Atlas of Details

Sir Joseph Paxton. Crystal Palace 1850-1851

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URL: https://www.detailsinsection.org/projects/crystal-palace

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Atlas of Details is a research project to demonstrate how insightful a section can be, in order to represent the complexity of the architectural artifact, since it allows the simultaneous perception of materiality and form, of building envelope and interior spaces. Atlas of Details is a project by The Formwork, an association established by professors and PhD candidates with diverse academic backgrounds (history, architectural design, technology, preservation) working at the IUAV University in Venice and at the Milan Politecnico. For more information about the Atlas of Details and The Formwork, please contact info@theformwork.org.

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Sir Joseph Paxton
Crystal Palace
1850-1851

Text
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IUAV Venezia

Architect
Sir Joseph Paxton (1803-1865)

Name of the building
Building of the Exhibition of the Works of Industry of All Nations;
Crystal Palace

Site
Hyde Park, London (UK);
then rebuilt, expanded and with important variations,
on Sydenham Hill, London

Client
Society for the Encouragement of Arts, Manufactures and Commerce
Royal Commission for the Exhibition of 1851

Contractors
Fox, Henderson & Co. (main contractors: wrought iron works,
timber carpentry at Chelsea sawmills; coordination of sub-contracting firms);
Firm Chance Brothers (glass panes suppliers);
Firm Birch (production of timber elements: Phoenix sawmills at Cumberland Market);
Firm Cochrane & Co., Impresa Jobson (cast iron elements);
Firm Fothergill & Co. (wrought iron bars);
Firm William Anderson Rose, firm Pontifex & Wood (decoration paint suppliers);
Firm Dowson & Co. (timber suppliers)

Engineer
Sir Charles Fox (1810-1874)

Other actors
Prince Albert of Saxe-Coburg, Henry Cole (organisers and promoters);
Charles Barry, Robert Cockerell, Thomas Donaldson, Robert Stephenson,
Isambard Kingdom Brunel, William Cubitt (*Building Committee*);
John Henderson (coordination of sub-contractors' activities);
William Cubitt (engineer in chief);
Matthew Digby Wyatt (management, superintendent of the
construction of the 1851 Exhibition building);
Charles Wild (supervision of calculations and final structural testing,
superintending engineer);
Henry Wilbee (construction foreman, assembly system for the transept vault);
John Cochrane (construction foreman and director of Fox's collaborators);
Charles Clark (assistant); William George Brounger (topographer);
Edward Cowper (design of the *in situ* "pre-fabrication" machines);
William Barlow (engineer, Paxton's structural consultant);
Earie (surveyor, clerk of works); Harwood (surveyor);
Barrow, Campbell, Fleming, Lindsey (*Sappers and Miners* corporals);
Bateman, Dodd, Fowler, Haite, Warren (general assistants);

Decorations
Owen Jones (responsible for the decorations, interiors and colour scheme)

Building permit
1849 initial planning of the event;
1850 open design competition, construction tenders and
awarding of the building contract

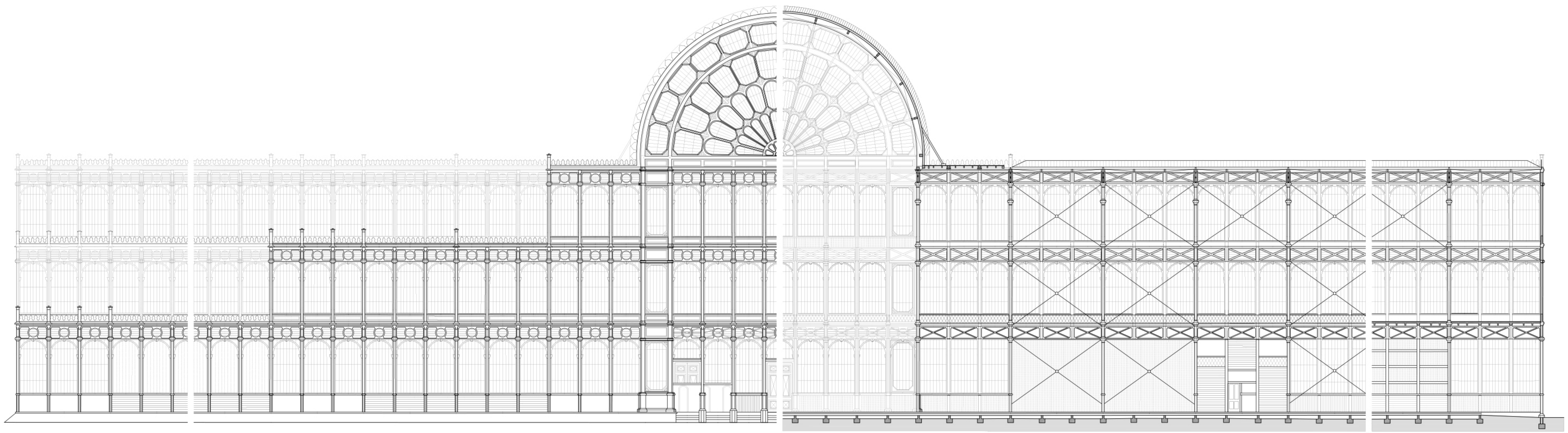
Start of construction works
1850

Project variations
Paxton's project was formally submitted to the selecting committee as a construction contract proposal based on a variation of the "mosaic-project" conceived by the *Building Committee*. Since July 1850, after the firm Fox, Henderson & Co. was awarded the main building contract, a number of significant project variations were agreed upon. These included a relevant change in the structural module; the decision to construct a great barrel vault which aimed to preserve a series of ancient oak trees sitting on the building site; and the decoration of the columns. Up until January 1851, other minor structural improvements (in particular, some concerning the stiffening and bracing of the Palace) kept being adopted.

End of construction works
1851 conclusion of construction works; 1852 dismantling;
1853 "re-construction" in Sydenham;
1866 fire; 1936 ulterior fire and definitive collapse

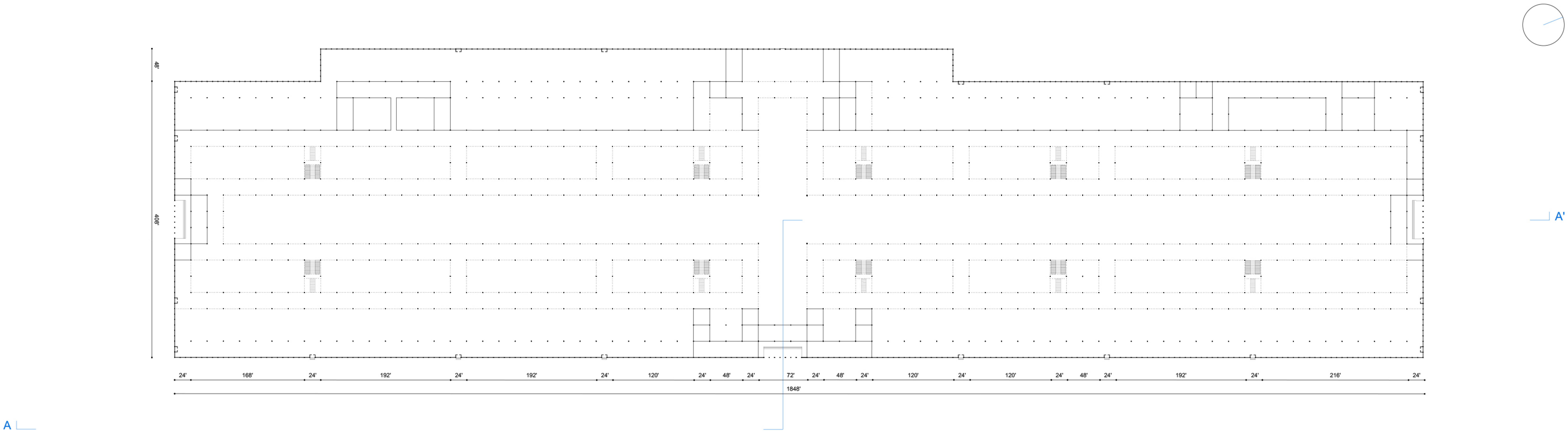
Prizes
Knighthood awarded to Joseph Paxton, Charles Fox, William Cubitt

Construction system
Modular post-and-beam system with timber, cast iron and wrought iron structural elements. Wide portions of the roofing and exterior walls were glazed.
The transept of the Palace was covered by a semi-circular vault supported by load-bearing "laminated" timber ribs.



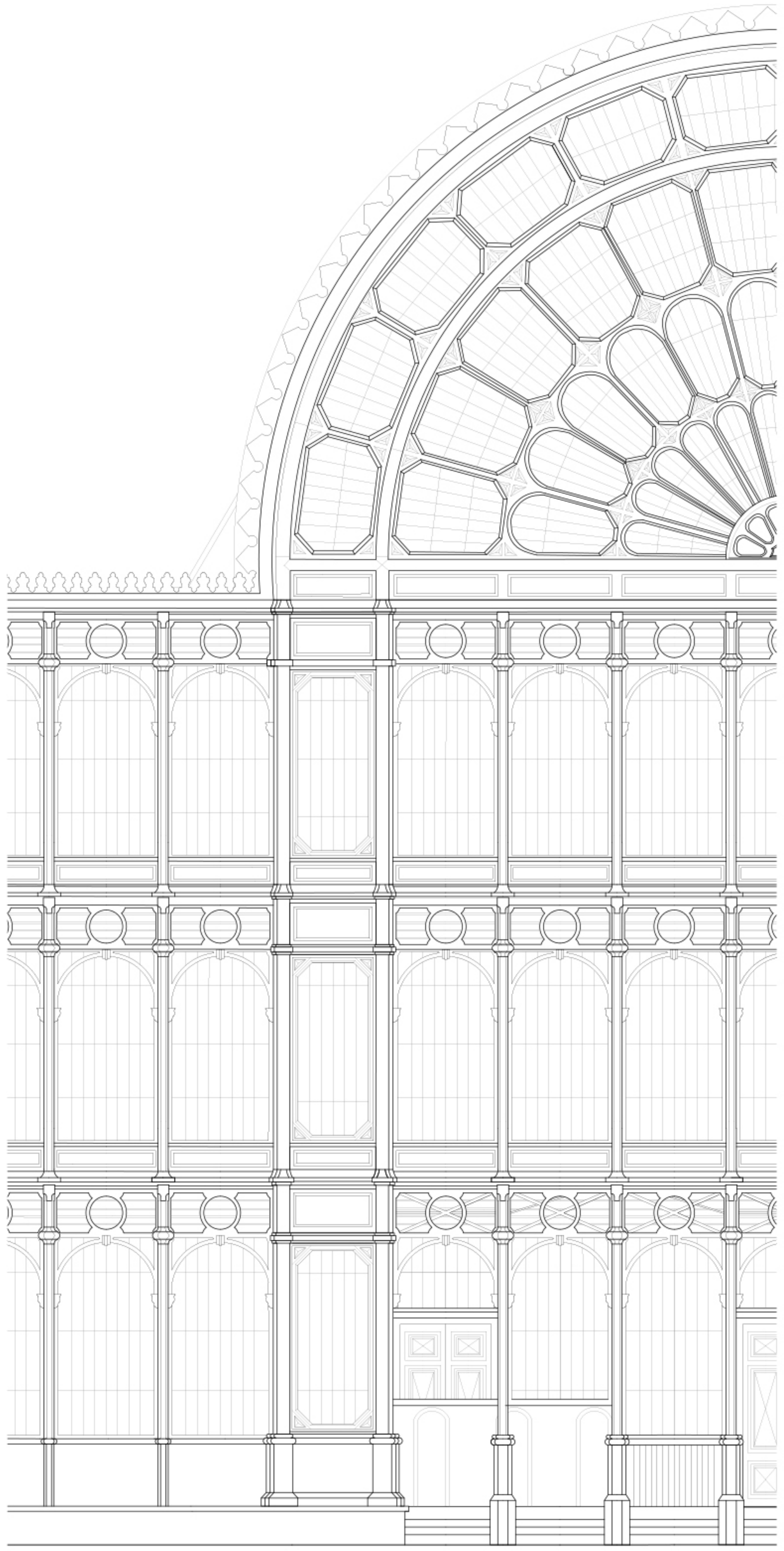
AA'. North elevation and section
Scale 1:250

0 1 5 m
0 4 12 24 ft.

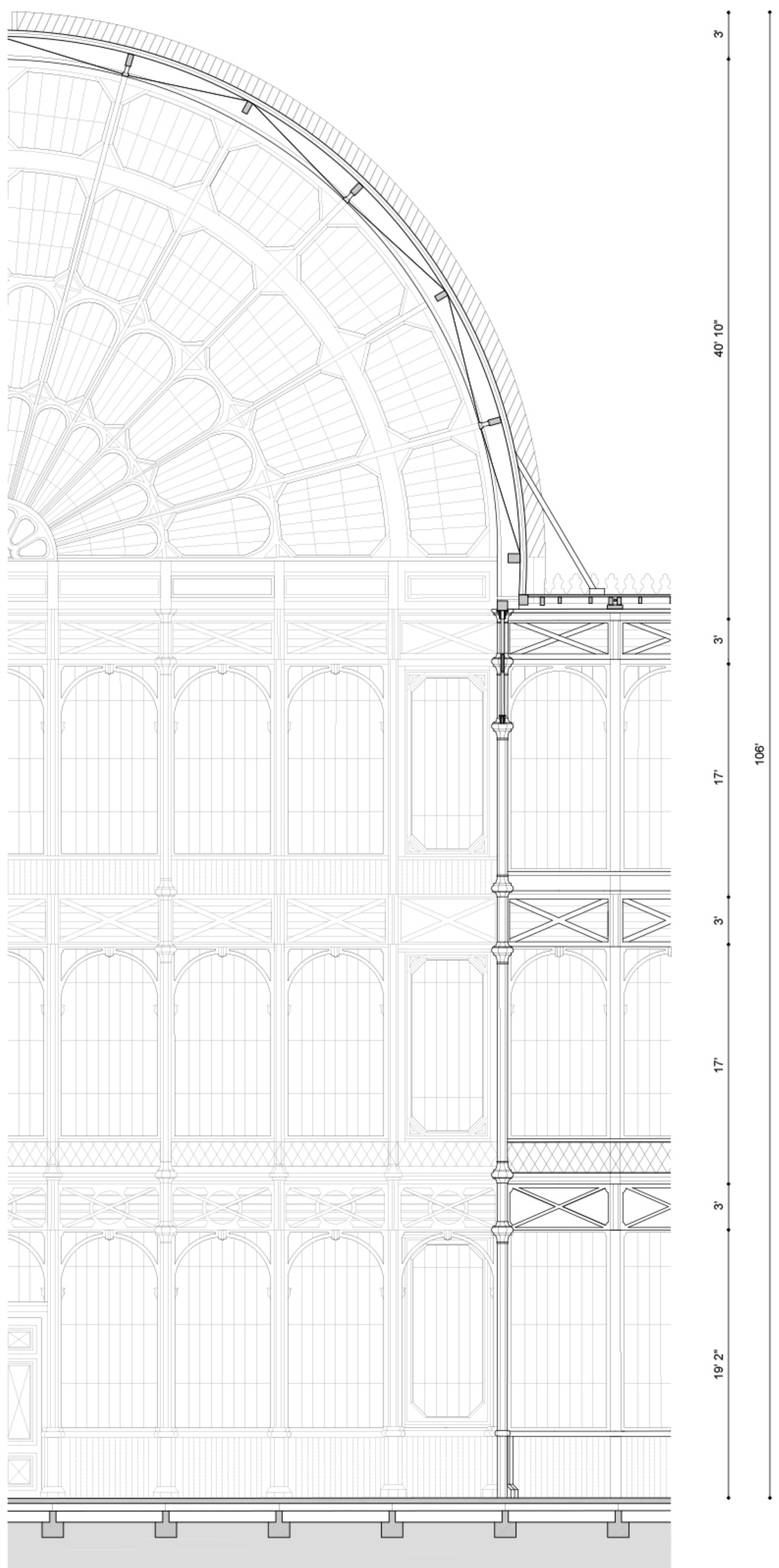


Plan, ground level
Scale 1:1250

0 10 50 m
0 24 96 ft.



Elevation

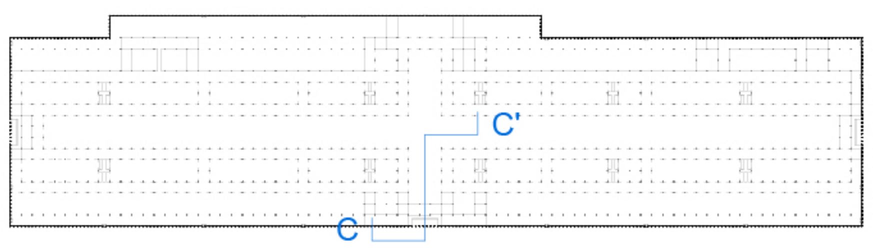


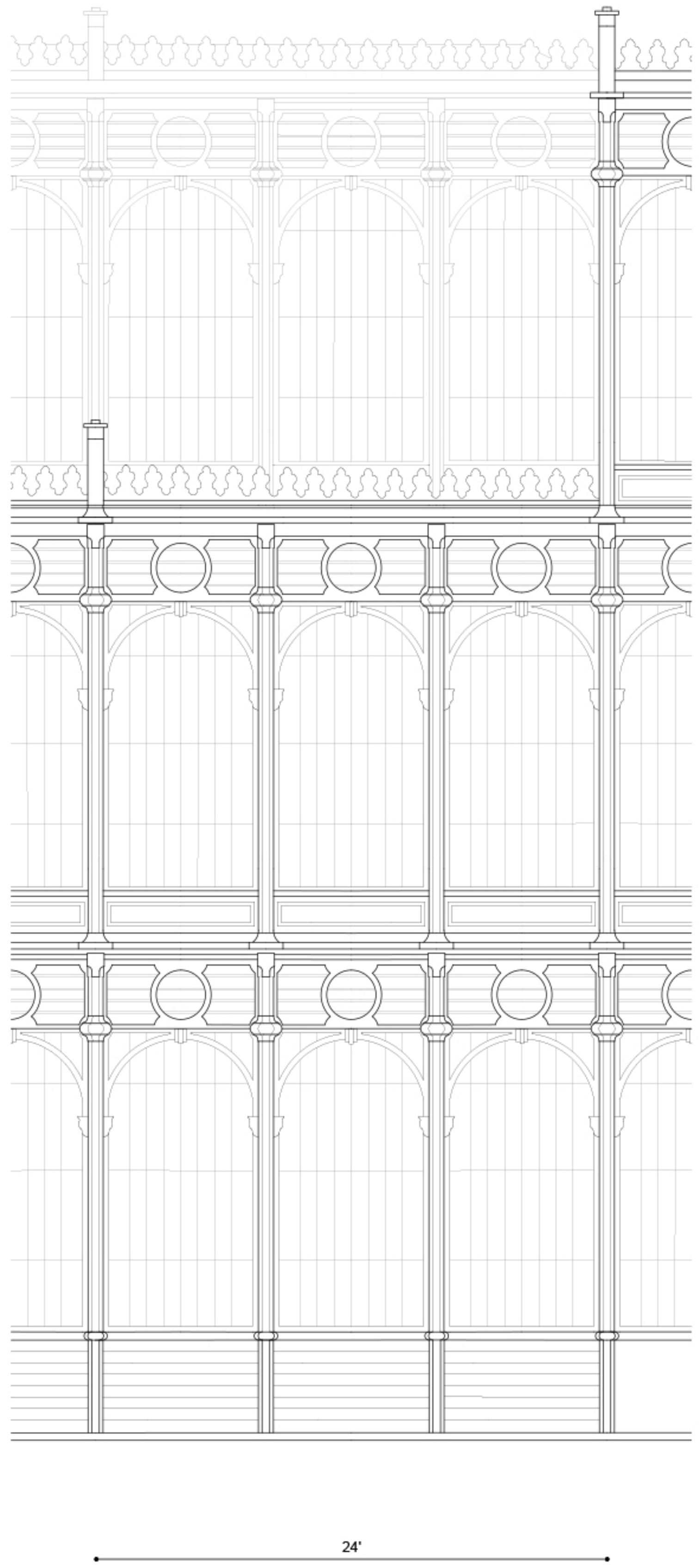
Section CC'

Scale 1:125

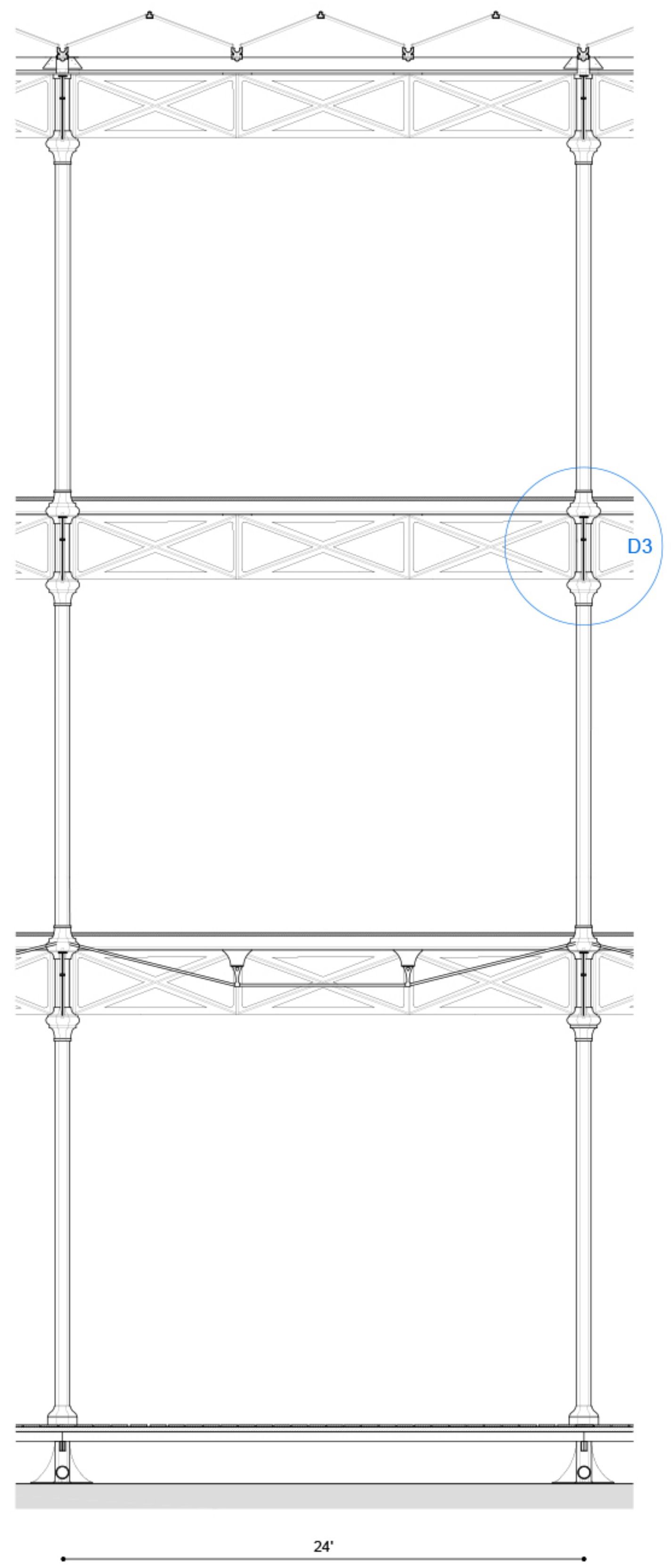
0 1 5 m

0 4 12 24 ft.

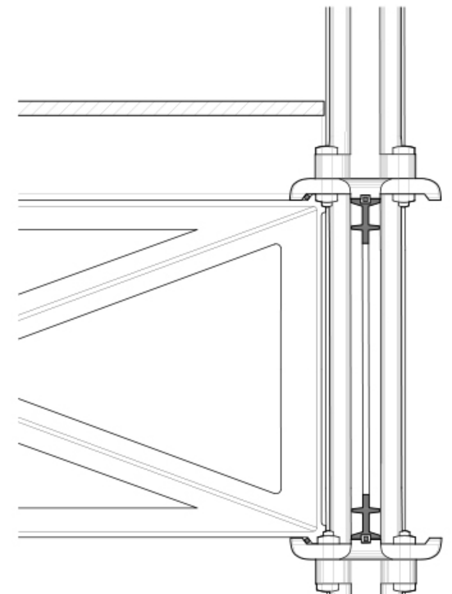




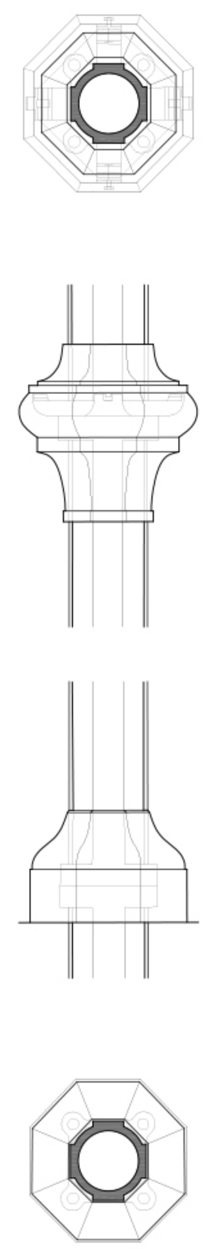
Elevation, modular unit
Scale 1:100



Section BB'
Scale 1:100



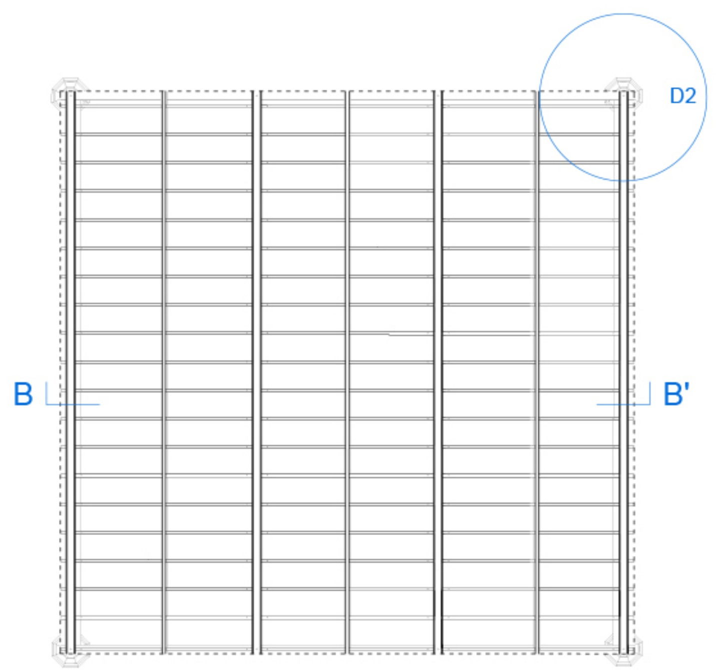
D3. Column-truss connection
Scale 1:20



D2. Detail, cast iron column
Scale 1:20

Structural module

The modular 24' x 24' structural grid allowed for a great spatial flexibility. The internal spaces were solely occupied by thin, circular ø 8" columns, placed at the vertices of each module. These were connected by lightweight lattice girders made of cast iron, wrought iron and timber. In certain areas, the columns were eliminated to achieve wider clear spans, their dimensions being multiples of that of the single structural cell. Vertically, the same aggregative logic allowed the palace to grow in height and gain storeys in specific zones. The cast iron columns, all externally identical and internally hollow, had different wall thicknesses, as required by the load conditions; each lattice girder typology was designed to answer to the different vertical loads. The columns culminated in "capitals" with clamps which hosted the ends of the girders, tightly tied with wrought iron or oakwood keys, or simple bolts. The connection between each column and girder was then masked by an ornamental capital; the same system was applied at the next storey.



Plan, structural modular unit
Scale 1:100

Scale 1:100

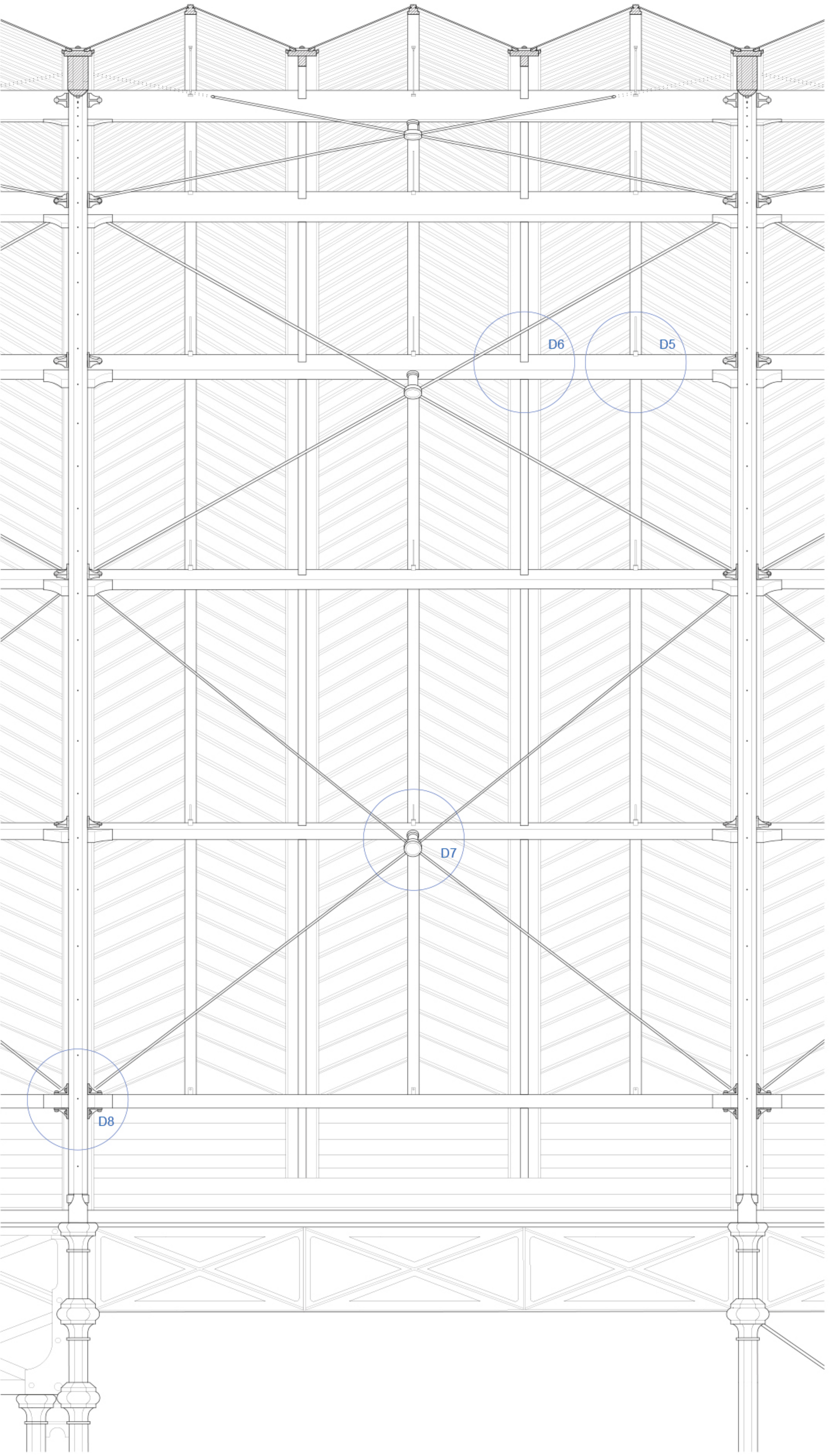
0 1 5 m

0 4 12 24 ft.

Scale 1:20

0 20 100 cm

0 10 40 in.



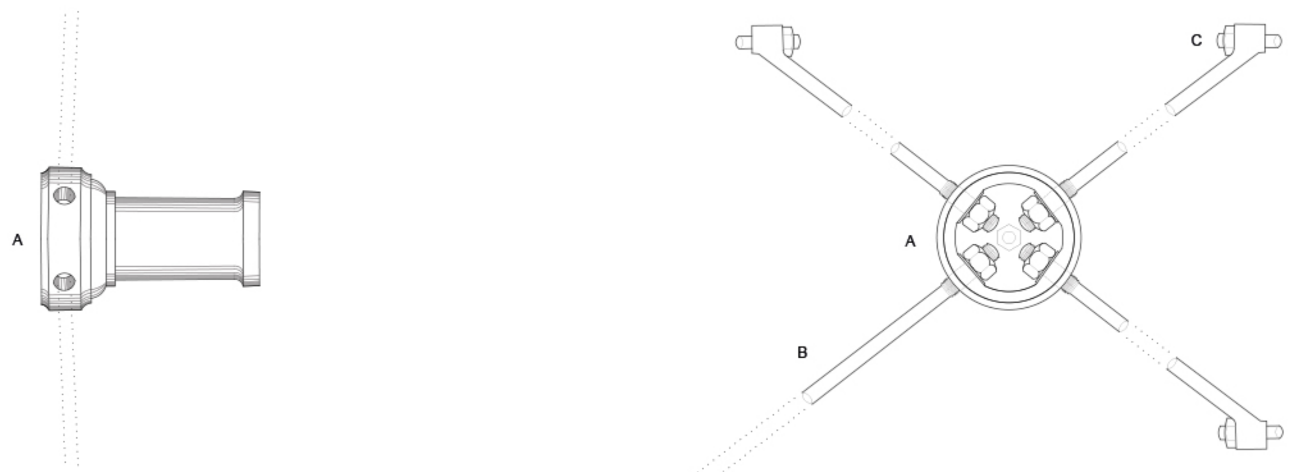
Longitudinal section, transept vault
Scale 1:50

Scale 1:50

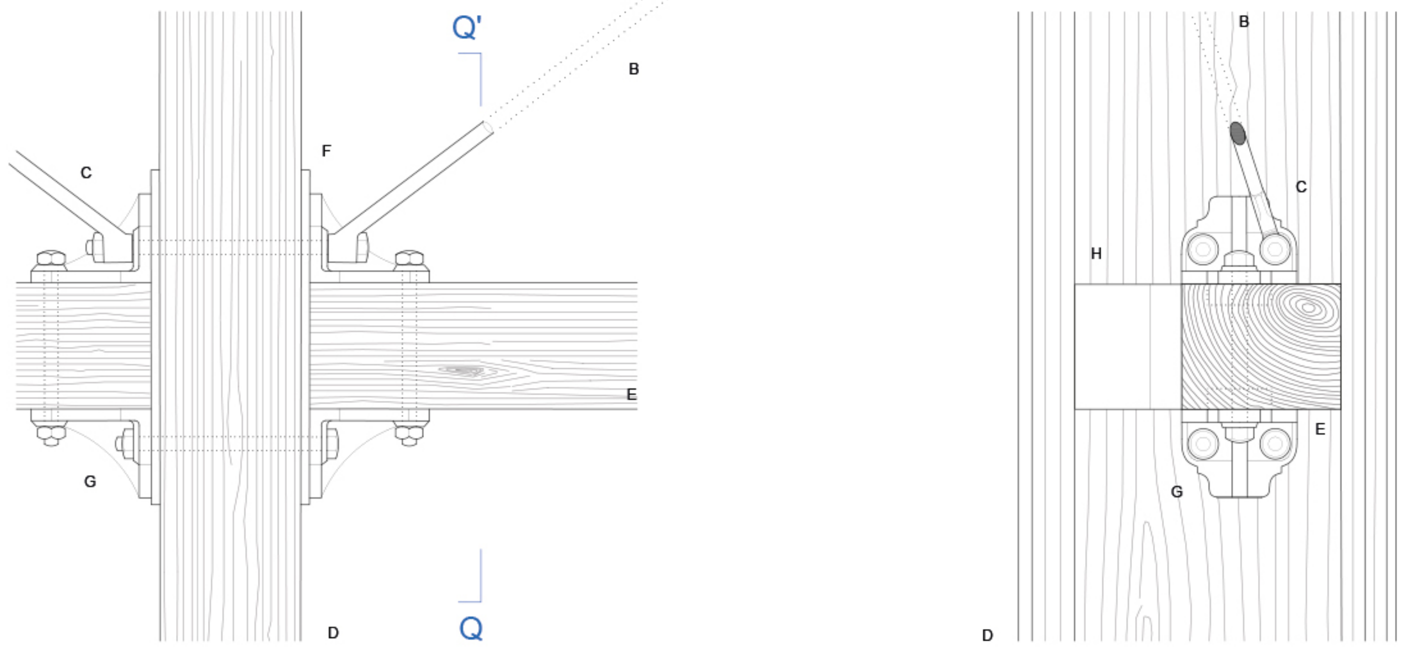
0 1 3 m
0 2 10 ft.

Scale 1:10

0 10 50 cm
0 5 20 in.

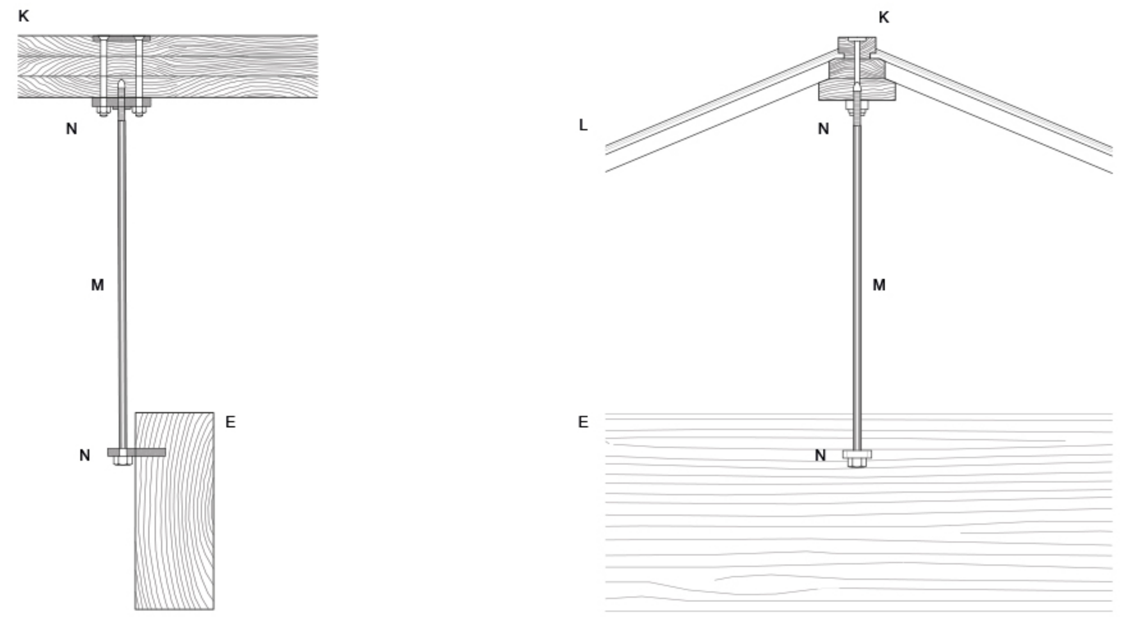


D7. Bracing system tensor, side and front view
Scale 1:10

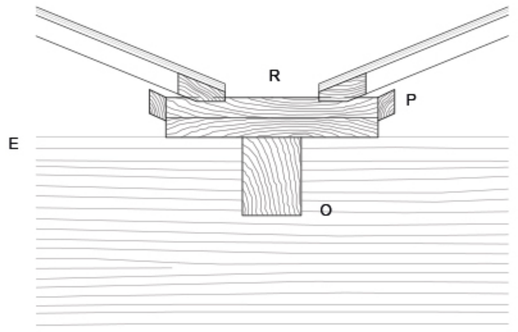


D8. Main rib-stiffening beam connection, front and side view (QQ')
Scale 1:10

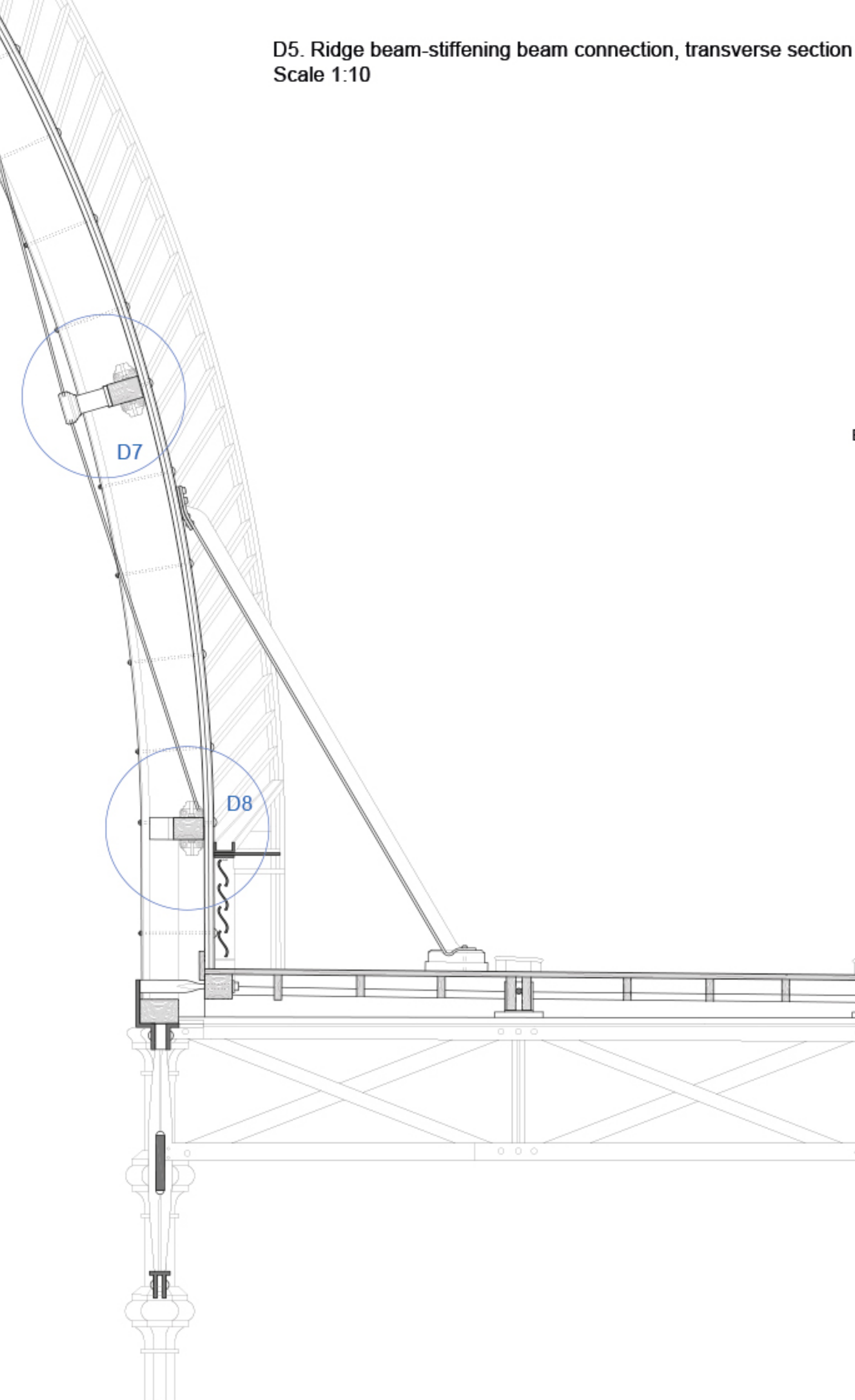
Details, vault bracing system
A. spacer for tie rod tensioning
B. bracing system tie rods
C. tie rod-main structure connection detail
D. laminated timber rib, 17,5" x 8"
E. vault stiffening beam, variable geometry
F. iron connecting plate
G. centrally stiffened iron L-shaped profiles
H. timber bracket, to support stiffening beams



D5. Ridge beam-stiffening beam connection, transverse section and front view
Scale 1:10

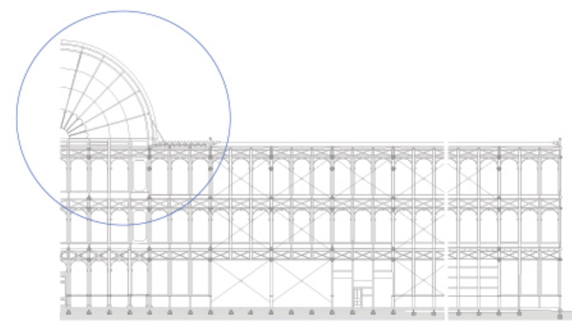


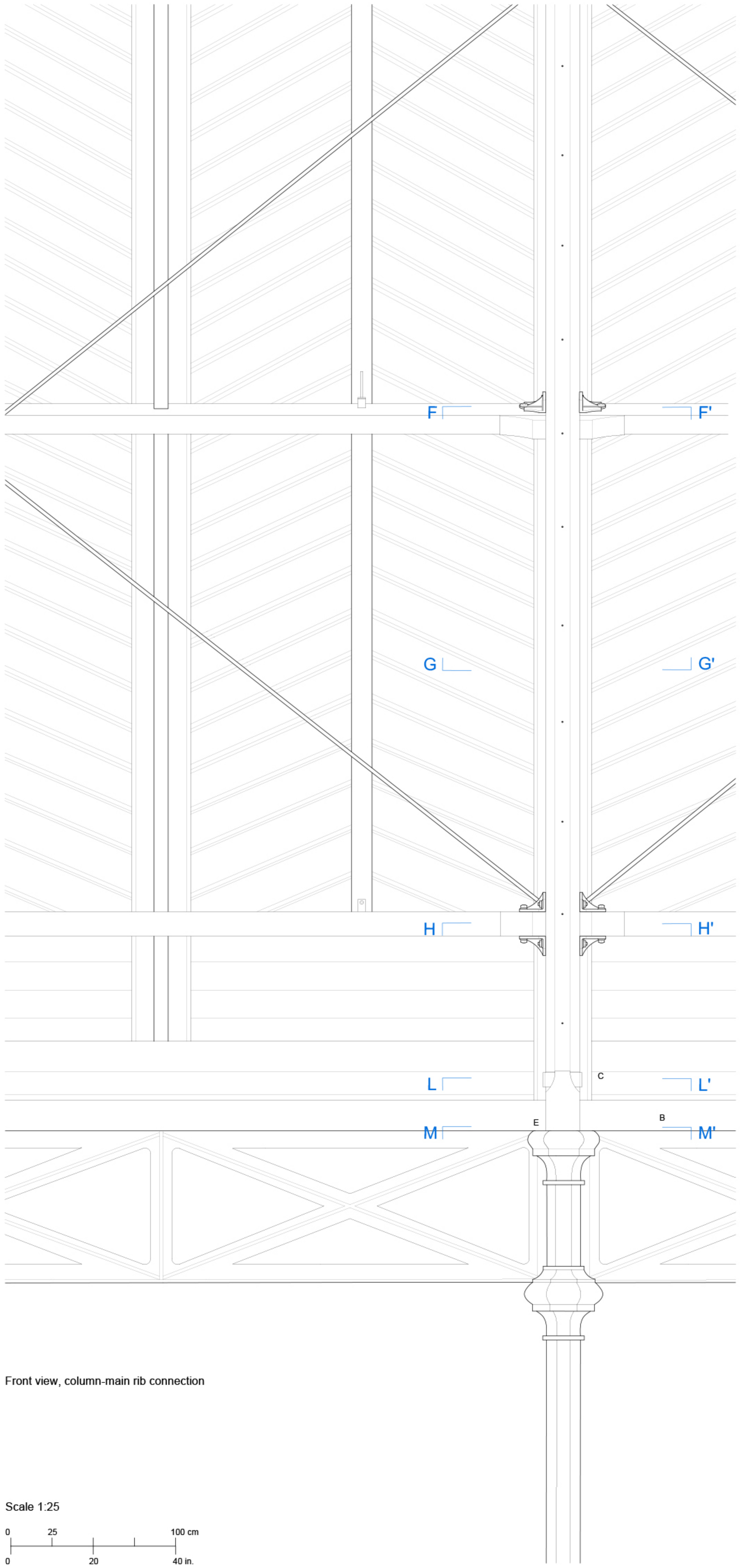
D6. Transverse section, secondary rib
Scale 1:10



Transverse section, transept vault
Scale 1:50

Details, vault roofing system
E. vault stiffening beam, variable geometry
K. "shed" vault roofing system ridge beam
L. "shed" roofing system glass panes
M. iron connection rod
N. small iron connection plate
O. secondary structural ribs, 4" x 3"
P. condensation water conduit
R. rainwater conduit

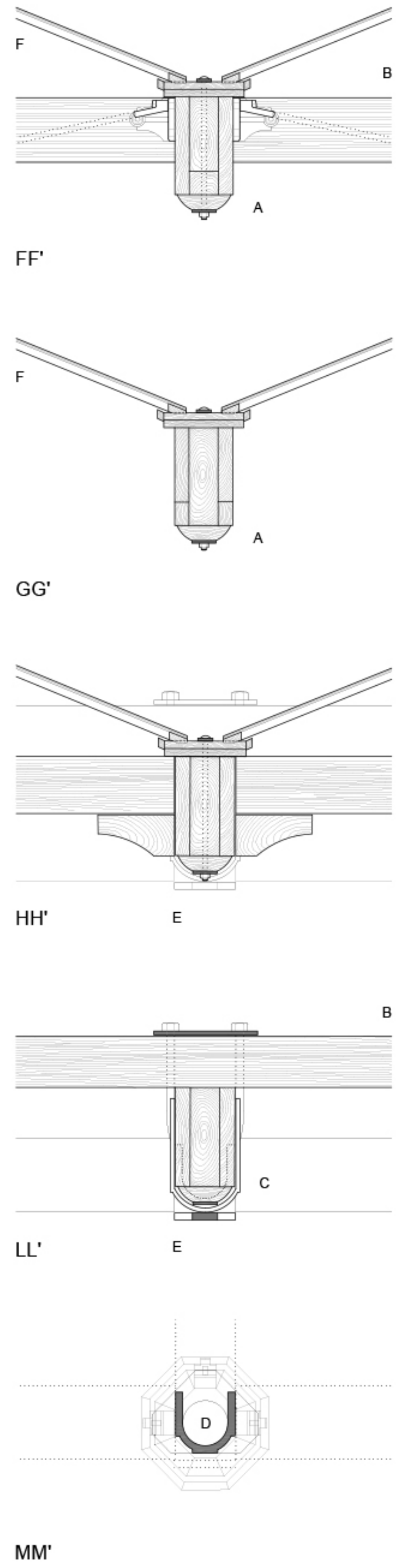




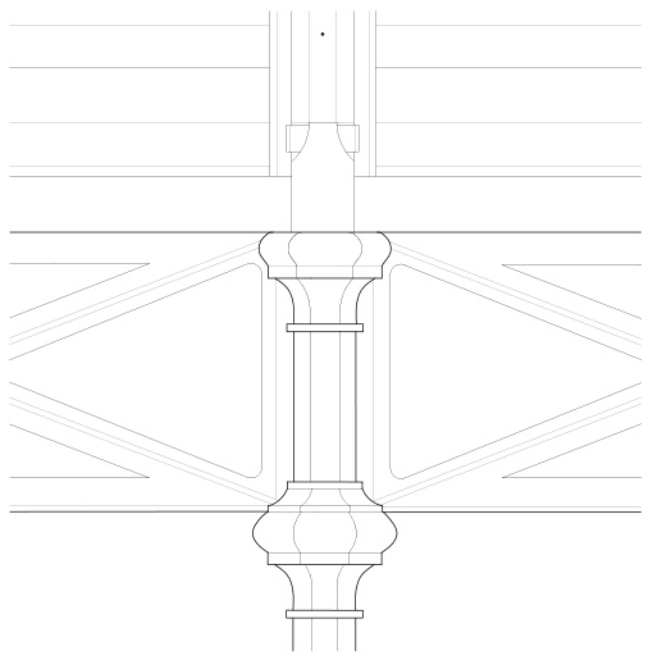
Front view, column-main rib connection

Scale 1:25

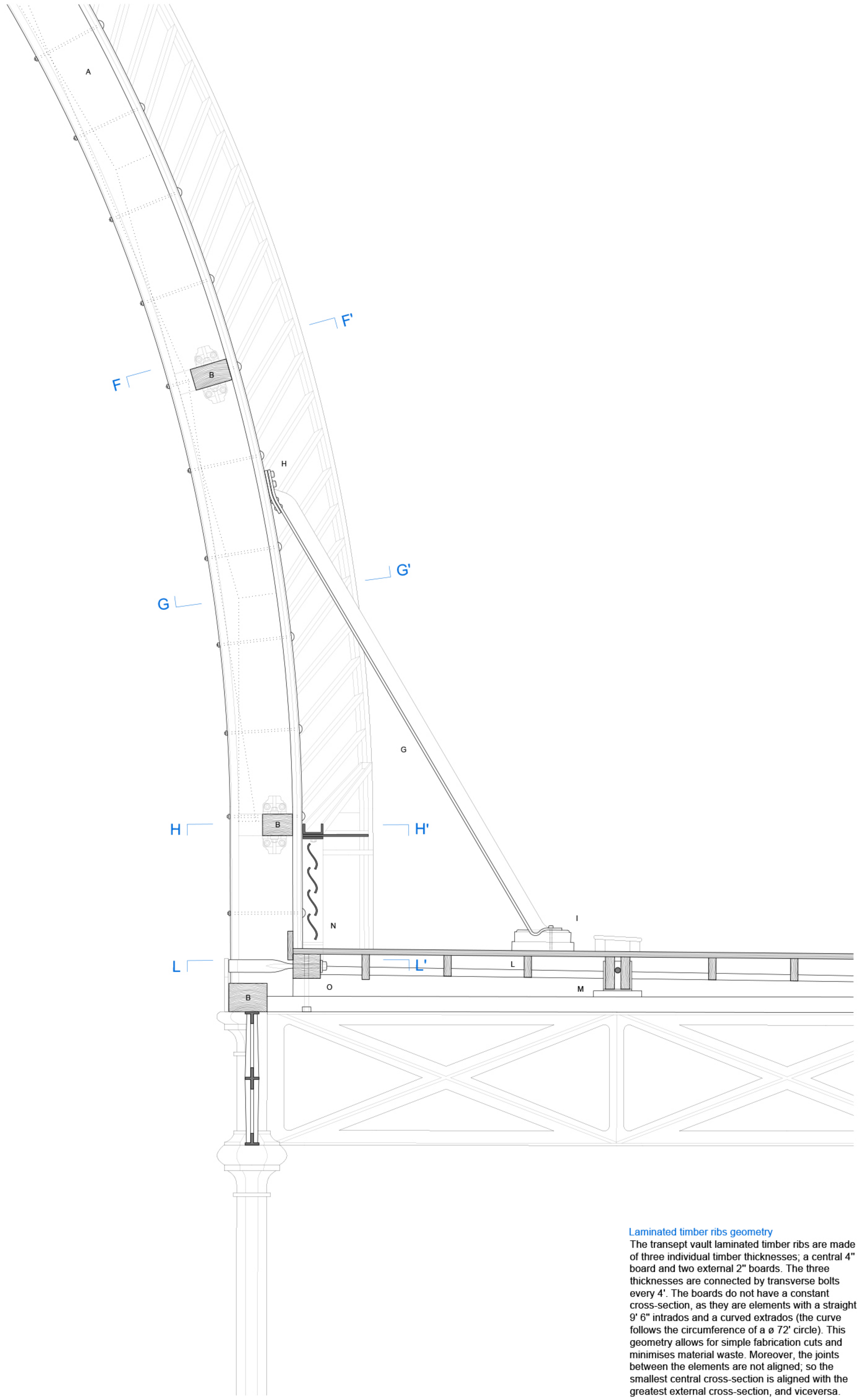
0 25 100 cm
0 20 40 in.



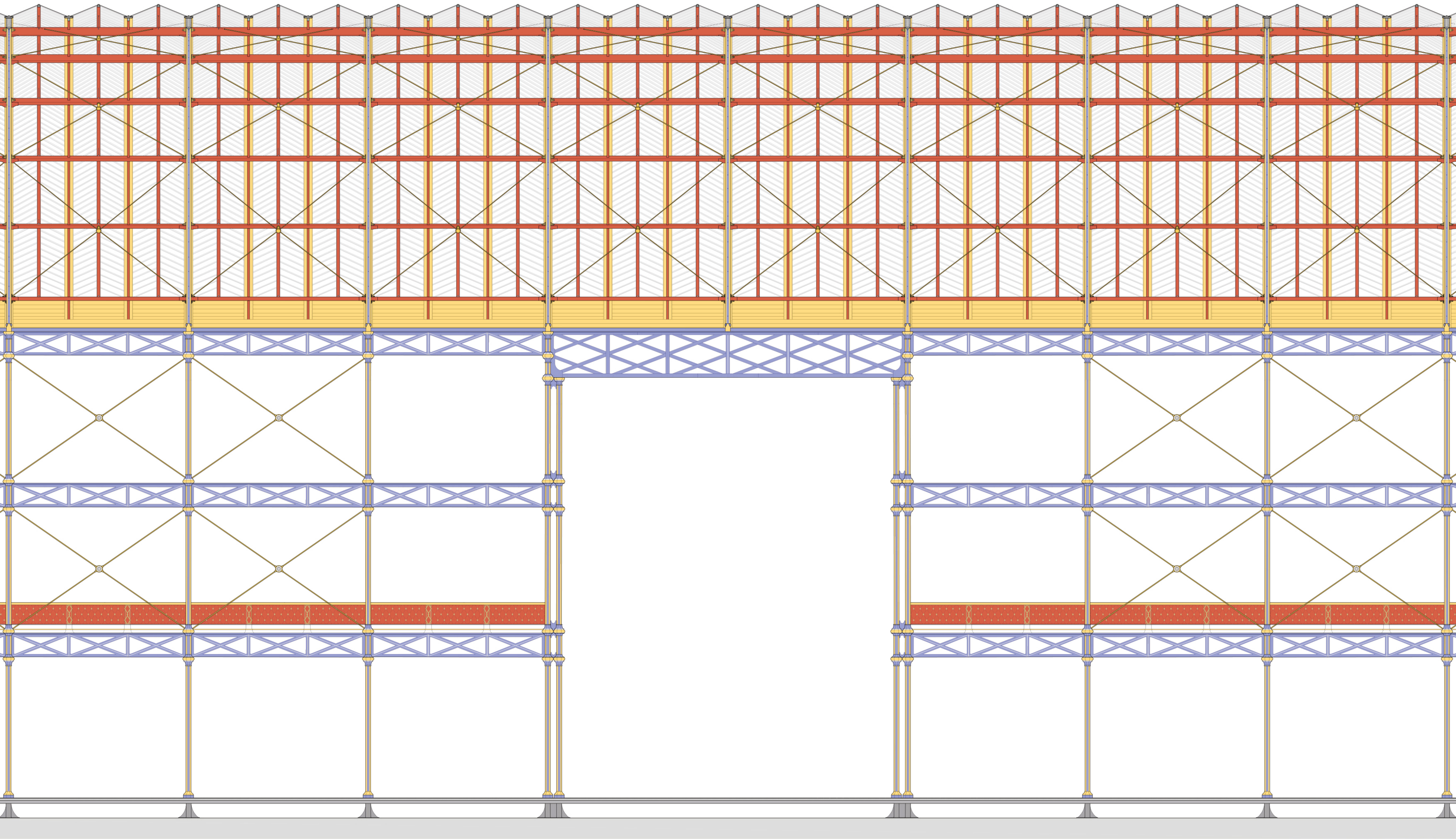
Section sequence, vault main rib



Construction elements, transept vault
A. transept vault primary structural rib
B. timber horizontal stiffening beam
C.primary rib iron connection band
D. hollow apex, cast iron column
E. ornamental plate, column-main rib connection
F. transept vault "shed" roofing system
G. T-shaped metal bar, main rib-lead flat connection
H. connection plate, main rib-T-shaped bar connection
I. T-shaped bar-lead flat connection
L. lead flat timber structure, double timber warping
M. lead flat timber structure, trussed timber beam
N. sashes for internal spaces ventilation
O. iron band-lead flat bolted connection



Laminated timber ribs geometry
The transept vault laminated timber ribs are made of three individual timber thicknesses; a central 4" board and two external 2" boards. The three thicknesses are connected by transverse bolts every 4'. The boards do not have a constant cross-section, as they are elements with a straight 9' 6" intrados and a curved extrados (the curve follows the circumference of a ø 72' circle). This geometry allows for simple fabrication cuts and minimises material waste. Moreover, the joints between the elements are not aligned; so the smallest central cross-section is aligned with the greatest external cross-section, and viceversa.



Longitudinal section, transept vault
Scale 1:100

Owen Jones' colour program
This reconstruction of the colours which the Crystal Palace structure was painted in is based on research conducted by Prof. Giovanni Brino, as well as on coeval iconographical sources, such as watercolours and chromolithographs.