Flat Slabs Research

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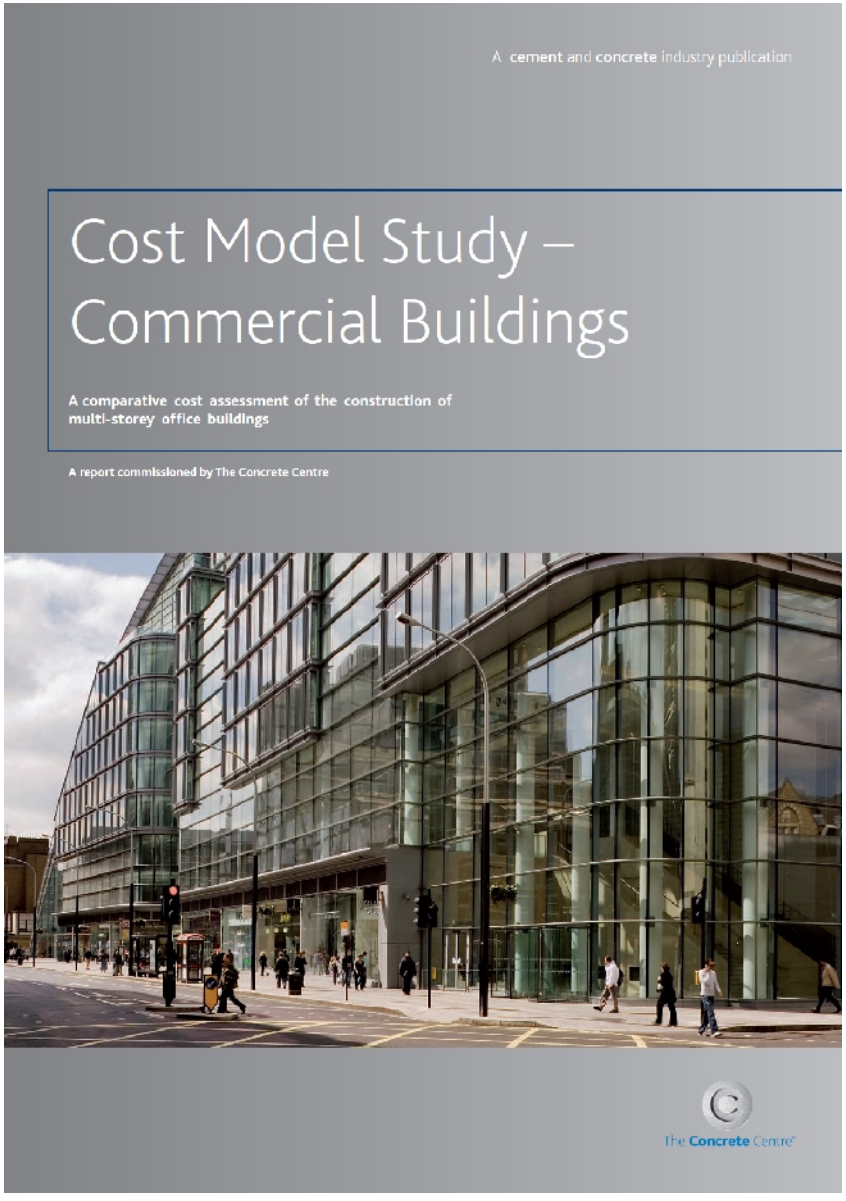
MPA The Concrete Centre

- Set up in 2003
- “to enable designers to realise the full potential of concrete”

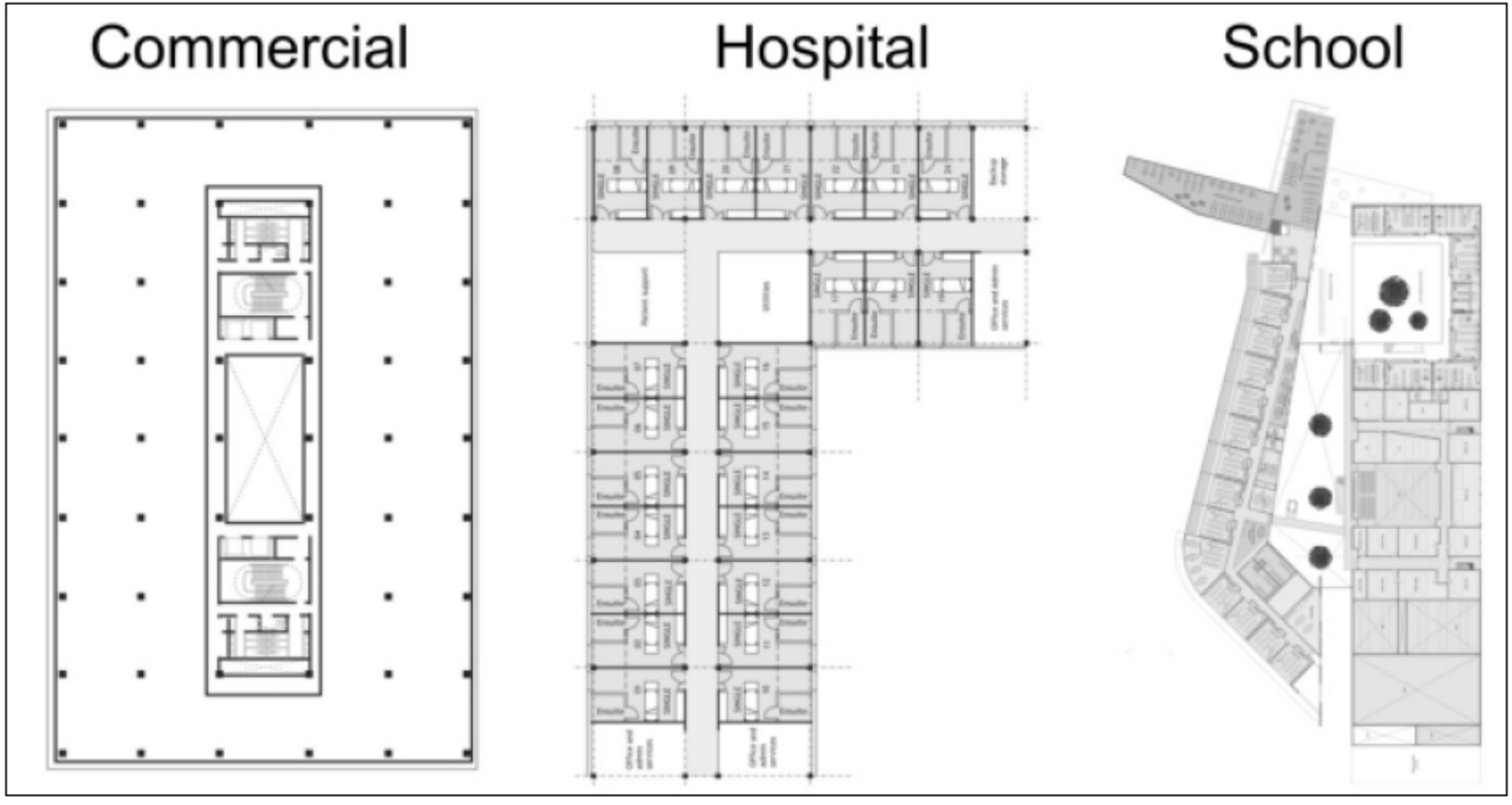
eCO_2 Study

- Cost Model Study
  - Commercial
  - Hospital
  - School
- Twenty designs
- Cradle to Gate
- Full building except M&E

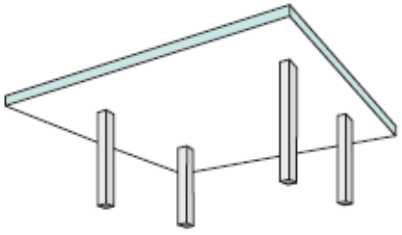
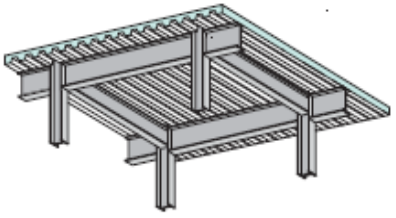
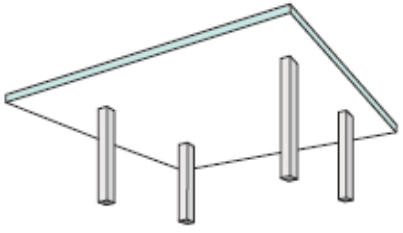
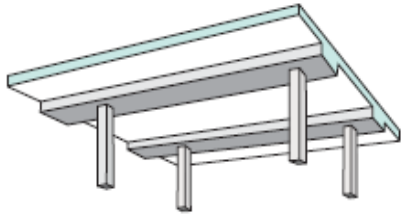
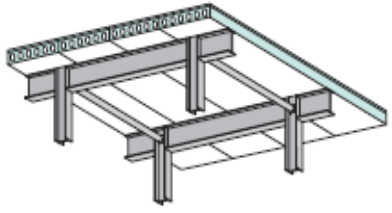
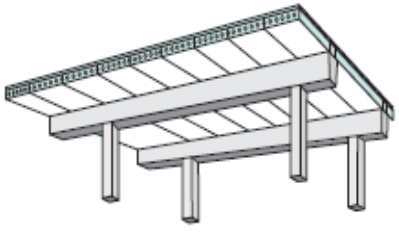
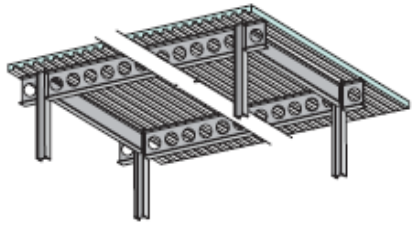


eCO_2 Study

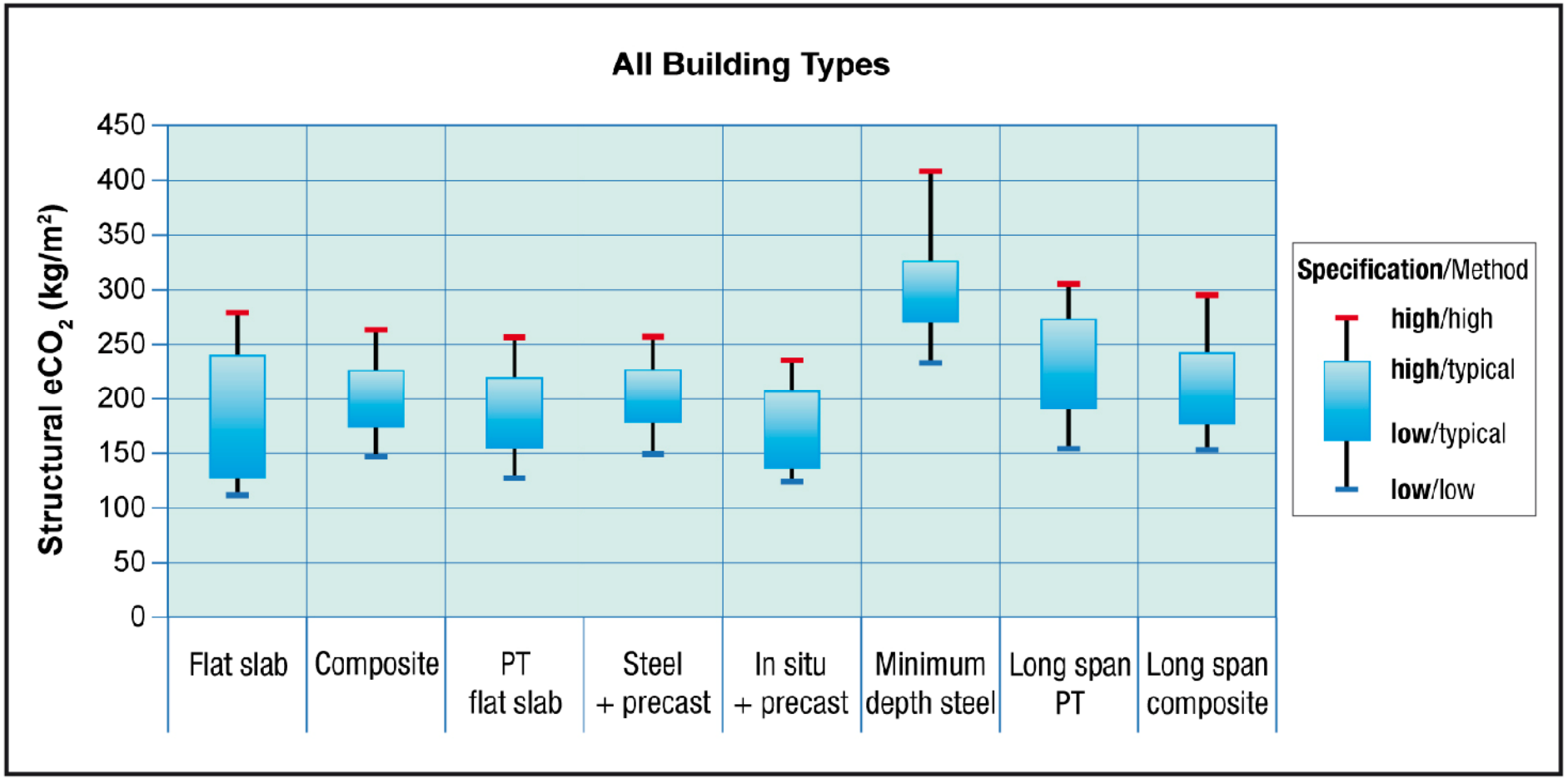
mpa The Concrete Centre



Study Method

Short-span options - Building A and B			Long-span options - Building B only
Option 1 - Flat Slab	**Option 2 - Composite**	**Option 3 - PT Flat Slab**	**Option 7 - PT Band Beams**
			
Reinforced in-situ concrete flat slab and columns	Steel beams and metal decking, acting compositely with in-situ concrete floor slabs. Steel columns	Post-tensioned in-situ concrete flat slab and reinforced in-situ concrete columns	Post-tensioned in-situ concrete flat slab and band beams with reinforced in-situ concrete columns
Option 4 - Steel + Hollowcore	**Option 5 - In-situ + Hollowcore**	**Option 6 - Slimdek**	**Option 8 - Long-Span Composite**
			
Steel beams acting compositely with precast concrete hollowcore floor slabs. Steel columns	Reinforced in-situ concrete beams and columns with precast concrete hollowcore floor slabs	Slimdek system comprising asymmetric beams and metal decking, acting compositely with in-situ concrete floor slabs. Steel columns	Long-span cellular steel beams and metal decking, both acting compositely with in-situ concrete floor slab. Steel columns

Results


All Building Types
Structural eCO2 (kg/m2)
450
400
350
300
250
200
150
100
50
0
Flat slab
Composite
PT flat slab
Steel + precast
In situ + precast
Minimum depth steel
Long span PT
Long span composite
Specification/Method
high/high
high/typical
low/typical
low/low

Flat Slab

Flat Slabs…

- Thin structure
- Flat soffits
- **No** beams

- 80% of concrete framed buildings are flat slabs
- 4 million m^2 built each year in UK

Flat Slab

- Sized for punching shear and deflection
- Additional reinforcement added to span steel to reduce deflections
- Typically 25% extra on a 7.5m x 7.5m grid with 250mm depth
- 5kg/m^2 or 4.4kg eCO_2 /m^2

18 000 tonnes CO_2 per year

Deflection

Knowledge of deflections in real slabs limited

- Cardington
- St George's Wharf

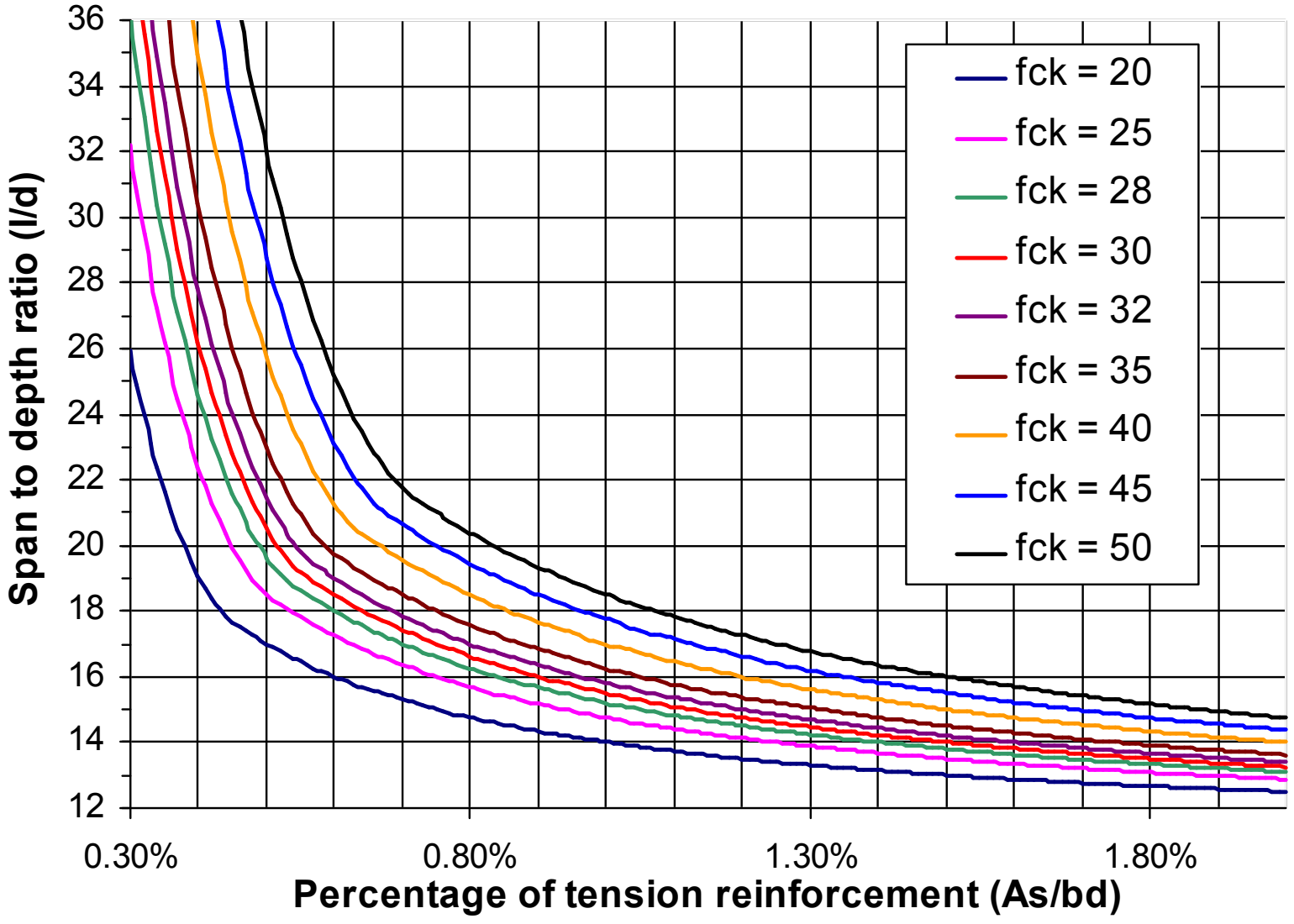
Typically design for deflection is by span to effective depth ratio

BS 8110

Simply Supported	Multiple Span	Cantilever
18	23.4	6.3

Deflection - EC2

Basic span to depth ratios



Deflection Limits

Knowledge of deflection limits limited

Typical limit (both BS8110 and EC2):

- Span/250 for all deflections
- Span/500 for deflections occurring after construction

(from work done in 1950s.)

Research Questions

- How much do flat slabs deflect?
- Membrane action in internal slabs?
- What limit is acceptable?
- Is additional reinforcement required?
- Where is additional reinforcement required?

Punching Shear

- Can govern the depth of a flat slab
- Further research required into the mechanism of punching shear
- Punching shear reinforcement in flat slabs increased by introduction of EC2 (in comparison with BS8110)
- Further reinforcement/depth likely in next iteration of EC2