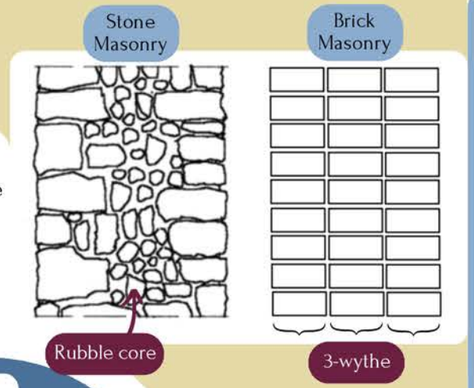
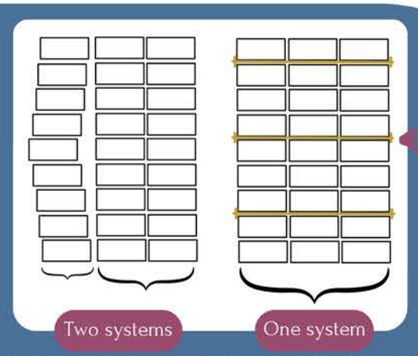
WALL TIES

Structural Intervention

Often, stone or brick historic buildings are made up of load bearing masonry structures meaning they are supporting the weight of the building. Load bearing masonry is typically multi-wythe - otherwise composed of more than one vertical layer of brick or stone. Occasionally, multi-wythe masonry also contain a rubble core.





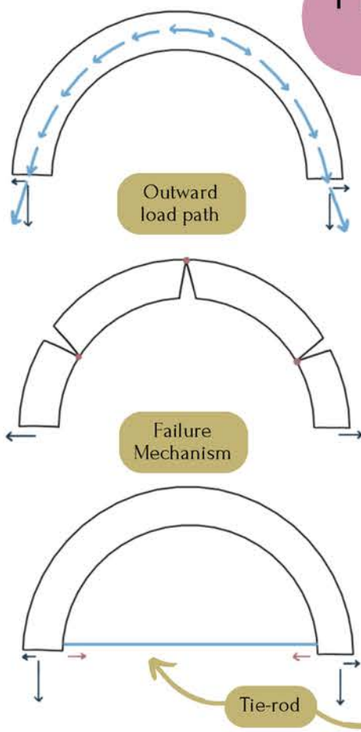
If these wythes separate, the strength of the wall is reduced as the wythes act individually. To strengthen this type of deterioration, transversal wall ties, also known as anchors, are used. By reconnecting the wythes together the wall act monolithically as one system.

METAL TIE-RODS

Structural Intervention

Arches work in compression and distribute forces along their curved shape. Load paths visually demonstrate how forces are transferred through a structure. The load path through an arch ends with a diagonal force, the horizontal component of the force acts outwardly. If this force is too strong it will lead to sliding and hinging failure mechanism.

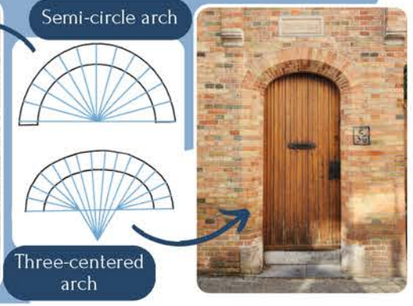
To stabilize an arch experiencing this failure, a metal tie-rod is installed across the bottom of the arch connecting both ends. The metal tie-rod holds and brings both ends inward to combat the outwards force exerted by the arch.



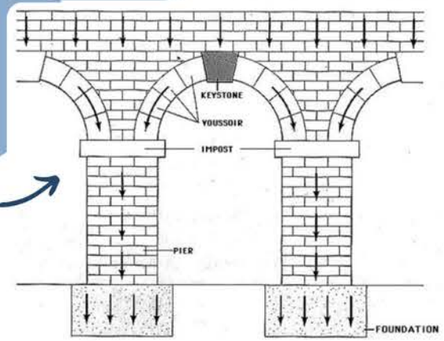
MASONRY ARCHES

Historic Construction

Masonry arches are composed of inclined wedge like stone or brick units configured into a curved shape. Arches can be constructed into various curved shapes.

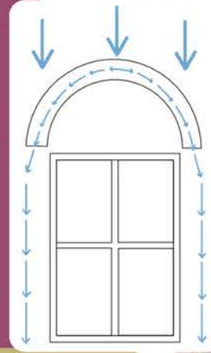


Arches work in compression and distribute forces along their curved shape and push out outwardly. The redistribution of the force path away from the non-structural openings is how many historic structures were able to create larger openings for doors and windows.

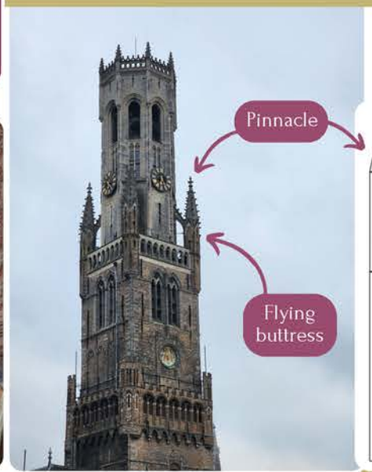


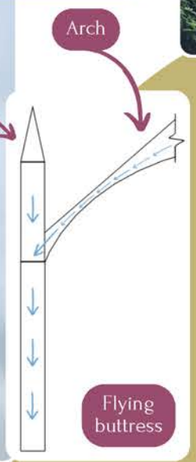
RELIEVING ARCHES

Relieving arches are a structural design technique used to reduce the load acting on a vulnerable spot below them, such as an opening for a window. Relieving arches are placed into a wall assembly to redirect forces through either ends of the arch. Some relieving arches also include a small gap. This ensures the force distribution to the ends of the arch, and prevents any load from transferring to the opening due to the lack of material in-between.



BUTTRESSES AND PINNACLES





Buttresses are structures built against other structures, such as walls, to provide stability against internal horizontal forces. A flying buttress uses an arch that "flies" off a wall and into a pier.

Pinnacles also serve a similar structural purpose. By adding extra weight from the pinnacle onto the buttress, the load path - forces - in the structure are redirected downwards safely.

CANALS TO CATHEDRALS:

DISCOVERING NORTHWESTERN EUROPE'S STRUCTURAL HERITAGE

Elizabeth Paikoff
Kate Wishewan

OVPM . OWHC . OCPM
Regional Secretariat
Northwest Europe and North America

CANALS TO CATHEDRALS:

DISCOVERING NORTHWESTERN EUROPE'S STRUCTURAL HERITAGE

The Organization of World Heritage Cities (OWHC) and its Regional Secretariat for Northwest Europe and North America organized the 2024 Young Travelling Scholarship. The winners of this scholarship program had the opportunity to discover World Heritage Cities and experience why UNESCO World Heritage needs to be preserved.

OVPM . OWHC . OCPM
Regional Secretariat
Northwest Europe and North America

Along our Canals to Cathedrals travels, we reconnected to our surroundings and discovered the meaningful impact of our environment on our lives. The preservation of our historic buildings, our monuments, our town squares - of our heritage does more than just connect us to the past. It grounds us, connects us to the present, to our communities; and in turn, brings our attention and focus to the future.

Every city we had explored on this trip only proved how much we as a society cherish our heritage. Our travels focused on discovering and learning more about heritage conservation from a structural engineering perspective. Every site we visited and past through, we observed the work, the effort, and the care put into preserving these sites. This brochure will be exploring two main ideas:

1. Society's strive to learn and understand the design and construction concepts and techniques of the past. A better comprehension of our historic structures, the more we can improve our methods for their preservation.
2. The structural interventions applied to historic structures that stabilize, strengthen, and repair them so that their heritage can continue to live on.

Our travels included visiting:

Explore our the OWHC Young Travelling Scholarship Blog!
https://www.owhc-youngtravelling.com/category/owhc-2024/canals-to-cathedrals-discovering-northwestern-europes-structural-heritage/

Explore our Instagram Blog!
https://www.instagram.com/the_late_heritage_travels/profilecard/?igsh=MWRIdjVzYTg5cjY3eQ==

FACADISM

Structural Intervention

Scala Cinema is a set of seven 5-storey apartment buildings built in an eclectic style and designed by architect J. De Blois in Brussels. Built sometime in the mid 1870s, these apartments were said to have won prizes in a façade competition in 1876-1878.

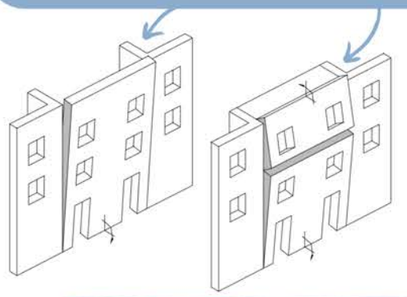
(Right) Scala Cinema 2024

(Left) Scala Cinema 1989

The buildings are currently undergoing a facade retention, as indicated by the yellow framing on the faces of the apartments.

Facadism, also known as facade retention, is the practice of preserving the facade - or the outer architectural face – while the original structure behind is torn down and a new structure is rebuilt behind.

Before the existing structure behind the facade can be demolished, the facade has to be temporarily stabilized as the facade will be vulnerable to out-of-plane failures such as overturning or buckling.



This facade has been stabilized using a triangular frame bracing system. The triangular structure is anchored onto the facade using a combination of walers, struts, and anchor rods. The frame is held down with ballasts - a heavy substance to improve stability.

Waler (horizontal beam)

Anchor rod (metal rod)

Strut (yellow metal plate)

Ballast (concrete blocks)

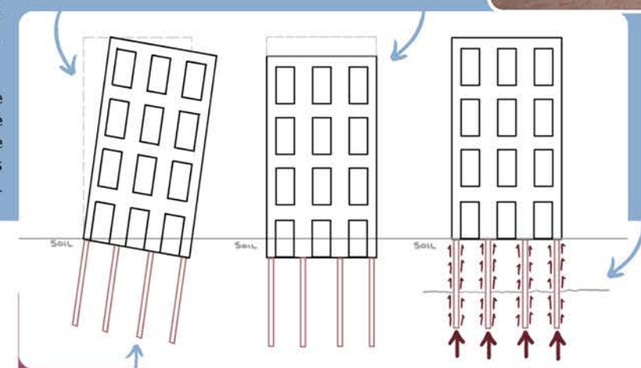
WOODEN PILE FOUNDATIONS

Historic Construction

Many buildings in Amsterdam appear crooked or as if they are leaning to one side. This apartment, located at New Spiegelstraat 62 and built in the 17th century, is just one example of a leaning building in Amsterdam.

The leaning of buildings in Amsterdam can be due to a multitude of reasons, the most common being building settlement. Foundation settlement is the downwards movement, or sinking, of a building. In Amsterdam, building settlement is typically caused by the deterioration of the foundation structure. Differential settlement occurs when the building settles unevenly, causing a tilt.

Amsterdam's soil, composed of sand, soft clay, and peat, is notably soft. The city is also about 2 metres below sea level. Because of these reasons, buildings in Amsterdam are built on pile foundations.



The force the soil exerts back up on the pile and the friction between the piles and the soil both work to hold up the building.

Piles

Pile foundation are used when the soil is too compressible or weak to support the weight of the building. Piles carry the loads - weight of the building - to a deeper layer of soil that is strong enough to support it.

Historic buildings built between the 16th and 20th century were built on wooden piles. Once the piles were driven into the ground, the rest of the building would be built on top. It is important to note that these timber piles were designed to be completely below groundwater.

Timber does not rot when submerged under water. Fluctuations in the sea level leaves the foundation vulnerable to the groundwater dropping and exposing the timber rot. Building settlement occurs when these wooden piles being to fail and no longer support the building.