# T4 – Analysis of barrel vaults

Background

Masonry vaults and arches can be found not only in historical buildings but above the basement and the ground floor of classical buildings (typically used structure till about the 1st world war) and tunnels. The calculation of masonry structures is complicated due to the lack of exact material properties (mortar quality, brick quality), due to the lack of exact knowledge of loads, and due to the cracks and other damages. To analyze and check these structures there are several simplified, manual and graphical methods for some special loads.

Symmetrical loading

with fixed support at both ends   three-hinged structure

Asymmetrical loading

with fixed support at both ends
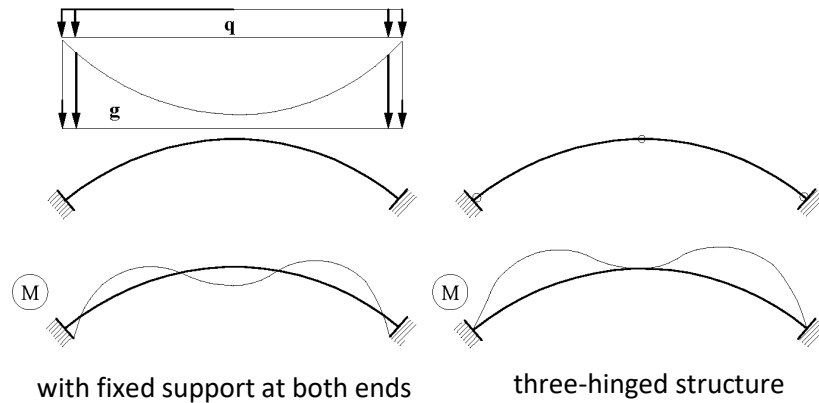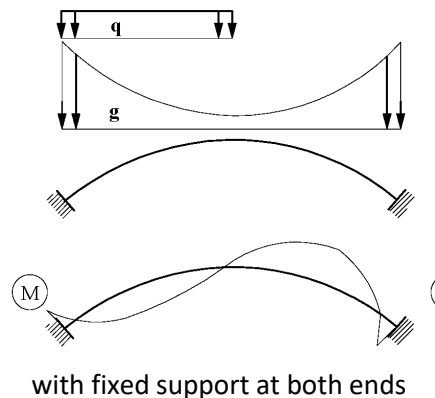
The aim of the practical

During the practical, a section of a barrel vault loaded by symmetrical loads is analyzed based on the thrust line theory. The three times indeterminate arch is calculated as a three-hinged structure. We carry out a plastic analysis considering a material without tensile strength. The resistance of the structure is calculated at the expected location of the maximal eccentricity. The backfill above the springing is considered only as a load, its horizontal reclining effect is neglected.

It is important to notice, that the asymmetrical loading is more dangerous, but as its calculation is more complex it is not presented during the practical. When analyzing an existing barrel vault or arch, it is important to know that non-uniformly distributed loads (just as an asymmetrical load during reconstruction) or concentrated loads (just as the charge of a new heavy wall) can easily destroy the vault or arch.

It is also important to notice, that the horizontal forces are carried by the supporting walls. The horizontal displacement of the springing determines whether the vault or arch is safe or not. In the case of classical buildings, charges coming from the upper floors help thick basement walls to provide the horizontal support.

Examples:
  an extra floor or elimination of a floor → increase or decrease in the vertical charges;
  digging a hole next to the main wall of the basement → partial elimination of the horizontal support