2017
6 - 7 November
Vicenza Convention Centre
@Fiera di Vicenza
Vicenza, Italy

INTERNATIONAL CAE CONFERENCE

33rd INTERNATIONAL CAE CONFERENCE AND EXHIBITION

A NEW STEEL LIGHT-WEIGHT LATTICE BEAM FOR APPLICATIONS INTO CULTURAL HERITAGE CONSTRUCTIONS AND ARCHEOLOGICAL SITES

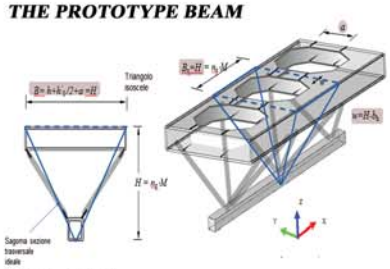
ANTONIO FORMISANO, GIANMARIA DI LORENZO, RAFFAELE LANDOLFO
DEPARTMENT OF STRUCTURES FOR ENGINEERING AND ARCHITECTURE, UNIVERSITY OF NAPLES "FEDERICO II", NAPLES, ITALY.

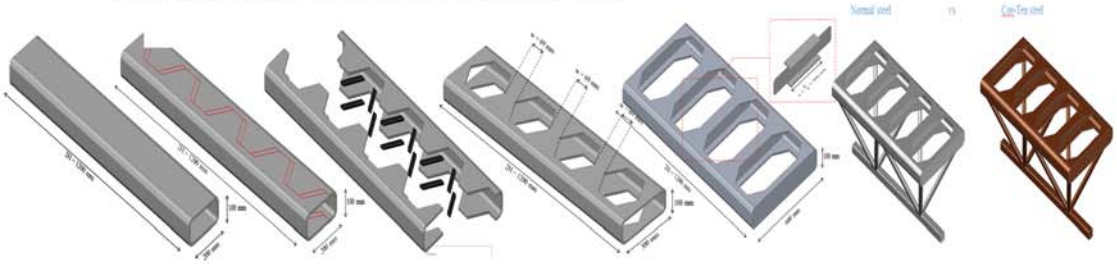
TARGETS OF THE PROJECT

THREE-DIMENSIONAL TRUSSES ARE A HIGHLY EFFICIENT TECHNICAL SOLUTION TO COVER LARGE SPANS AND LATTICE STRUCTURES ARE WIDELY APPLIED IN ANY FIELD OF CIVIL AND INDUSTRIAL ENGINEERING. ON THE BASIS THESE PREMISES, THE PROJECT «DEVELOPMENT AND INDUSTRIALIZATION OF INNOVATIVE SYSTEMS OF WELDED COMPOSITION STEEL BEAMS FOR LIGHT FLOORS AND ROOFS WITH APPLICATIONS INTO MONUMENTAL BUILDINGS AND ARCHAEOLOGICAL SITES» HAS BEEN DEVELOPED IN COOPERATION WITH THE ITALIAN STEEL CARPENTRY COMPANY SIDEREDIL S.A.S. AND FINANCED WITH FUNDS PROVIDED BY BOTH THE CAMPANIA REGION OF ITALY AND THE EUROPEAN COMMUNITY.A COMPOUND STRUCTURE MADE OF LATTICE BEAMS AND STRUCTURAL GLASS SLABS IS HEREIN PROPOSED AS STRUCTURAL SYSTEM FOR PROTECTION OF MONUMENTAL AND ARCHEOLOGICAL SITES. DUE TO BOTH THE RISK EXPOSURE OF MONUMENTAL HERITAGE TO BE PROTECTED AND THE USE OF STRUCTURAL GLASS, THE DEFINITION OF AN APPROPRIATE DESIGN CRITERION IS MANDATORY IN ORDER TO AVOID DEVELOPMENT OF BRITTLE COLLAPSE MECHANISMS, MAINLY DUE TO STATIC AND DYNAMIC VERTICAL LOADS. THE ATTENTION IS HEREIN PAID TO THE DESIGN PROCEDURE, WITH A BRIEF DESCRIPTION OF BASIC IDEAS BEHIND THE PROJECT ITSELF AND THE MAIN FOCUS ON THE PARAMETRIC CAPACITY DESIGN OF STRUCTURAL MEMBERS. THE PROPOSED PROCEDURE, WHOSE VALIDITY IS QUITE GENERAL, HAS BEEN SUBSEQUENTLY VERIFIED BY LINEAR AND NONLINEAR NUMERICAL ANALYSES CALIBRATED ON THE BASIS OF EXPE

PROTOTYPING OF A DRILLED BOX-PROFILE

THE PROTOTYPE BEAM

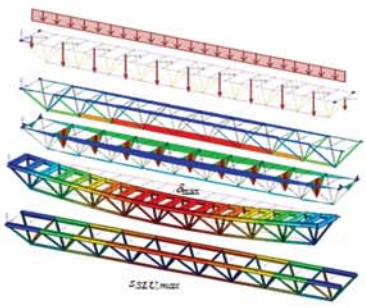




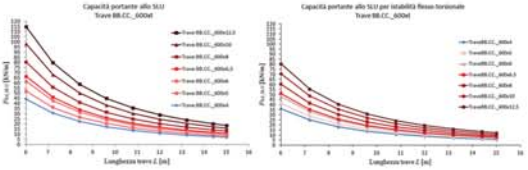
PRO_SAP

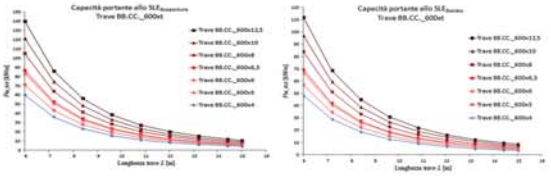
PROTOTYPE PROCESSING:GEOMETRIC MODEL

SLU ANALYSIS FOR GRAVITATIONAL LOADS
SLE ANALYSIS FOR DEFLECTIONS



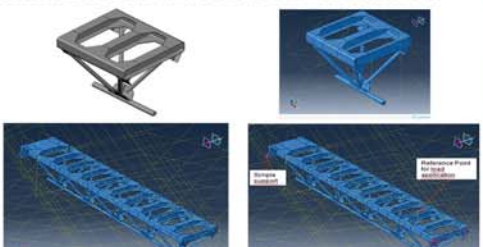
SLU ANALYSIS WITH FLEX-TORSIONAL INSTABILITY



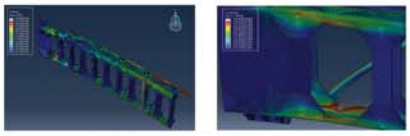


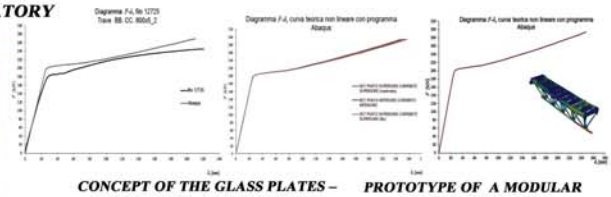
ABAQUS

PROTOTYPE PROCESSING:GEOMETRIC MODEL



EVALUATION OF THE BEHAVIOUR OF PROTOTYPES TO BE TESTED IN THE LABORATORY





REAL BEAM PROTOTYPE

CONCEPT OF THE GLASS PLATES – STEEL BB.CC. BEAMS SYSTEM

PROTOTYPE OF A MODULAR COVERAGE SYSTEM

OBTAINED RESULTS

THREE DIFFERENT TYPES OF BEAMS, NAMELY SHORT (600 MM HIGH), MEDIUM (900 MM HIGH) AND TALL (1200 MM HIGH), ARE DESIGNED AND MANUFACTURED.EACH BEAM TYPE IS IDENTIFIED THROUGH THE ACRONYM BB.CC._H X T, WHERE BB.CC. MEANS "CULTURAL HERITAGE" IN ITALIAN, WHILE H AND T ARE THE BEAM HEIGHT AND THICKNESS, RESPECTIVELY. THE BEAMS ARE OBTAINED BY WELDING STANDARD EUROPEAN PROFILES AND THEY ARE MADE OF S355J2W HIGH STRENGTH STEEL, WHICH HAS ENHANCED RESISTANCE TO ATMOSPHERIC CORROSION. THE TOP CHORD MEMBER IS BUILT STARTING FROM AN INITIAL COLD-FORMED RECTANGULAR HOLLOW SECTION (RHS), WHICH IS LONGITUDINALLY CUT IN TWO HEMI-PROFILES SUBSEQUENTLY ASSEMBLED THROUGH WELDED TIE PLATES. THESE ALLOW TO DISTANCE THE HEMI-PROFILES, TO REDUCE GEOMETRIC TOLERANCES DURING THE ASSEMBLY, TO FURNISH THE SUPPORT FOR THE GUIDE OF GLASS SLABS AND TO STIFFEN LOCALLY THE TOP CHORD-WEB MEMBER NODES. WEB MEMBERS, WHICH DEFINE THE EDGES OF THE PYRAMID MODULE, ARE MADE OF HOT-ROLLED ROUND BARS (R) OR CIRCULAR HOLLOW SECTION (CHS) PROFILES. THE BOTTOM CHORD MEMBER IS MADE OF ROUND (R) PROFILES, SQUARE (SQ) HOT-ROLLED LAMINATES OR SQUARE HOLLOW SECTION (SHS), THE LATTER IN CASE OF VERY LONG TRUSSES. BOTTOM CHORD NODES ARE DESIGNED AS FULLY RIGID JOINTS AND STIFFENED WITH PLATES HAVING THICKNESS TF OF THE SAME MAGNITUDE ORDER OF PROFILES AND TIE PLATES COMPOSING THE TOP CHORD. DEPENDING ON THE SPAN AND DESIGN LOADS, TYPICAL VALUES OF TF SPAN OVER 5, 10 OR 15 MM. RESPECTIVELY FOR LIGHTWEIGHT AND HEAVY TRUNKS. THE SAME DESIGN CRITERION IS USED FOR JUNCTIONS ALONG CHORDS, MADE WITH JOINTS AND COVER JOINTS TO IMPROVE THE TRANSPORTABILITY AND MAKE SIMPLER THE HANDLING OF BEAMS. FINALLY, THE SUPPORTING DEVICES ARE DESIGNED AS SIMPLE SUPPORT AND MADE OF STIFFENED PLATES. THE BEAMS ARE DISPOSED PARALLEL TO EACH OTHER, WITHOUT INTERMEDIATE SUPPORTS NOR SECONDARY AND TERTIARY ORDER OF BEAMS. THE 3D LATTICE BEAMS THEMSELVES PROVIDE LATERAL STABILITY. TO FORM THE FLOOR, THE BEAMS ARE SURMOUNTED BY SUITABLE GUIDES, SUPPORTING LAMINATED STRUCTURAL GLASS SLABS WHICH, IF APPROPRIATELY DESIGNED AND COATED, ALLOWS PROPER ILLUMINATION OF THE GOODS, WHILE PROTECTING THEM FROM SOLAR RADIATION.FINALLY, IT IS WORTH OF NOTICING THAT, ALTHOUGH BB.CC. BEAMS ARE OBTAINED FROM STANDARD PROFILES, THEY CONTAIN SEVERAL INNOVATIVE PROCESS AND PRODUCT ASPECTS, PARTICULARLY RELATED TO THE TOP CHORD, WHOSE MANUFACTURING PROCESS ALLOWS INTRODUCING A NEW PRODUCT CATEGORY, NAMELY THE CELLULAR RECTANGULAR HOLLOW SECTION (C-RHS). NOTICE THAT C-RHS ENLARGE THE RANGE OF COMMERCIAL EUROPEAN RHS PROFILES, WHOSE HEIGHT CROSS SECTION REACHES AT MOST 400 MM IN THE COLD-FORMED (CF) CASE AND 500 MM FOR HOT-ROLLED (HR) SECTIONS.