Structural Aspects of the Dalmarnock Tests

M Gillie and T Stratford
University of Edinburgh
Background

- Few tests of complete structures
  - Cardington concrete structure – data incomplete
  - Lab-scale tests

- Dalmarnock offered
  - Real fire
  - Fire and structural behaviour monitored
  - Unique
The Structure

- Cast in-situ concrete – built 1960s
- Some plans
- NDT survey prior to tests
- One-way (ish) spanning floor slab
- 6” (15mm) deep
- Bottom reinforcement mesh
- Top reinforcement near supports
- Fire compartment 4.5m x 3.5m
CONY
CAPE STAIR
BEDROOM
BEDROOM
LIVING ROOM
BATHRM
KITCHEN
HALL
The Structure

- Non-structural wall
- Structural wall
- Structural column

Doorways

Window

Fire compartment

3.6m

4.6m
Measurements

- Vertical deflections of the heated floor slab
- Temperatures within the floor slab
- Strains on the upper surface of the floor slab
- Horizontal deflections of the internal structural wall
Deflection gauge locations

A (1800,830)
B (1980,1490)
C (660,2450)
D (1310,2450)
E (1840,2370)
F (2450,2450)
G (3040,2580)
H (1920,3180)
I (1870,3900)
Thermocouple locations
• 6 stations in plan
• 4 t-cs at each station
• Holes grout-filled
Strain gauge locations
Results - Deflections

![Graph showing downward vertical deflection over time for different gauges](image-url)

- Gauge A
- Gauge B
- Gauge E
- Gauge H
- Gauge I

Downward Vertical deflection (mm) vs. Time (s)
Deflections – Short Span

![Graph showing vertical deflection over time across a short span.](image)
Horizontal Deflections of Wall

Inward horizontal deflection (mm) vs. Time (s)

- Top
- Middle
- Bottom
Results - Temperatures

![Graph showing temperature changes over time for different depths in GAMMA and DELTA samples.](image)
Results - Temperatures

EPSILON

THETA
Results - Temperatures

- Temperatures in slab not uniform
- Not captured by previous structural tests
- This runs counter to most design guidance
  - Is the guidance conservative?
  - Less energy absorbed by most of the slab...
  - ...but much more locally
  - Adjacent areas hot and cold
  - Fires travel - implications?
- Work on travelling fires and cooling being undertaken
Results - Strains

Gauges 7a, 7b, 7c, 7d, 7e, 7x

Strain ($\mu$strain) vs Time (min)

-250 -200 -150 -100 -50 0 50 100

0 2 0 4 0 6 0 8

7a 7b 7c 7d 7e 7x
Results – Crack Patterns

- Cracks developed above lines of rebar curtailment
- Possibility of compartmentation breach with larger spans
- Recommend non-uniform curtailment of rebar
Crack Pattern after the Fire
To do

- Use the results as basis for numerical modelling to
  - Explore the behaviour in more detail
  - Examine a greater range of structural geometries
  - Understand the implication of local and travelling fires
Close

- Comprehensive data set available – please ask
- Numerical modelling in hand
- Any questions