

# The 4th International Conference on Arch Bridges

## *Contents*

### **PLENARY LECTURES**

Theory and history of the thrust line for masonry arches. a brief account.....1	
A. AGENO, A. BERNABÒ, F. FOCE AND A. SINOPOLI	
Arches: evolution and future trends.....11	
S. PÉREZ-FADÓN MARTÍNEZ	
Reduce costs by building optimal network arches.....26	
P. TVEIT	
Application of concrete filled steel tubular arch bridges and study on ultimate load-carrying capacity.....38	
B. CHEN, Y. CHEN, Z. QIN AND H. HIKOSAKA	
Procedure for the construction of large concrete arches.....55	
L. FERNÁNDEZ TROYANO	

### **CONTRIBUTED SESSIONS**

#### ***HISTORY, ANCIENT CASE STUDIES***

Timber arch bridges: a design by Leonardo.....69	
C. CERALDI AND E. RUSSO ERMOLLI	
A brief comparison between mechanical aspects and construction of arch bridges during the XVIIIth and XIXth Centuries.....79	
M. CORRADI AND V. FILEMIO	
The gradelle bridge on St. Massimo Channel in Padova.....87	
G. MIRABELLA ROBERTI AND E. TEMPORIN	
Arch bridges made by Croatian builder Milivoj Frkovic.....97	
J. RADIC	
Old arch bridges in Hamadan province.....105	
M. MAKARCHIAN	
The stone bridge in southern Italy: from the Roman tradition to the middle of the 19th centuries.....113	
L. BOVE, I. BERGAMASCO AND M. LIPPIELLO	

## **ASSESSMENT**

The behaviour of open spandrel brickwork masonry arch bridges.....	125
C. MELBORUNE AND H. TAO	
Railway masonry arch bridge of venice lagoon: history, technology and structural behaviour.....	134
A. BARBIERI, V. CHIARADIA AND A. DI TOMMASO.	
Inspection, assessment, and monitoring of railroad arch bridges in southwestern Pennsylvania.....	144
T. BOOTHBY, K. HULET AND T. STANTON	
Assessment, reliability and maintenance of masonry arch railway bridges in Europe.....	152
Z. ORBÁN	
Dynamic effects in arch bridges- a field study.....	162
B. HARVEY AND W. HOUGHTON	
Reliability-based assessment of a concrete arch bridge.....	172
V. GATTULLI AND G. CONFLITTI	
Masonry arch bridges in Poland.....	182
J. BIEN AND T. KAMINSKI	
A first level structural analysis tool for the Spanish railways masonry arch bridges.....	192
J. MARTÍN-CARO, J. MARTÍNEZ AND J. LEÓN	
Research on deterioration for Rakanji stone arch bridge, Honyabakei, Oita, Japan.....	202
T. AOKI, I. KOMIYAMA, S. MIYATA, M. MIURA AND Y. IGARASHI	
Use of integrated survey techniques: measuring the iron bridge.....	211
B. BLAKE AND D. DE HAAN	
New developments of sonic tests applied to thick masonry structures.....	221
J. CASCANTE, P. CRESPI, G. FRANCHI, A. MIGLIACCI AND P. RONCA	
Valuation of seismic vulnerability as support for conservation of masonry bridges.....	231
C. CENNAMO AND S. D'ANGELO	
Evaluation of arch bridge defects. a handbook for Network rail.....	241
B. HARVEY AND I. BUCKNALL	

## **STRUCTURAL ANALYSIS**

Plasticity, coulomb friction and sliding in the limit analysis of masonry arches.....	253
A. SINOPOLI, M. RAPALLINI AND P. SMARS	
Developments to the ring masonry arch bridge analysis software.....	263
M. GILBERT AND H. AHMED	

The stone bridges design: from old treatises to new numerical methods.....	273
I. BERGAMASCO, G. D. ANZA, L. DODARO AND M. LIPPIELLO	
Seismicity of super-long concrete arch bridge with over 600m center span.....	282
K. MIZUTORI, K. KOSA AND H. OTSUKA	
Study on stability criterion of super-long concrete arch.....	292
H. NAKAMURA, N. TAMEHIRO, T. TANABE AND J. NIWA	
Upper bound limit analysis of multispan masonry bridges including arch-fill interaction.....	302
A. CAVICCHI AND L. GAMABAROTTA	
A numerical method for no-tension analysis of masonry arches.....	312
S. GALASSO, M. PARADISO AND G. TEMPESTA	
Masonry orthotropic vaults in historical construction: the herring-bone pattern technology.....	322
A. BARBIERI, C. CARLONI AND A. DI TOMMASO	
Large displacement analysis of slender arches.....	332
M. ARICI AND M. GRANATA	
Geotechnical issues in the analysis of masonry arch bridges.....	343
C. SMITH, M. GILBERT AND P. CALLAWAY	
The statics of pointed masonry arches between ‘limit’ and ‘elastic’ analysis.....	353
D. AITA, R. BARSOTTI, S. BENNATI AND F. FOCE	

### ***EXPERIMENTAL STUDIES***

Experiments on arch bridges.....	365
P. ROCA AND C. MOLINS	
Cyclic load capacity and endurance limit of multi-ring masonry arches.....	375
C. MELBOURNE, A. TOMOR AND J. WANG	
Verification of local and global bridge action of a tied arch railway bridge with orthotropic deck during consecutive test phases.....	385
W. DE CORTE, PH. VAN BOGAERT, H. DE BACKER AND B. DE PAUW	
The mechanical behaviour of mortars in triaxial compression.....	395
R. HAYEN, K. VAN BALEN AND D. VAN GEMERT	
Masonry compressive strength enhancement under eccentric axial load.....	405
J. MARTÍNEZ, J. MARTÍN-CARO AND J. LEÓN	
Transverse strength of a model masonry arch bridge.....	413
T. BOOTHBY, E. ERDOGMUS AND Y. YURIANTO	

## ***REPAIR AND STRENGTHENING***

Fatigue performance of composite and radial-pin reinforcement on multi-ring masonry arches.....	427
C. MELBOURNE AND A. TOMOR	
Structural upgrading of a brick masonry arch bridge at the lido (venice) .....	435
C. MODENA, M. VALLUZZI, F. DA PORTO, F. CASARIN AND C. BETTIO	
Development, actuality and strengthening of double curved arch bridge in china.....	444
P. DAWEN AND H. JINXIANG	
Respair of stone masonry arch bridges.....	451
D. OLIVEIRA AND P. LOURENÇO	
The adaptation of masonry arch bridges. the cerezo bridge experience.....	459
J. MARTINEZ AND L. GARCÍA CASTILLO	
Increased load capacity of arch bridge using slab reinforced concrete.....	469
M. MIRIR AND T. HUGHES	
Slender steel arches with particular hanger arrangement for modernising concrete bridges.....	479
PH. VAN BOGAERT, W. DE CORTE, B. DE PAUW AND H. DE BACKER	
Service load testing, numerical simulation and strengthening of masonry arch bridges.....	489
C. BROOKES AND P. MULLET	
Restoration of the Pont Trençat (Broken Bridge). Barcelona, Spain.....	499
X. FONT	

## ***MODERN BRIDGES-NEW DEVELOPMENTS***

Design of the main spans of the Chongqing Caiyuanba Bridge.....	511
M. CHUANG TANG AND J. SUN	
Design of the Dongguan Shuidao Bridge in Guangdong, China.....	517
Y. CHEN, B. CHEN AND H. ZHENG	
Design and construction of Napu Bridge, Zhe-Jiang, China.....	525
Y. YANG, B. CHEN AND W. HUANG	
Design of the Second Highway Bridge over Yellow River in Zhengzhou, China.....	531
W. ZHANG, B. CHEN AND W. HUANG	
Research of the concrete arch bridges up to 1000m in span.....	538
V. CANDRLIC, J. RADIC AND I. GUKOV	
Studies on long-span concrete arch bridge for construction at Ikarajima in Japan.....	548

K. KAMISAKODA, H. NAKAMURA AND A. NAKAMURA	
KRKA River Bridge near Skradin.....	558
Z. SAVOR, J. RADIC AND G. PUZ	
Steel teid arch bridges with fan hanger arrangement.....	566
B. DE PAUW, PH. VAN GOGAERT, W. DE CORTE AND H. DE BACKER	
Aluminium pedestrian bridge in Parco San Giuliano, Mestre, Venice, Italy.....	576
G. MAZZAROLO, P. FRANCHETTI AND C. MODENA	
Design recommendations for reinforced masonry arches.....	583
P. LOURENCO, K. PALÁCIO AND J. BARROS	
Bridge over the River Jarama at Titulcia (Madrid) .....	593
J. LLOMBART, J. REVOLTOS AND S. COUTO	
Bridge over the River Tagus on the Alcántara Reservoir.....	602
J. LLOMBART, J. REVOLTÓS AND M. ALPAFICES	
The viaduct of the grande ravine:	
A bridge with a limited and controlled arch effect.....	610
J. CROISSET, J. RYCKAERT, G. VIEL AND A. SPIELMANN	
Pedestrian arch footbridges.....	620
M. REVENTÓS, J. PRIÓ AND A. MARS...	
New bridge over the River Anoia between Igualada	
and Santa Margarida de Motbui.....	629
M. REVENTÓS AND A. MARS	
Arched steel structure that supports the cover of Santa Catarina's Market	
in Barcelona.....	638
J. VEOLASCO	

### **NETWORK ARCH BRIDGES**

Force variations and slackness in tied arch bridges with crossing hangers.....	651
H. DE BACKER, B. DE PAUW, W. DE CORTE AND PH. VAN BOGAERT	
Erection of network arches.....	661
M. RÄCK, F. SCHANACK AND P. TVEIT	
Network arches for railways bridges.....	671
B. BRUNN, F. SCHANACK AND U. STEIMANN	
Network arches for road bridges.....	681
W. GRASSE, S. TEICH, P. TVEIT AND S. WENDELIN	
Fatigue optimization in network arches.....	691
S. TEICH	

## **CFST BRIDGES**

Concrete-filled steel tubular arch bridges:

dynamic testing and fe model updating.....703

W. REN, B. JAISHI AND Z. ZONG

Nonlinear seismic analysis of the second Saikai Bridge-a concrete filled tubular

(CFT) arch bridge.....716

H. FUJITA, Q. WU, M. YOSHIMURA, K. TAKAHASHI, S. NAKAMURA AND K. FURUKAWA

Erection analysis of the cfst arch bridges by vertical swing method over the

Jing-Hang Canal in Xuzhou, China.....726

C. SUN, B. CHEN AND Y. YANG

Dynamic response analysis of the second Saikai Bridge-a concrete filled tubular

(CFT) arch bridge.....733

K. TAKAHASHI, Q. WU, M. YOSHIMURA, H. FUJITA, S. NAKAMURA AND FURUKAWA

The influence of rigidity value of concrete filled steel tubular (single tube) arch

rib to static calculation results.....743

J. WEI, L. ZHAO, B. CHEN AND G. PENG

Study on natural vibration and nonlinear seismic response of concrete filled

Tubular (CFT) arch bridge constructed in China.....753

Q. WU, B. CHEN, K. TAKAHASHI, H. MATSUZAKA AND S. NAKAMURA