

4.Zero waste

Understanding existing buildings – five studies to complete before design work starts

Fiona Cobb presents a brief guide to the key desk research required to understand the types of construction, likely structural capacities and latent defects of an existing building.

Introduction

In 2020, the IStructE Climate Emergency Task Group surveyed the organisation's members¹ to establish what guidance would be most useful when aiming to reduce embodied energy in projects. Most requested was advice on the reuse of existing buildings, and this article is one of a series addressing this topic (see the IStructE *Climate emergency webpage*² for further articles).

To reduce embodied energy in new building projects, there will be an increasing focus on the reuse of 20th century building structures whose development is not affected by historic significance. This article is intended to assist engineers who may be working on this sort of project for the first time. There is a focus on UK-centric sources of information, but the search principles apply regardless of location.

 **FIGURE 1:** Cross-referencing Ordnance Survey (top) and WWII bomb maps (bottom) can explain changing site features

When starting work on an existing building, an essential first task is to carry out research into its history, which in turn provides insight into the building's form, materials, strength and likely latent defects. It is rare to find a set of drawings which provides a full and up-to-date record of the existing structure, so the engineer must build up their own picture by researching historic documentation. Armed with this research, the engineer can share strategic advice with the design team and advise the client on cost-effective intrusive investigations.

The five broad themes of a research study are described below.

1) Map regression

Historic maps are particularly useful for charting when a site might have been first developed, and how this development has changed over time – a process called 'map regression' (Figure 1). The aim is to generate a list of dates tied to development phases; and clues as to the building's use might also emerge along the way. Knowing the approximate date of a building gives clues as to the type of construction and therefore its likely structural capacity and latent defects.

Different types of map can be used to build up a picture of a site and its immediate surroundings. Engineers frequently use geotechnical and flood maps, but specific local conditions require additional research (e.g. caves, mines, railways, tunnels, bomb damage).

While there are many subscription services for map data, paid searches can be prohibitively expensive on smaller projects. In the UK, much of the information is freely available online and a list of selected sources is included at the end of the article. For example, UK open-source Ordnance Survey maps are generally accurate and cover the period from 1871 to 1952, while more recent maps must be paid for.

Maps prior to 1871 are very useful, but it can be more difficult to relate their features to modern site boundaries. A reasonably comprehensive desk study can be compiled, at minimal expense, in a couple of hours.

2) Statutory bodies

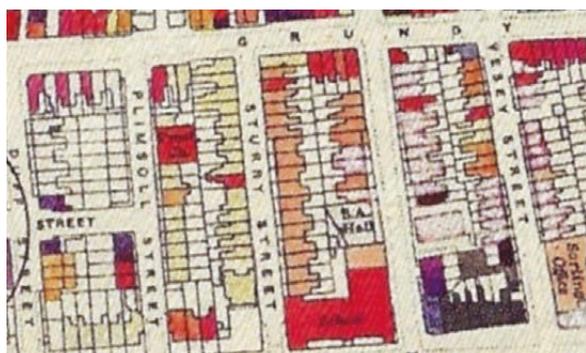
Governments have long sought to legislate on all aspects of buildings and property, including development control (planning) and safety/standards (building control). Searches of these statutory records can yield historic plans and/or details of development on the site.

In the UK, the Planning Portal (www.planningportal.co.uk/) can be searched for a full planning history of a site since 1947. Planning records are public information and records can be inspected at council offices or online, depending on their age, though these can vary in quality and consistency. Building control records are private, so records can only be inspected if a letter from the building owner is provided to grant permission.

Since 1996, the UK's CDM Regulations have required by law that clients are provided with a full set of records for their building – although these records aren't always easy to trace. For records prior to 1996, it's worth checking on site for dusty filing cabinets and boxes, even (and sometimes especially) when the building users are adamant that no such records exist!

Although research on heritage buildings is not covered in detail here, it is usually worth doing a basic search in case specialist advice is required. The aim is to establish whether:

- | a building protected for its historic character (*listed*) is on or near the site
- | the building is within an area protected for its historic character (*conservation area*)
- | the building is within an *archaeological protection zone*.



In the UK, these details can be searched via the websites of the three devolved governments and their respective heritage organisations.

3) Primary research

Primary research is the process of uncovering original documents relevant to the building, which are held in public or private archives. Tracing archives can be time consuming, but increasingly catalogues are available online, especially for public archive centres, e.g. RIBA Library, National Archives.

If a building has been in single ownership for many years, there is likely to be a facilities manager, and possibly also an archivist, to assist. Alternatively, initial searches may have established the name of the original engineers (or their new parent company) who might be approached for copies of original construction documents.

The IStructE Library keeps an informal UK Consultants Tracker (www.istructe.org/resources/guidance/consultant-tracker/) which can be incredibly useful in locating records for companies which have stopped trading. There are ample opportunities for dead ends due to fire, flood, retirement, reorganisation or a clear-out. However, on many past projects, I have traced the original consultants and been given a full set of drawings, details and loading allowances.

In addition to drawings and documents, there are picture archives which can yield photos and paintings, some during construction, such as those from London's Royal Horticultural Halls in **Figure 2**. Images of temporary works and construction methods can be very useful when considering proposed alterations.

Other types of primary evidence may include committee minutes, legal documents, financial accounts and/or site notes. They tend to offer little definitive evidence about the fabric of a building, but may help answer questions about when/why/whom and/or early plans.

A final, but often overlooked part of research is to chat to people. Building users are often keen to know about proposals. Taking the time to explain your work, and what you are looking for, will often elicit help and information. Oral accounts often yield valuable information about building uses/loading, significant events and/or building defects, which might not otherwise be revealed from archives or inspections.

There are a few points to note here about persistence:

1) **Seek advice from the archivists to obtain a comprehensive search list.**

Local archives often contain a wealth of information but finding it can be



CITY OF WESTMINSTER ARCHIVES

extremely difficult. Catalogues might not exist at all or be online. Collections might be spread across multiple locations, due to geographical, fiscal or organisational boundaries.

- 2) **Keep a flexible mindset on names and addresses.** Sites which span different streets/blocks have the habit of switching between postal addresses over time, so check catalogues for all possible addresses if the current address yields little. Names can be similarly problematic. I was recently drawing a blank when searching for a building from 1850 whose pedigree

would normally produce a full set of drawings. Searches on the name of the organisation it had housed yielded some meagre results, but did give a hint that the organisation was often referred to by an acronym. Only when I searched on the acronym did the full collection of records appear.

- 3) **Get an engineer to look at the archive catalogue list.** At an Oxford University college, the Clerk of Works had asked the Muniments Keeper to search for structural drawings and nothing was found. I visited the archive to check on a different part of the site and had

FIGURE 2: Construction photos showing reinforcement (top) and temporary works (bottom) at Royal Horticultural Halls

the chance to review the drawing list – where I found a full set of reinforcement details. Non-technical staff are generally unfamiliar with structural terminology and so don't understand the relevance of catalogue entries.

4) Secondary research

Secondary research is information which has already been uncovered, sorted and published by others. For historic buildings that might be series such as Pevsner's *Buildings of England*, or pamphlets by local history or civic societies. Some buildings have details published in the press and trade literature.

The history of buildings is also a history of innovation in materials and construction techniques. In the UK, there is a fairly predictable pattern of structural typology by date up to the early-to-mid 20th century. These buildings were often empirically designed and will often have residual capacity which can be harnessed. Conversely, from the mid-20th century onwards, there can be considerable variety in the structural form and detailing, and the leaner the design, the less amenable the structures are to alteration.

The scope of secondary research will vary depending on what has emerged from map regression, statutory body searches and primary research. There are too many possible sources of information to list here, but the IStructE Library is an excellent place to start.

The BCSA guide to historical steelwork³, for example, is particularly useful for information on strength and properties of steel, but also the typical loading allowances for different periods up to recent times. Or the manufacturers' brochures and historical patents which describe new structural developments, e.g. types of fireproof floor structures developed around 1900.

5) Pulling it all together

A successful research study should gather a considerable amount of information on the site and its development. In its raw form, this is typically quite fragmented, so ideally the information should be distilled into working drawings. I usually opt for three separate drawing types: *schematic*, *existing drawings* and *opening-up drawings*.

A *schematic* illustrates the site 'at a glance'. This is particularly useful if a building has been constructed in multiple phases, both helping to inform further investigations, and providing a key plan for design reports and/or drawings.

Figure 3 shows an example schematic where three main phases of development were identified among many:

“ MAP REGRESSION COMBINED WITH A WIDER ARCHIVE SEARCH IS INVALUABLE AND CAN USUALLY BE COMPILED AT MINIMAL EXPENSE

- | Building A, built in 1895, had filler-joist floors on loadbearing masonry.
- | Building G was a 1985 braced steel frame with rainscreen cladding and precast hollowcore slab floors.
- | Building H, from 1963, had hollow-pot slabs on a concrete-encased steel frame, but its stability system was perplexing. Historic finance committee minutes revealed that the building had been built over the remains of a 19th century lecture theatre – an invaluable discovery when assessing overall stability and the feasibility of adding an extra storey.

Once a measured survey is available, a conventional set of 1:50 or 1:100 plans and sections can be used to build up a record of the findings as *existing drawings*. This can include findings on loading allowances and materials alongside drawn information.

It is sometimes tempting to 'straighten' survey drawings so that columns and beams line up as if drawing a new build, but this should be resisted to avoid introducing error. It is important that drawings are an accurate representation of the existing structure, including original construction tolerance and subsequent deformations.

Modern floor plans can give a surprising amount of information about the history of an old building.

The thickness of walls, for example, can indicate where old structure still exists and where modern fabric has been added. Odd nibs or beams can suggest where old walls were removed, and the presence of chimney breasts in a room can indicate how the historic plan-form worked and where the original doors were located.

However, do take care to check the accuracy of drawings against inspections on site (as plans are often changed during construction or not realised at all) and don't assume that there will be one set of historic drawings which provides everything that you want.

The process of recording and testing the accuracy of archive information against visual inspections and site investigation is inevitably iterative. A well-compiled set of existing drawings is an invaluable record which will be useful for the whole design and construction team, for the duration of the project.

Lastly, it is also generally worth considering a set of *opening-up drawings*, prepared in parallel with the existing drawings. This is not strictly 'research', but I tend to think of this set of drawings as a place to store all the questions left over from my research which will need to be answered by site inspection and investigations. A set of opening-up drawings often forms the basis for an investigation contract and also informs the design team on commissioning of appropriate safety surveys prior to intrusive investigation (e.g. for asbestos, lead paint).

Summary

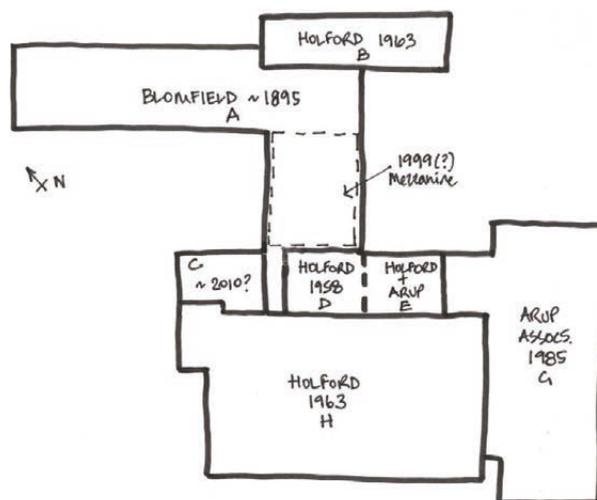
There are no hard-and-fast rules to carrying out a desk study of the existing structure, but map regression combined with a wider archive search is invaluable and can usually be compiled at minimal expense. The aim is to establish phases of development and corresponding dates, to give clues to the different types of construction, likely structural capacities and possible latent defects.

Recording this information on a set of existing drawings is useful for planning further inspections and investigations, as well as for sharing information with the design team and contractors.

For next steps (covering advice on intrusive investigation, site surveys, estimating age of construction and typical latent defects), see the first three 'Useful resources'.

Understanding the history of a building or site will help to unlock its future potential.

↓ FIGURE 3: Historic development schematic, Queen's Schools at Eton College



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Fiona has over 20 years' experience as a structural engineer and has been a Conservation Accredited Engineer since 2009. She is author of the *Structural Engineer's Pocket Book* and established Cobb & Company Consulting Engineers in 2020.

USEFUL RESOURCES

Understanding buildings

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Richardson C. (2000) 'The dating game', *Architect's Journal* [Online] Available at: www.architectsjournal.co.uk/archive/the-dating-game (Accessed: February 2021)

Various authors (2015–16) 'Conservation compendium. Parts 1–18', *The Structural Engineer*, 93 (1) to 94 (6) [Online] Available at: www.istructe.org/thestructuralengineer/article-series/conservation-compendium/ (Accessed: February 2021)

Map data

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Bomb Sight (2013) *Mapping the WW2 bomb census* [Online] Available at: <http://bombsight.org/#15/51.5050/-0.0900> (Accessed: February 2021)

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2) **Institution of Structural Engineers (2021)** *Climate emergency* [Online] Available at: www.istructe.org/resources/climate-emergency/ (Accessed: February 2021)

3) **Gent D. (2019)** *Historical Structural Iron and Steel Sections: Properties of historical cast iron, wrought iron and steel sections*, London: BCSA

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