

Titolo Italiano: Analisi strutturali di archi e volte in muratura (3CFU; 16 ore)

Titolo Inglese: Structural analysis of masonry arches and vaults (3CFU; 16 hours)

Course description

Masonry curved elements – such as arches, domes and vaults – represent one of the most widespread structural typologies in the historical buildings. Their stability is due to their shape and self-weight magnitude and distribution.

This course has the scope of introducing the main approaches for the analysis of their stability and safety and the design of repairing and strengthening interventions.

After a historical introduction on the typologies characterizing masonry curved structures, the traditional rules of art used in the past centuries for the design of the shape and of the geometry of the constitutive elements (arch thickness, buttress height and width, etc.) are discussed.

Both the classical and advanced analysis methods for arches and vaults are reviewed. Particular attention is devoted to the Limit Analysis (LA) approach based on the Heyman's assumptions for the masonry material.

Some of the main theories for modelling arches and vaults are presented. In particular, the catenary equation, the theory of curved beams, the shell theory, the membrane theory of shells and the generalized eccentricity method are introduced as modelling tools for the analysis of arches and vaults. Then, some criteria for the assessment of the structural safety, both under vertical loads and under earthquake actions are discussed and applied to practical examples.

Finally, a vast part of the course is devoted to the Thrust Network Analysis (TNA) of masonry vaults, a computational technique for the limit analysis of masonry vaults subjected to both vertical and horizontal loadings. With this regard some case studies are presented regarding the analysis of real masonry arches and vaults. Finally, a MATLAB code that implements the specialization of the TNA to the case of planar arches is presented and discussed.

Course program

#	Topics	Teacher
1	Archi e volte in muratura: inquadramento storico, tipologie e regole dell'arte <i>Masonry arches and vaults: historical overview, typologies and rules of art</i>	Brandonisio Giuseppe
	Metodi di calcolo classici e moderni per l'analisi di archi e volte in muratura <i>Classical and advanced analysis methods for masonry arches and vaults</i>	
2	Teoria tecnica delle travi ad asse curvo <i>Theory of curved beams</i>	Marmo Francesco
	Geometria degli archi e equazione della catenaria <i>Arch geometry and catenary equation</i>	
3	L'analisi limite degli archi in muratura e le ipotesi di Heyman <i>Limit analysis of masonry arches and Heyman's assumptions</i>	Brandonisio Giuseppe
	Misurare la sicurezza statica di archi e volte in muratura <i>How to measure the static safety of masonry arches and vaults</i>	
4	Il comportamento sismico di archi e volte in muratura: dall'analisi del danno ai metodi di analisi strutturale <i>Seismic behaviour of masonry arches and vaults: from the damage to the analysis methods</i>	Brandonisio Giuseppe
	Analisi sismica degli archi e volte in muratura: da Leonardo da Vinci al Sisma Bonus <i>Seismic assessment of masonry arches and vaults: from Leonardo da Vinci to the Sisma Bonus</i>	
5	Cenni sulla teoria dei gusci ed eccentricità generalizzata per la verifica di funicularità <i>Essentials on the theory of shells and method of the generalized eccentricity for the evaluation of their funicular efficiency</i>	Marmo Francesco
	Geometria delle volte e teoria membranale dei gusci <i>Vault geometry and membrane theory of shells</i>	
6	Analisi del reticolo di spinta (TNA) per l'analisi di volte in muratura sotto azioni verticali <i>Thrust network analysis (TNA) of masonry vaults subjected to vertical loadings</i>	Marmo Francesco
	Analisi del reticolo di spinta (TNA) per l'analisi di volte in muratura sotto azioni orizzontali <i>Thrust network analysis (TNA) of masonry vaults subjected to horizontal loadings</i>	
7	Misurare la sicurezza sismica di archi e volte in muratura <i>How to measure the seismic safety of masonry arches and vaults</i>	Brandonisio Giuseppe
	Effetto della geometria ed efficacia degli interventi di adeguamento sismico di archi e volte in muratura <i>The role of geometry and effectiveness of seismic retrofit of arches and vaults</i>	
8	Analisi del reticolo di spinta (TNA) per l'analisi di volte in muratura: Casi studio <i>Thrust network analysis (TNA) of masonry vaults: Case studies</i>	Marmo Francesco
	Implementazione di un codice MATLAB per l'analisi funicolare di archi di forma arbitraria. <i>MATLAB implementation of the funicular analysis of arches of arbitrary shape.</i>	