [27]. Additionally, the elevations were taken from the same source [27] and adapted by the author to aid in surveying the current condition of the loft to recommend methods of repair (Figure 9 and Figure 10).


**Figure 7.** Drying loft: *a)* East wall; *b)* West wall (2017).

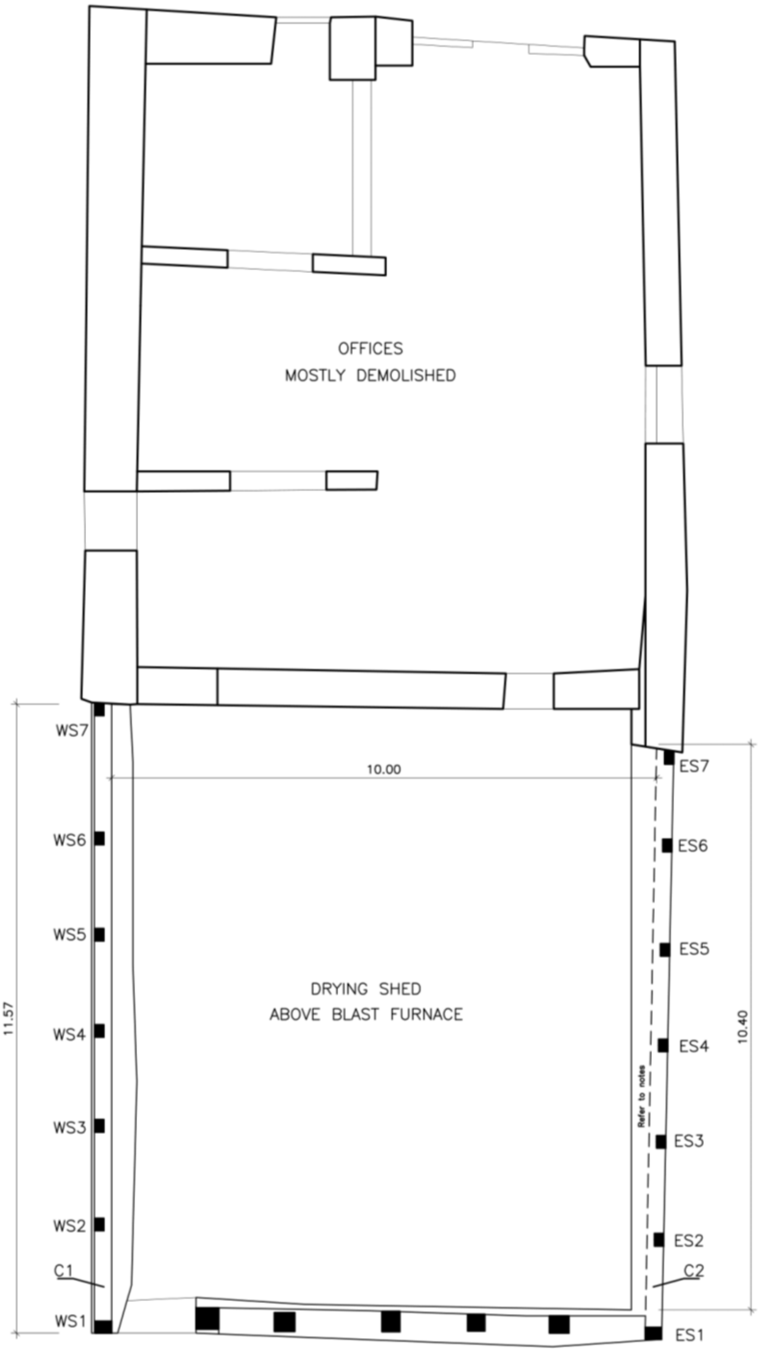


**Figure 8.** This is the construction of the timber frame over the blast furnace in c.1740 [27]. The sill plate on the east side has almost disappeared because of decay. ESY stands for East Wall Stud "Y"; WSX stand for west wall Stud "X", C1 West sill plate and C2 East sill plate.


**Figure 9**. Detailed survey of the East elevation: *a)* Localization scheme of the East wall studs, and *b)* Individual stud details (2017).

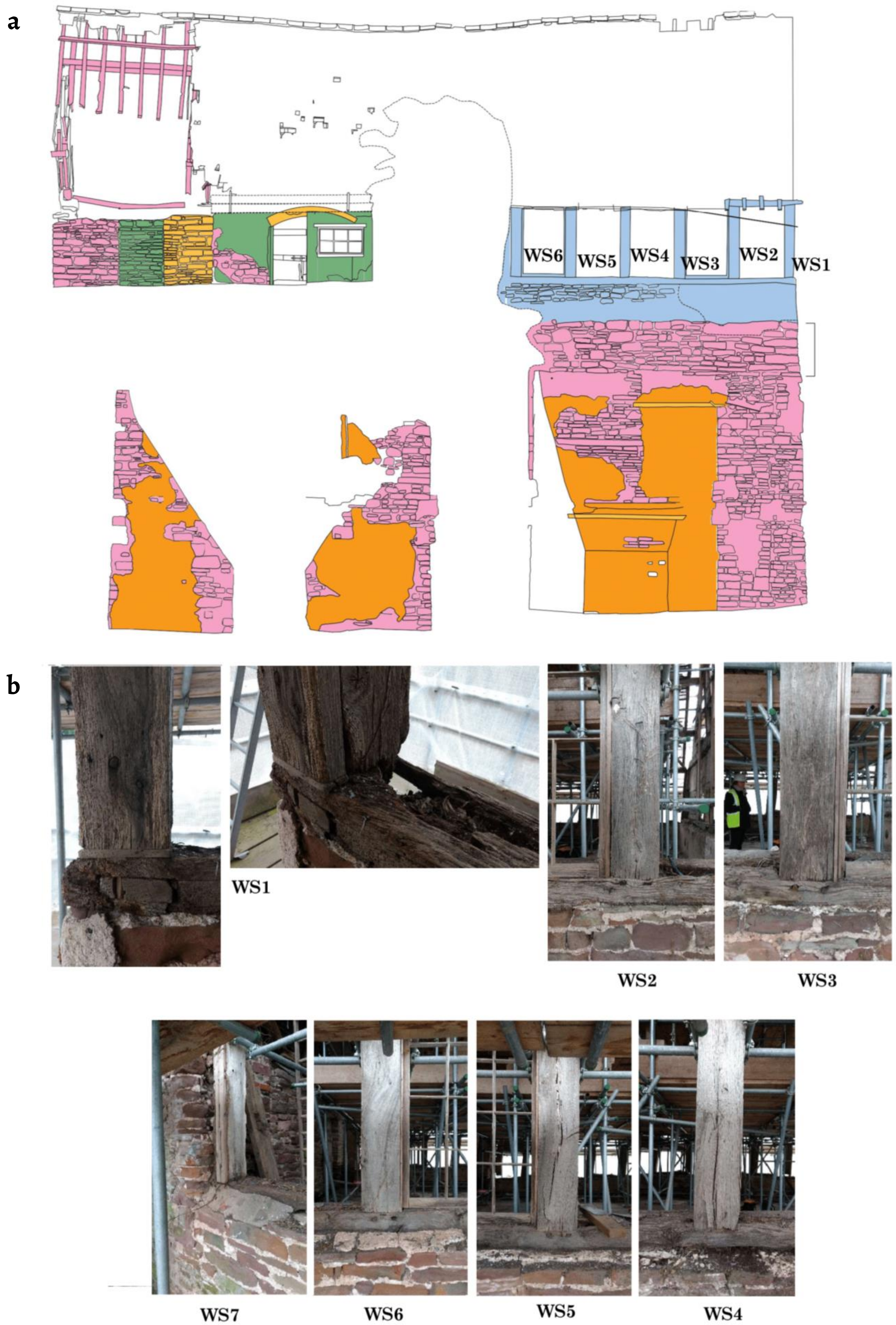


**Figure 10.** Detailed survey of the West elevation: *a)* Localization scheme of the West wall studs, and *b)* Individual stud details (2017).

**Recommended method of repair**

The recommended approach to the implementation of these techniques involves a comprehensive examination of the issues at hand by knowledgeable professionals in the field. This examination would then be followed by the conduct of repair trials in limited areas to test the viability of the methods being proposed. In order to ensure that the repairs are in harmony with the original materials and structure, it is crucial to use materials that are compatible with those of the historic joinery. Finally, the repair process must be completed in accordance with established guidelines such as the Building Regulations and recommendations from the Building Research Establishment. Possible strategies for the east and west walls of the Drying Loft are:

- Sill plates: The complete replacement of the east sill plate is necessary as it is nearly non-existent. Additionally, repairs to the plinth wall are required. These repairs should be performed according to the scheme outlined on page 10. On the west side, partial replacement is necessary, as some parts of the timber are sound. The repairs should follow the scheme on page 10. On the west wall, traditional methods, such as re-pegging, should be used to regenerate joints where necessary. On the east wall, new scarfs joints should be re-joined to the new sill plate.
- Studs: On the east wall, new scarfed joints will be added to the bottom part of all seven studs.
- Decay and infestation: The west wall shows signs of beetle attack and woodworm, for instance, refer to west stud 01. However, these attacks are likely to be historic, as they are dark and dirty and there are many spider webs nearby. The beetles are likely to have been killed by predators, so there is no cause for concern as they are inactive.

## Conclusion

The aim of this report is not to delve into the intricacies of conserving historic timber frames, but to briefly highlight some of the key principles that are widely accepted in the field and that inform the various repair methods and techniques used. Timber is one of the oldest building materials used by humans. Prior to the fifteenth century, it was the most widely used material, until brick and later iron gained popularity. During the Victorian era, the high demand for wood in shipbuilding led to widespread use of timber frames in the United Kingdom. It is believed that oak was a popular choice for construction until the seventeenth century, and many traditional buildings made from this durable material are still standing today.

Then, Gunns Mills was analysed as a case study for repairs techniques of timber framed buildings. In the first part of the text the main repair techniques were described to use it as reference for the second part, which aimed to recommend an approach to the repair of east and west walls of the Drying loft. The first section of the report evaluated the advantages and disadvantages of various repair methods. The case study also highlighted several important factors to consider, such as appreciating the historical significance of the site and recognizing that repairs should not only be based on structural requirements, but also consider the building's historic value and visual appearance, as well as the conservation philosophy being adopted.

At Gunns Mill, the required work goes beyond simply repairing the timber. The building is comprised of various materials, including stone, wattle and daub, and brick walls, which must be studied in order to understand their interrelatedness. However, this comprehensive analysis of the building's construction falls outside the scope of this article, however great for future investigations. The future of Gunns Mill remains uncertain, but it is hoped that with ongoing support and funding, this important piece of industrial heritage can be preserved for future generations.

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