THE NEW CIVIL ENGINEERING BUILDING FOR THE UNIVERSITY OF CAMBRIDGE: UNBOLTABLE, ADAPTABLE AND ABLE TO COMMUNICATE.

Paul Astle
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PROJECT
PROJECT BACKGROUND

• Location
• Masterplan
FUTURE CONNECTIVITY

VARIABLE EXTENSION
(Columns at variable spacing can be added to extra and)

FLEXIBLE ARRANGEMENT
(Blocks can be added to either end in any sequence)

ADAPTABLE FOR FUTURE GROWTH
(Design is 'open ended' only constrained by its limitations)
WHO’S WHO

CLIENT: University of Cambridge Estate Management

USERS: Cambridge University Engineering Department

PM/QS: AECOM

Client Design Team
- Architect: Grimshaw
- Structural Engineer: Smith and Wallwork
- Services Engineer: Max Fordham

SDC Design Team
- Architect: RH Partnership
- Structural Engineer: Ramboll
- Services Engineer: KJ Tait

RIBA 0 - 3

RIBA 4 - 6

2017

2019
CLIENT DESIGN DRIVERS

- Low whole life energy
- Design for manufacture
- Lean design
- Design for deconstruction
- Embedded sensors
- Visual engineering
RAMBOLL STRUCTURES SUSTAINABILITY STRATEGY

LEAN DESIGN

- Appropriate Loading
- Deflection Criteria
- Vibration Criteria
- Design for Manufacture
- Design for Deconstruction
- Embodied Energy Assessment (ECM)

Live Load Reduction
Optimised Combinations
BUILDING OVERVIEW

- Central terrace
- Blue-green roof
- Rainscreen cladding on gables
- Timber curtain walling system with thermo-chromic brise soleil fins
- 4,400 m²
- 3 storeys
- Riser chimneys

400 m² double height structures lab with strong floor

RAMBØLL
BUILDING OVERVIEW

Raft foundation

Flue supports

Exposed precast hollowcore planks

285t steel

Braced lift/stair cores

Transfer truss

Hanging mezzanine & feature stair in foyer

Primary bracing

Future services openings

RAMBOLL
STABILITY SYSTEM

Primary bracing

Semi-continuous moment frame
STABILITY SYSTEM

Stiffness controlled by end plate yielding
STABILITY SYSTEM

Connections specified with force and stiffness

\[
K^*:\text{ Double sided beam-column connection: } 233,000 \text{ kN.m/rad} \\
\text{Single sided beam-column connection: } 112,000 \text{ kN.m/rad}
\]
STRONG FLOOR

- 10m x 20m x 1m thick PT slab
- Supported on 21 elastomeric bearings
- PT to 11N/mm²
- Embedded sensors
TRANSFER STRUCTURES

- 2 x 14m (2 bays) storey height trusses
- 1 x 21m (3 bays) storey height truss
TRANSFER STRUCTURES

- Exposed structure and connections
• Aim to maximise the potential for deconstruction and reuse of primary steel frame
• Primary columns and beams account for 45% of frame by weight (130t)
• Standard open sections
• Lengths greater than 10m
• Minimise openings and fabrication
DESIGN FOR DECONSTRUCTION

150x250 RHS WITH 12mm PLATE

15mm THK 5355 STIFFENER PLATE

PRECAST PLANK

DUCTILE SEMI-CONTINUOUS CONNECTION

PRECAST PLANK NOTCHED A COLUMN

EXTENDED END PLATE

DETAIL

TYPICAL EDGE OF STEELWORK DETAIL SECTION

Ramboll
DESIGN FOR DECONSTRUCTION

- Provide tie details which can be unbolted
DESIGN FOR DECONSTRUCTION

- Provide tie details which can be unbolted
DESIGN FOR DECONSTRUCTION

- Ensuring columns can be unbolted
OVERCOMING BARRIERS TO REUSE

CIVIL ENGINEERING BUILDING
STEELWORK INFORMATION TAG

COBié REFERENCE: CS-CE-00-958967
SECTION: UC305x305x158
MATERIAL: S355JR
FIRE RATING: 60mins
ULTIMATE DESIGN LOADING: $N_{ud} : 2500\text{kN}$
$V_{ud} : 100\text{kN}$
$M_{ud} : 350\text{kNm}$

EXAMPLE ONLY
OVERCOMING BARRIERS TO REUSE

Adaptation
- Removing bays
- Introducing new structure
- Alterations to PC planks
- Services openings

Deconstruction
- Plank removal
- Reclaiming steel sections
- Truss deconstruction
BUILDING SENSORS

- Basement raft and walls
- Strong floor
- GSHP monitoring
- Roof outlet flow
- Primary beams and columns on GL D

Monitoring during construction
BUILDING SENSORS

- 42 FBG sensors
- 2 for each column and beam
BUILDING SENSORS

Mean strain change in beam on G.L. D above Level 3

- East span
- Middle span
- West span

200 Microstrain
12°C drop

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