Comité Français de Mécanique de Sols et Géotechnique
and the
British Geotechnical Association

APPLICATION OF
THE OBSERVATIONAL METHOD
AT KINGS PLACE
LONDON

Sir Robert McALPINE
Design Group

OM at Kings Place

- The decision making process for construction of the 16m deep basement
- Applying the observational method
- Outcomes and lessons learnt

Sir Robert
McALPINE
Design Group

The Project Team

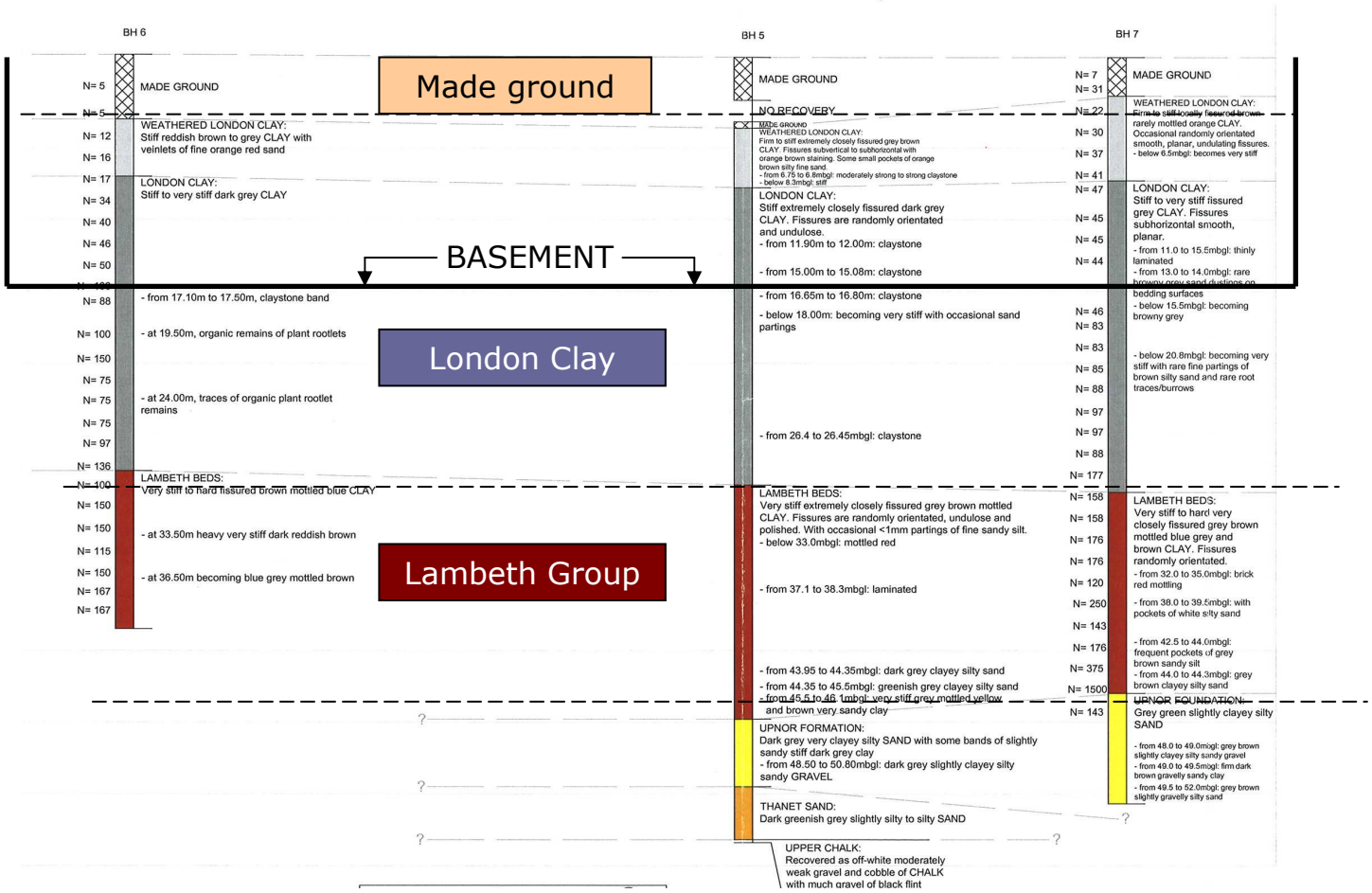
- Client - Parabola Land (Peter Millican)
- Main Contractor - Sir Robert McAlpine
- Engineer - Arup Newcastle

kings place
music+art+restaurants

Sir Robert McALPINE

ARUP

Ground conditions



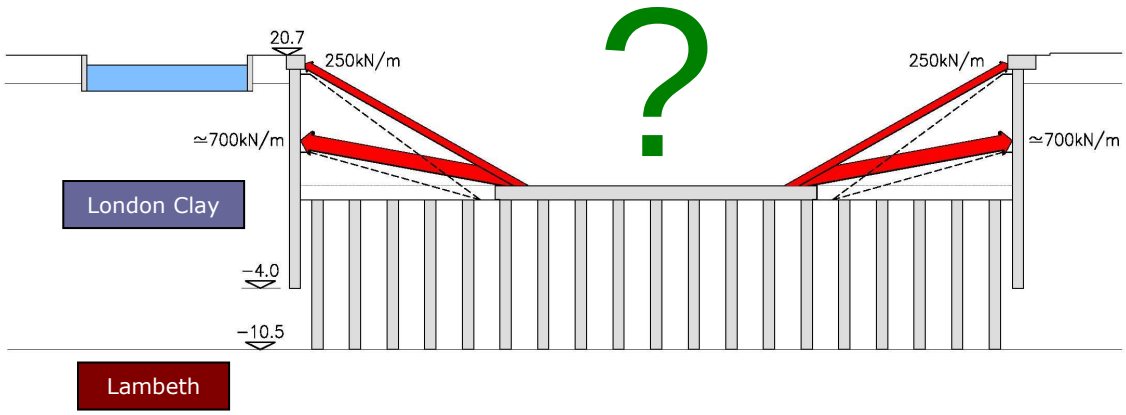
Sir Robert McALPINE
Design Group

16m deep basement construction

Original scheme

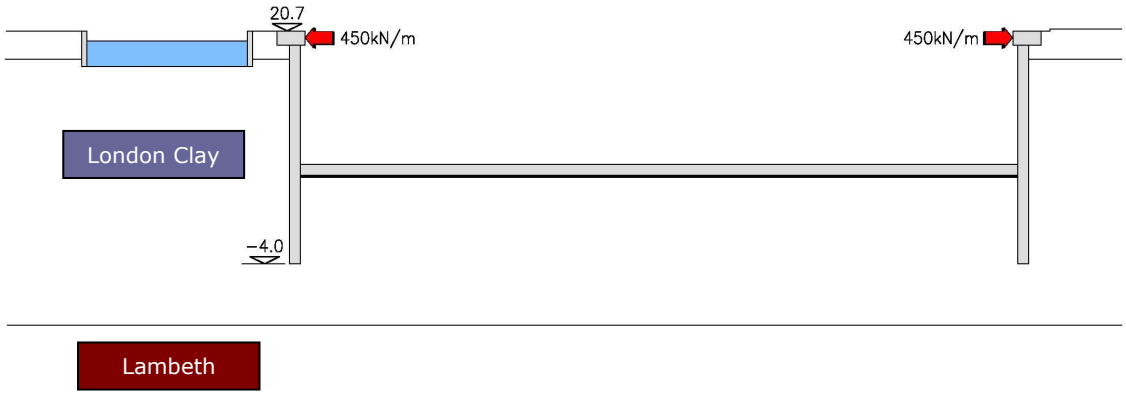
1.2m secant wall

- 2 levels of props
- 240 bearing piles
- 1.5m thick raft



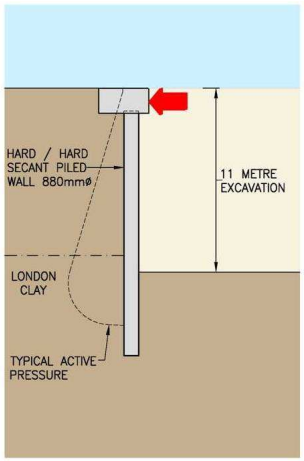
Alternative scheme

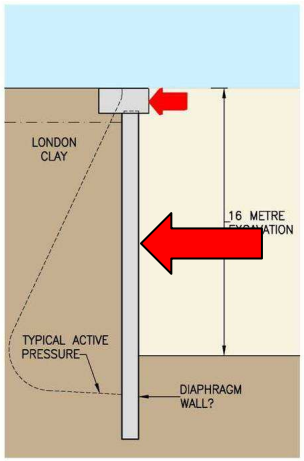
- 1.0m diaphragm wall
- 1 level of props
- 1.0 to 1.5m raft slab



Sir Robert McALPINE
Design Group

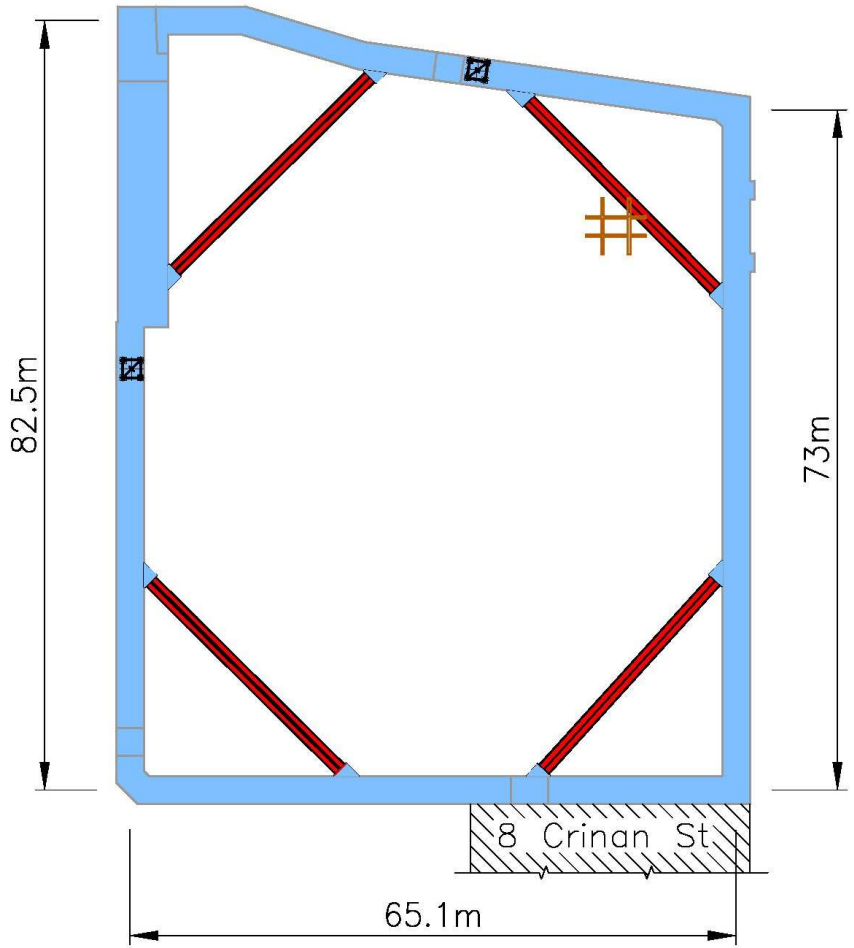
Decision process

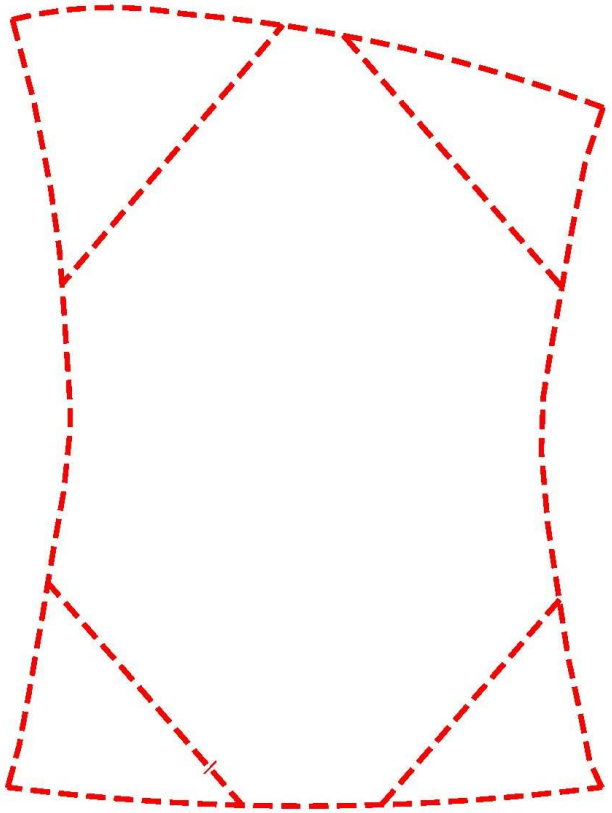




Sir Robert McALPINE
Design Group

Capping beam/prop analysis

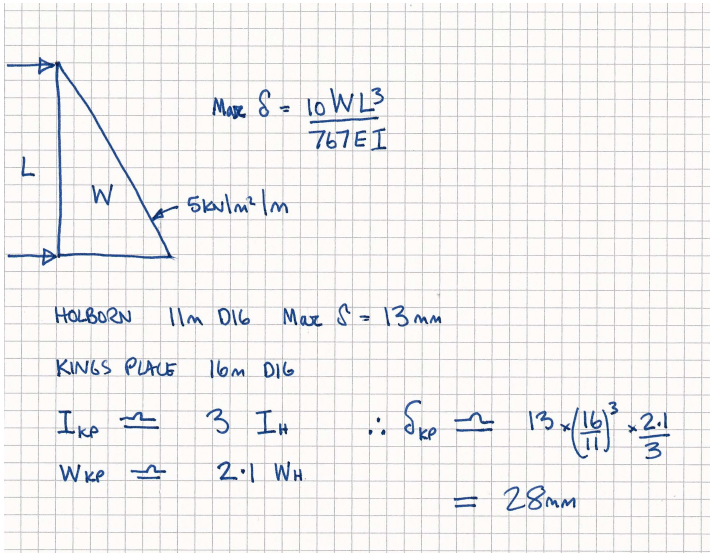


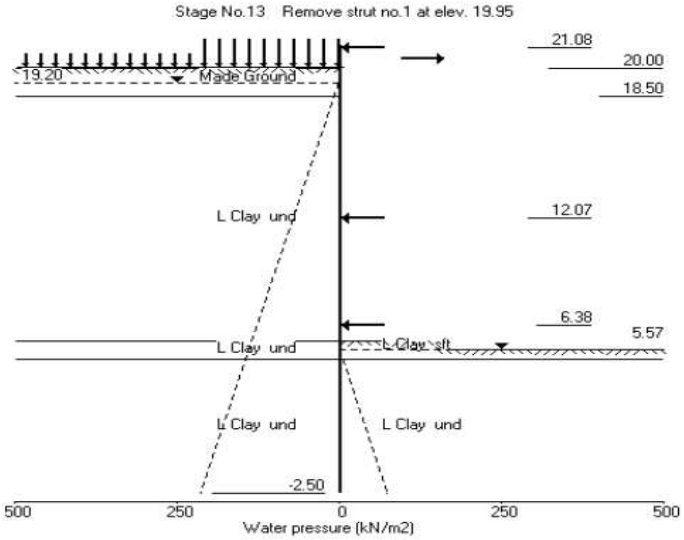


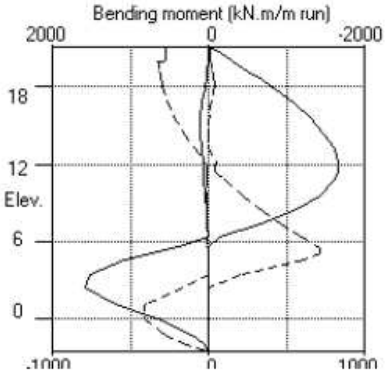
Sir Robert McALPINE
Design Group

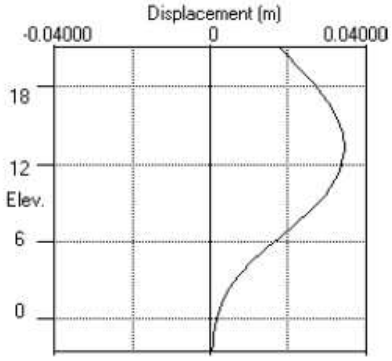
Analyses

- Demonstrate that the proposal works
  - By hand
  - 2D analyses - Wallap
  - 3D analyses - FLAC

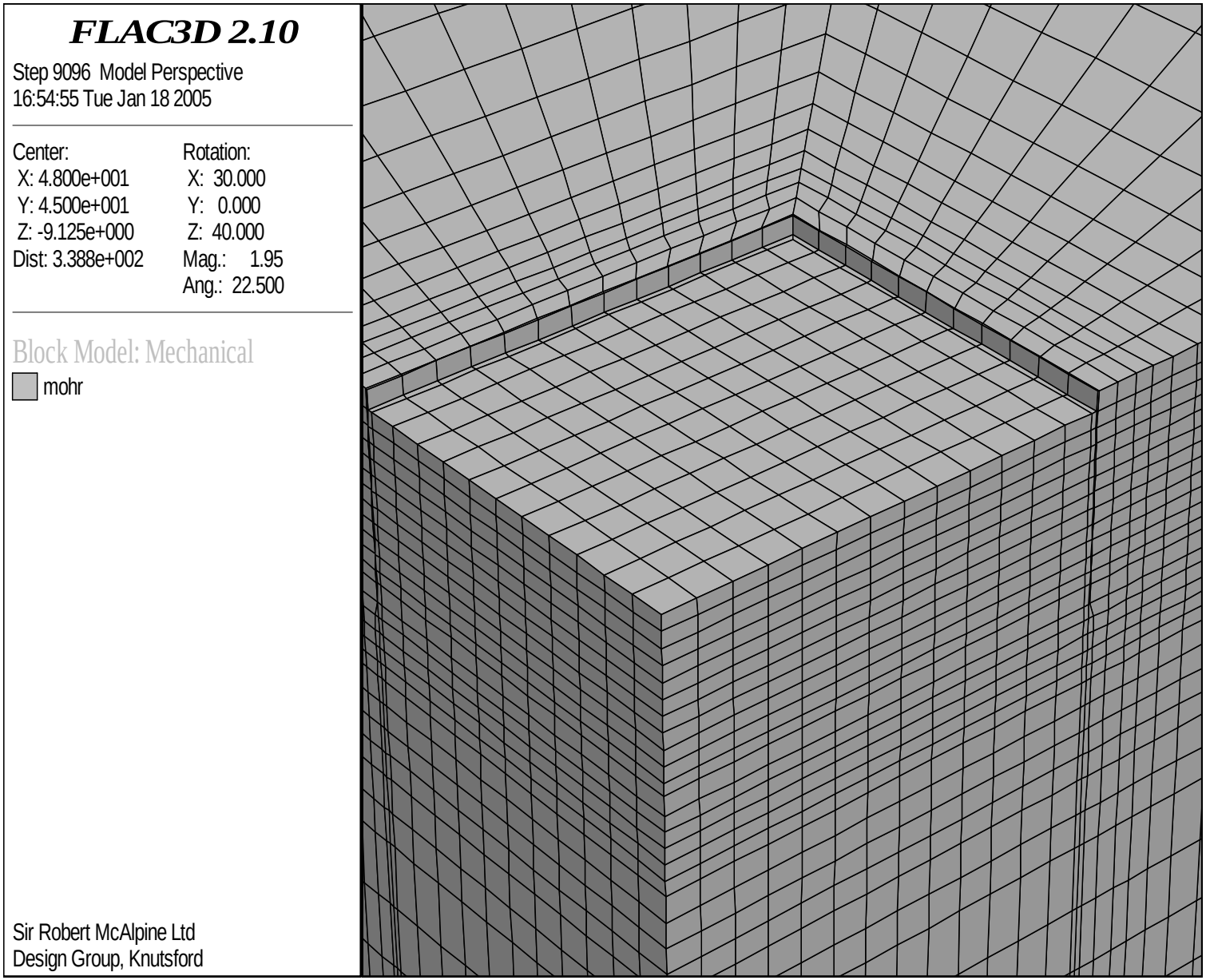




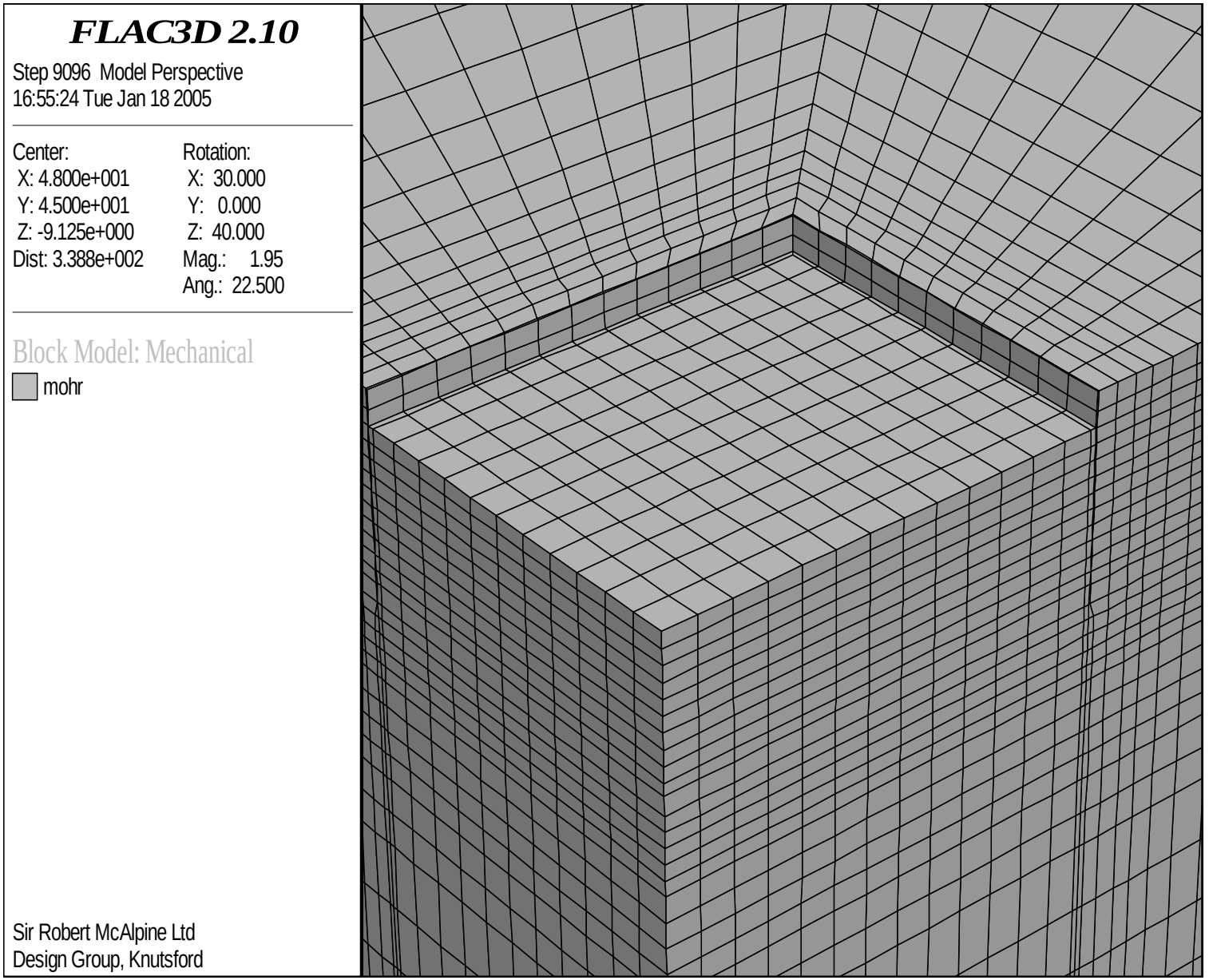




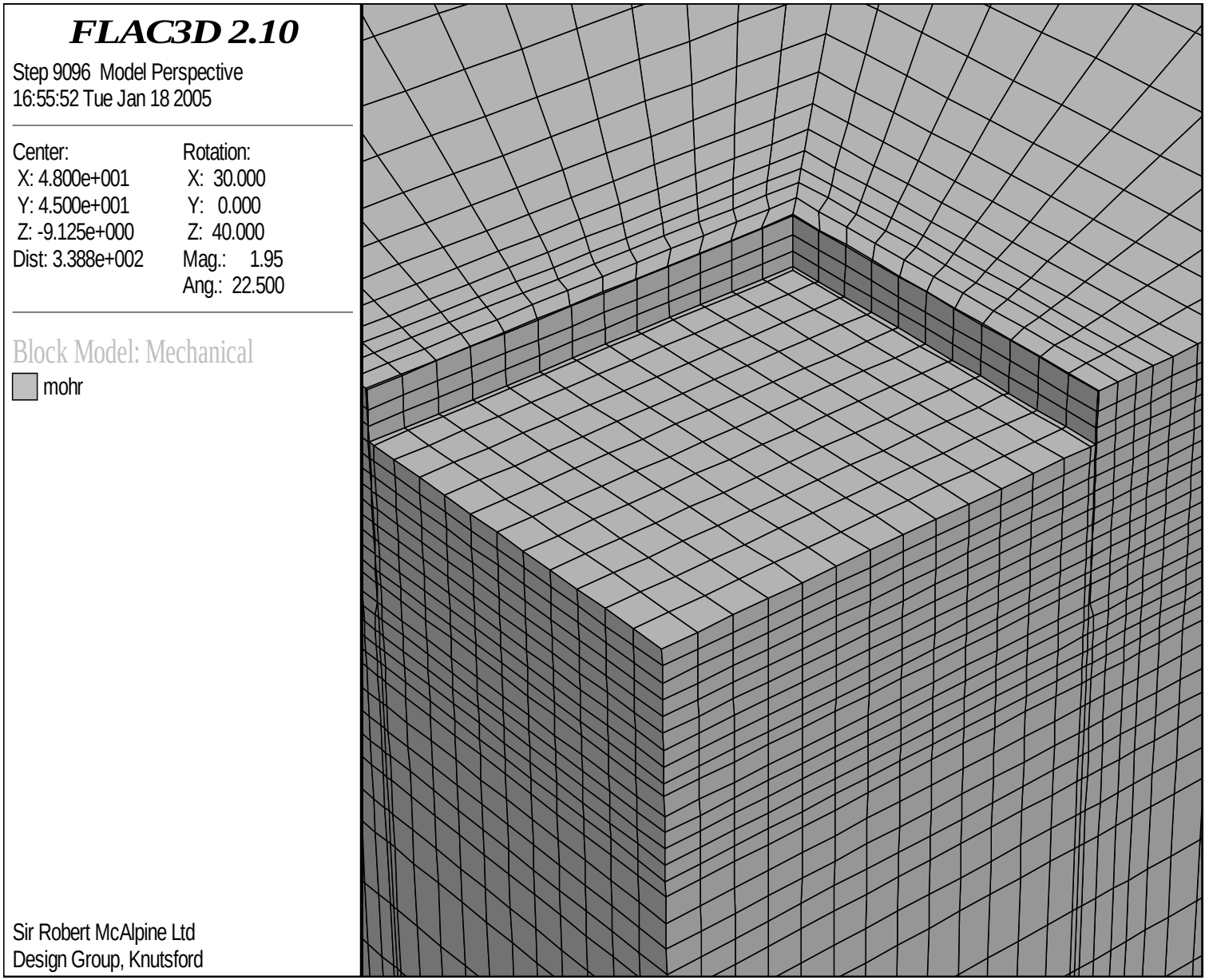
Sir Robert McALPINE Design Group



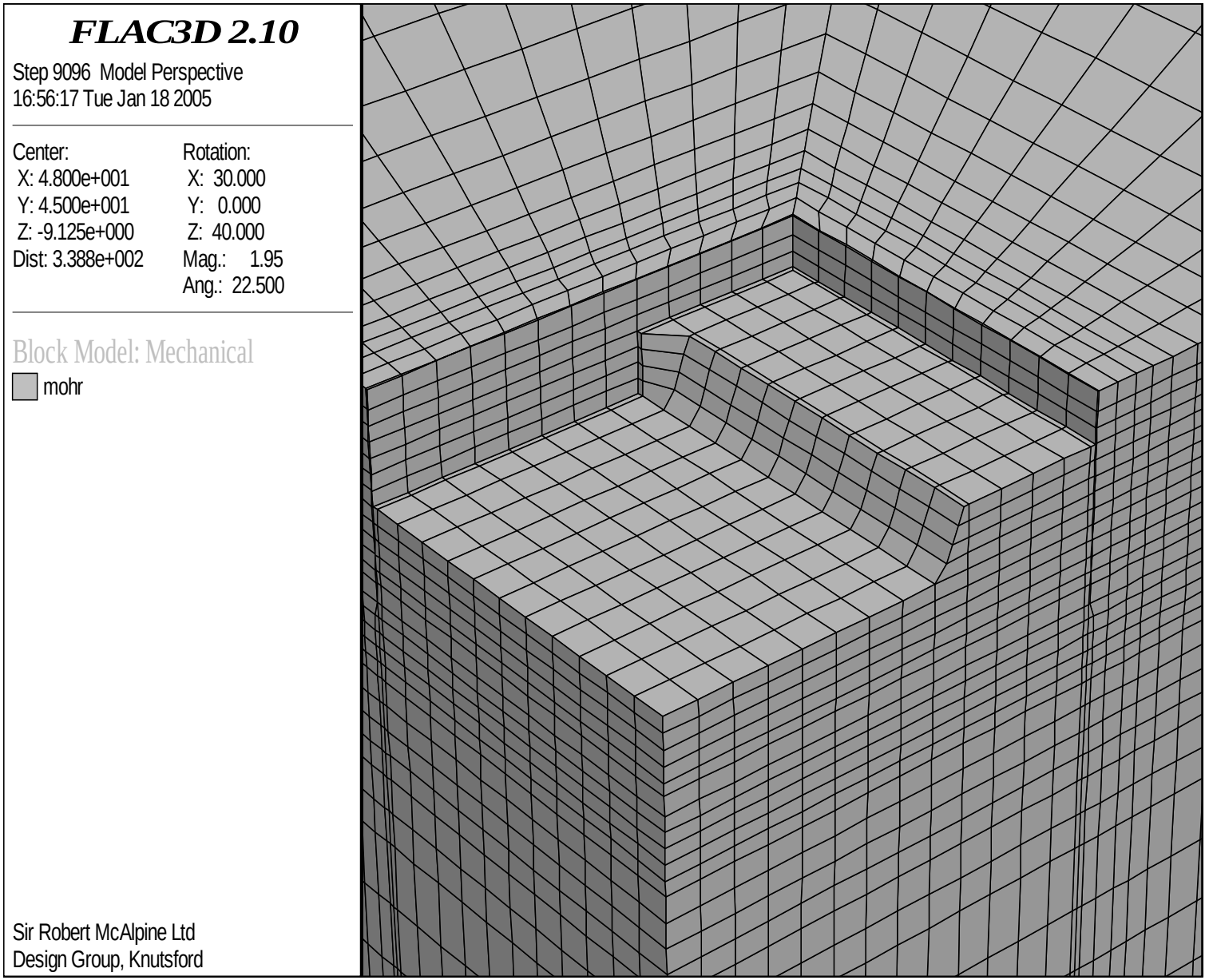
Sir Robert McALPINE Design Group



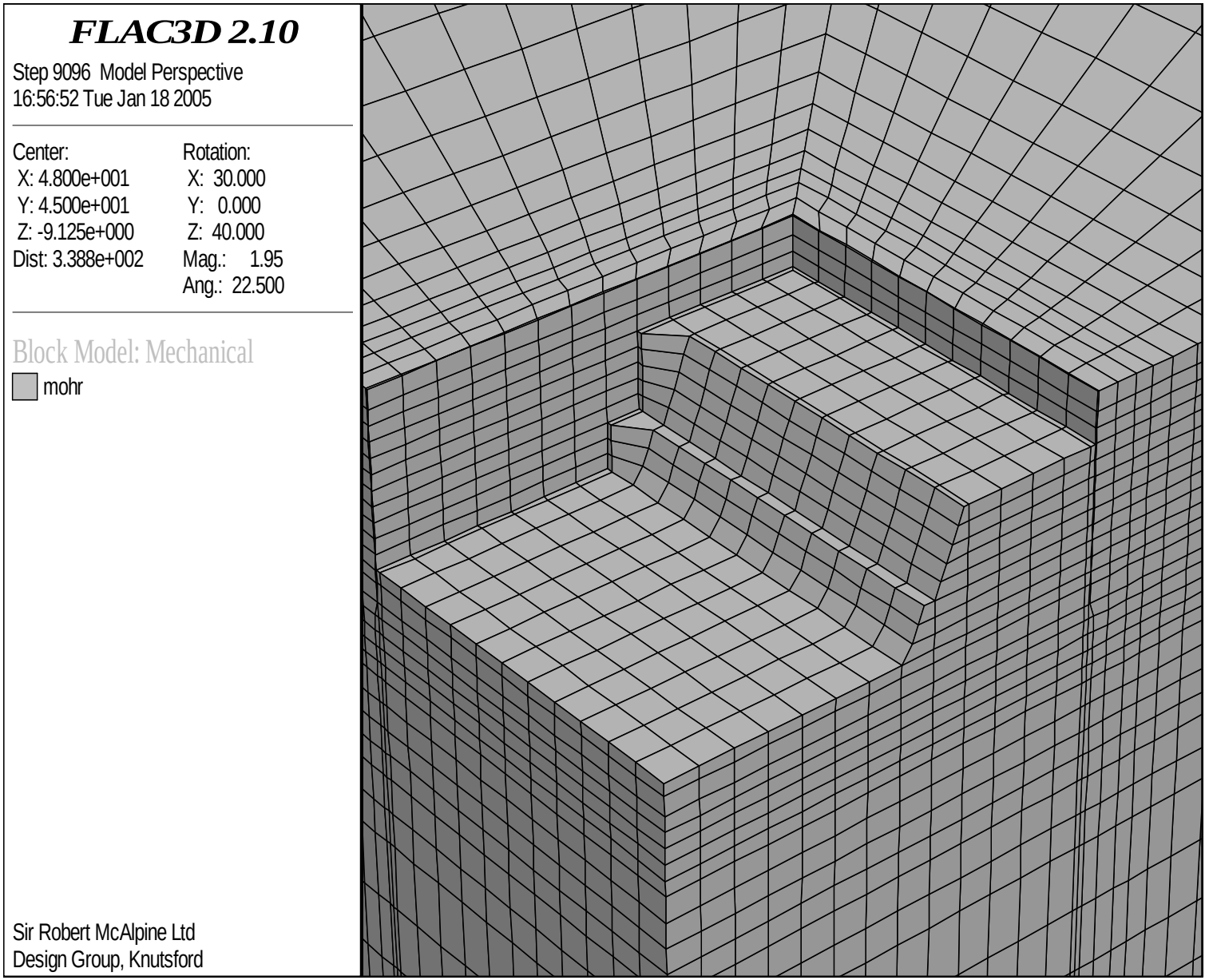
Sir Robert McALPINE Design Group



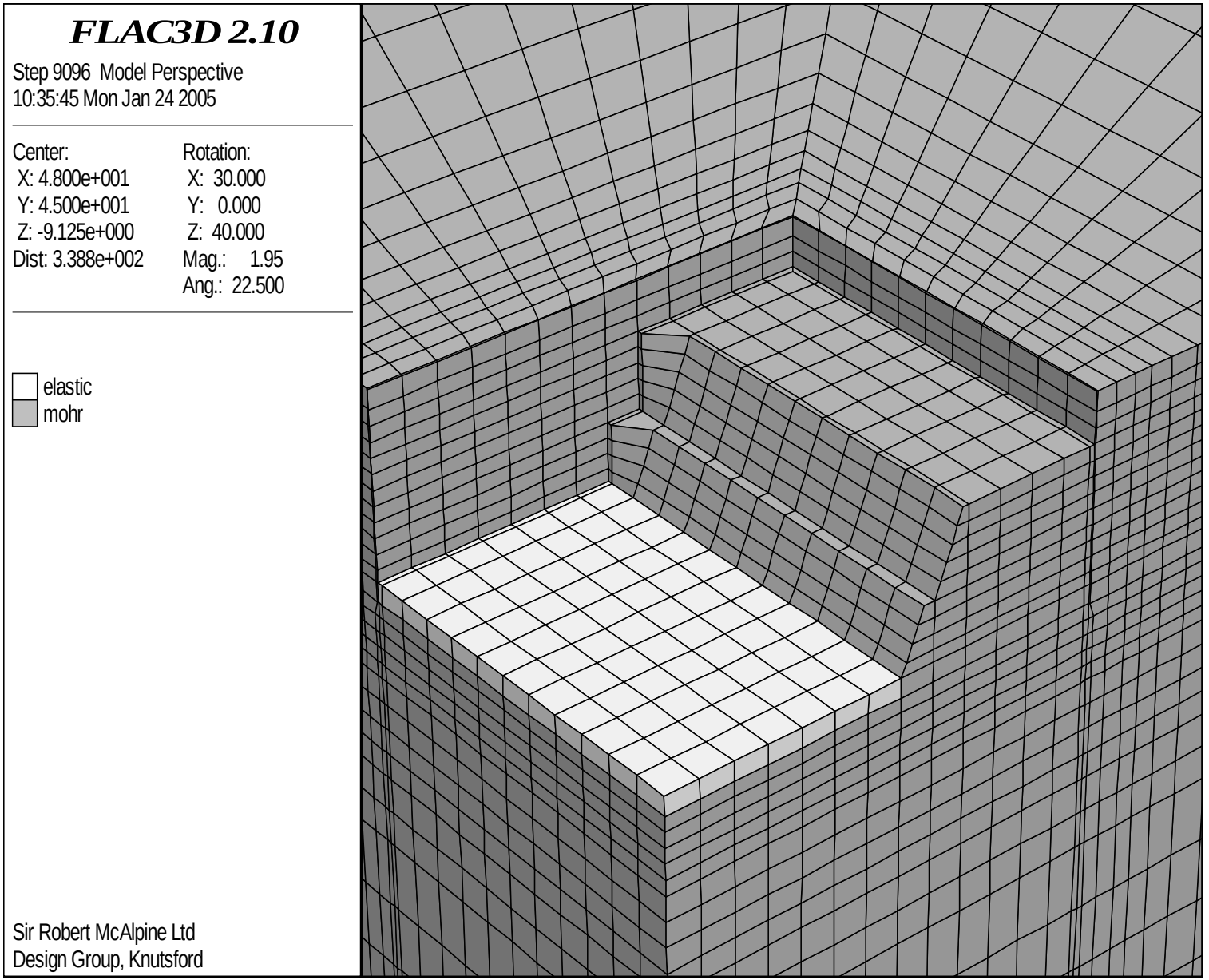
Sir Robert McALPINE Design Group



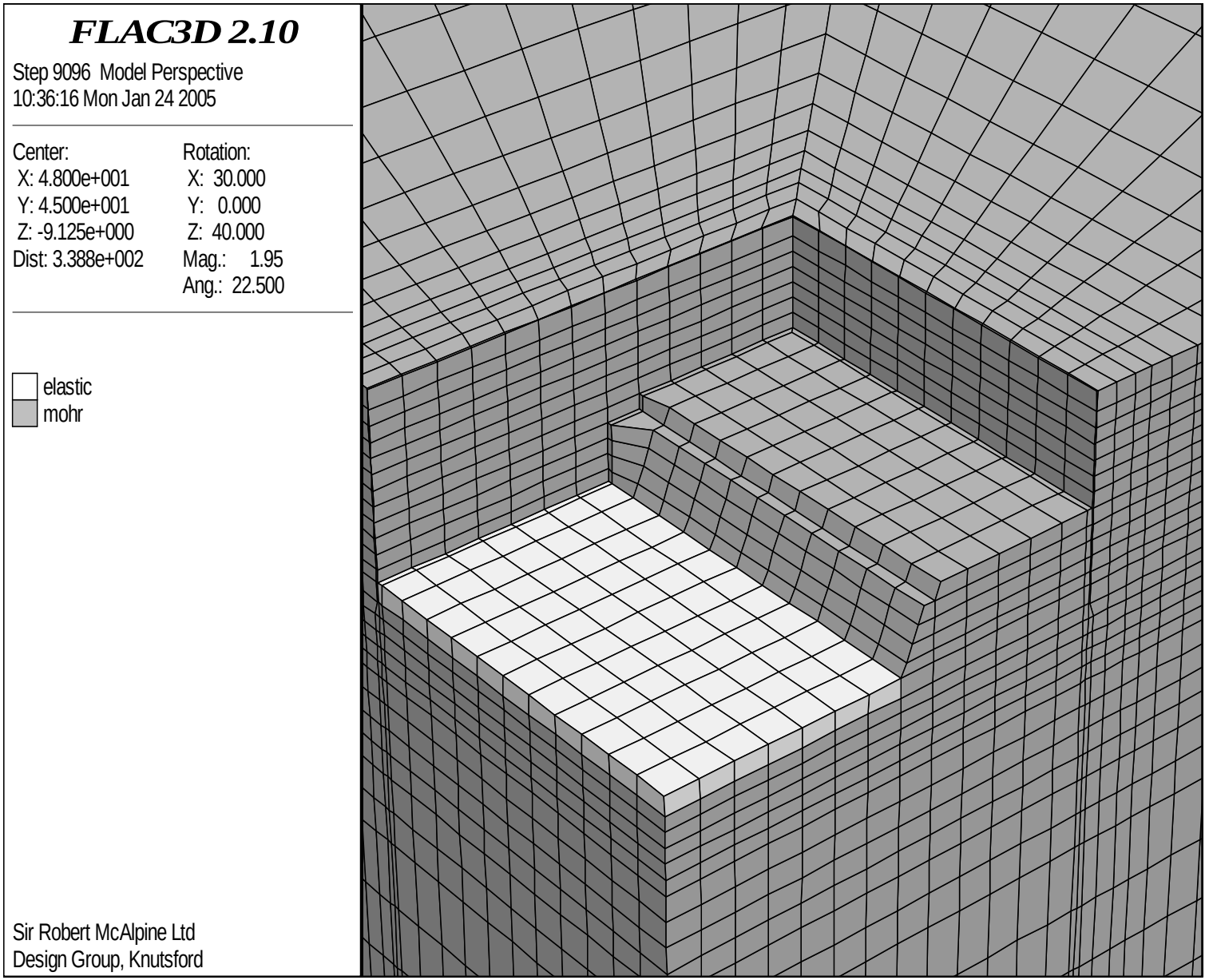
Sir Robert McALPINE Design Group



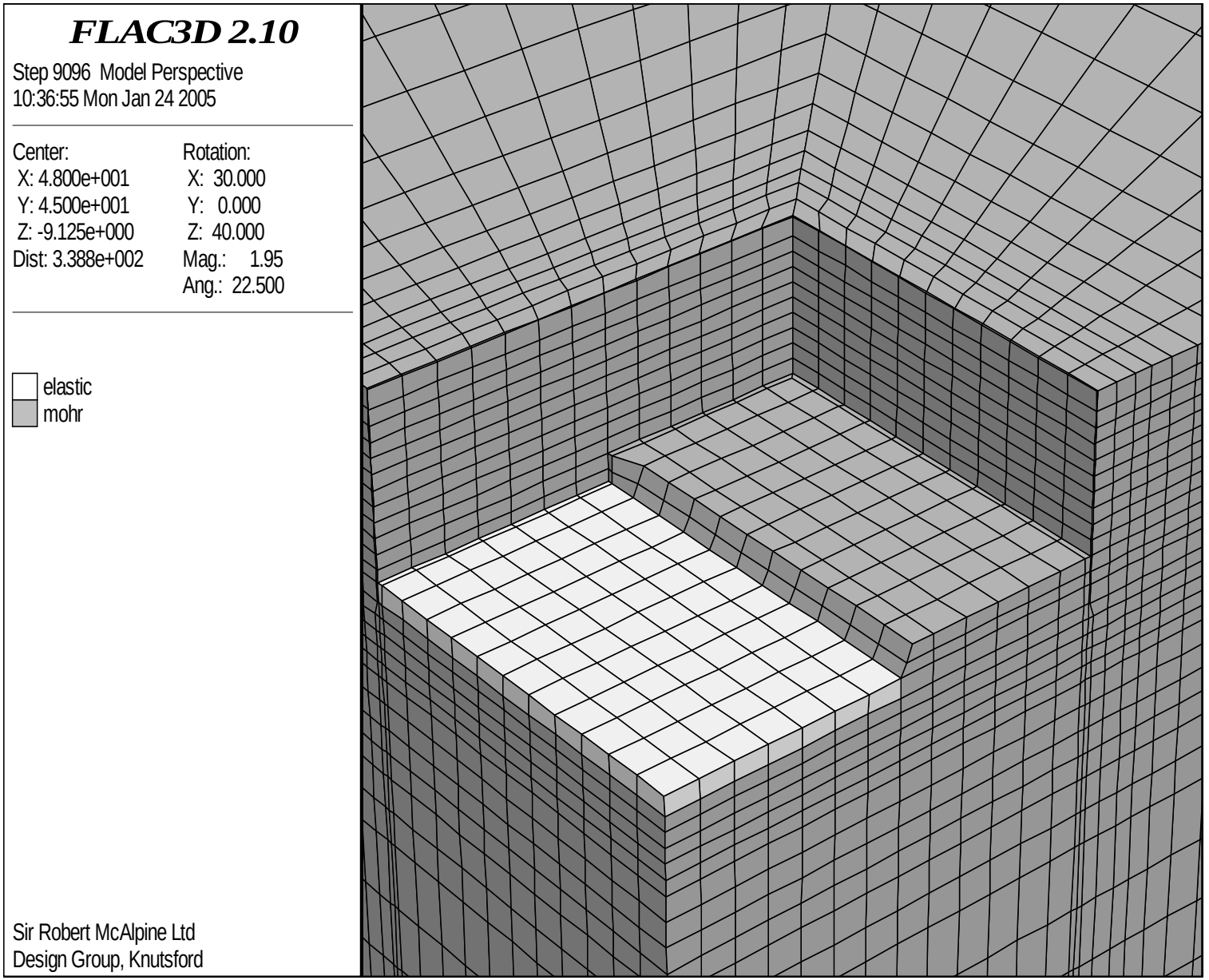
Sir Robert McALPINE Design Group



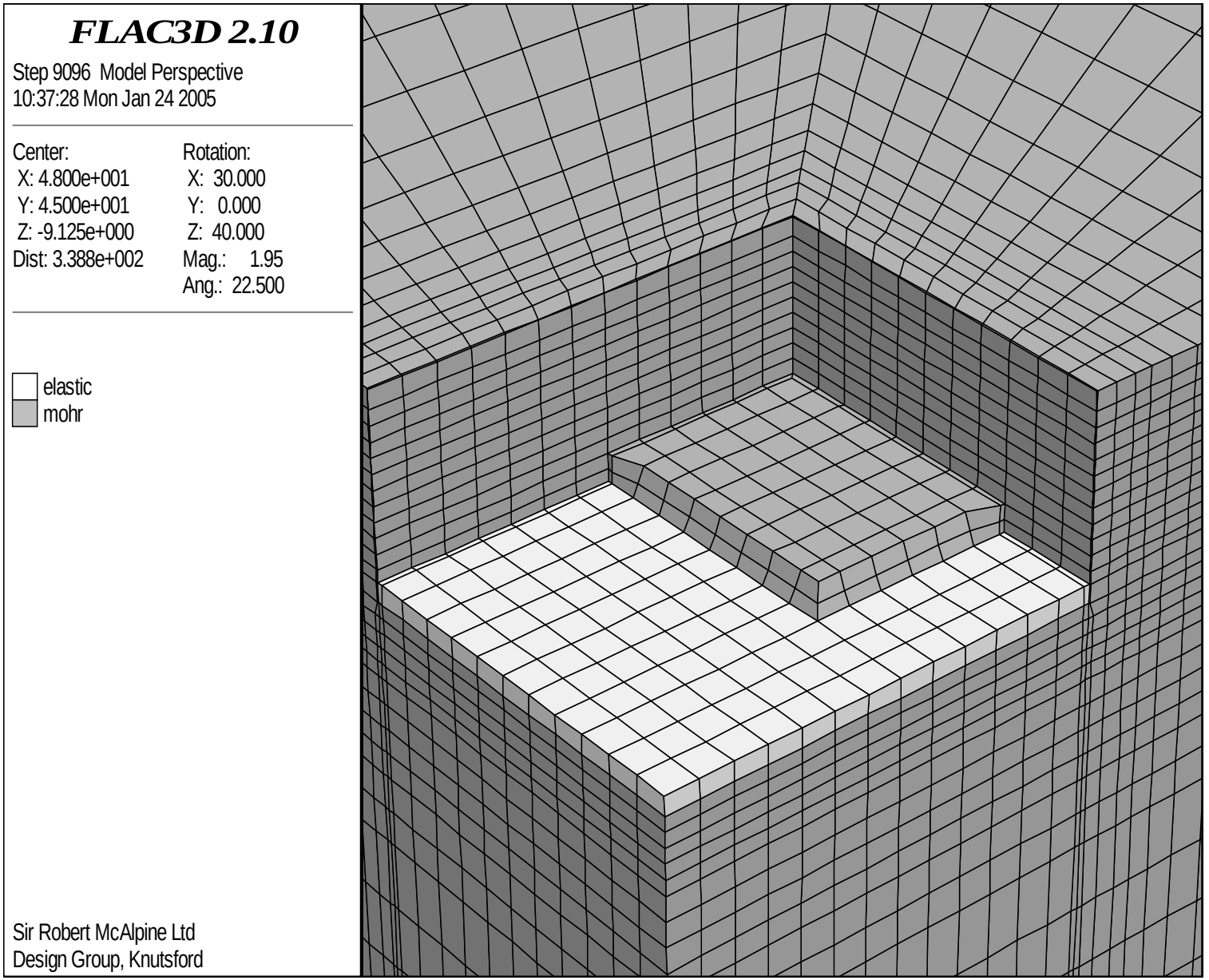
Sir Robert McALPINE Design Group



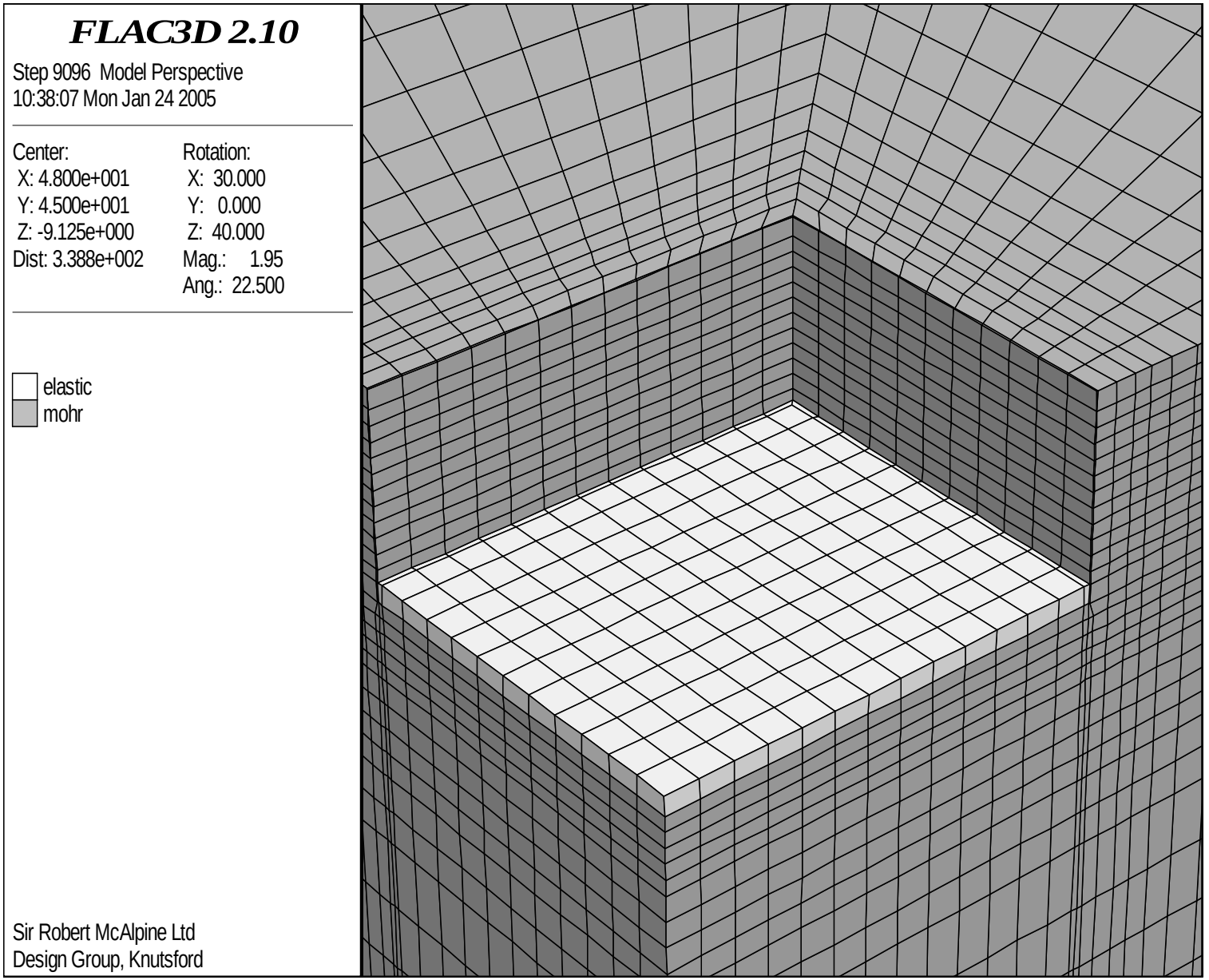
Sir Robert McALPINE Design Group



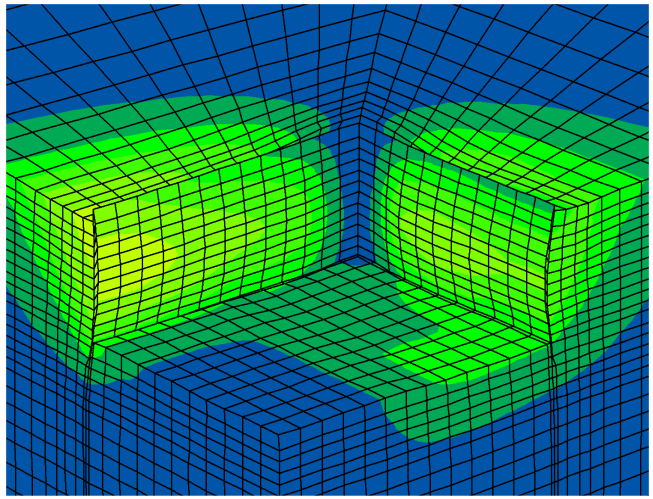
Sir Robert McALPINE Design Group



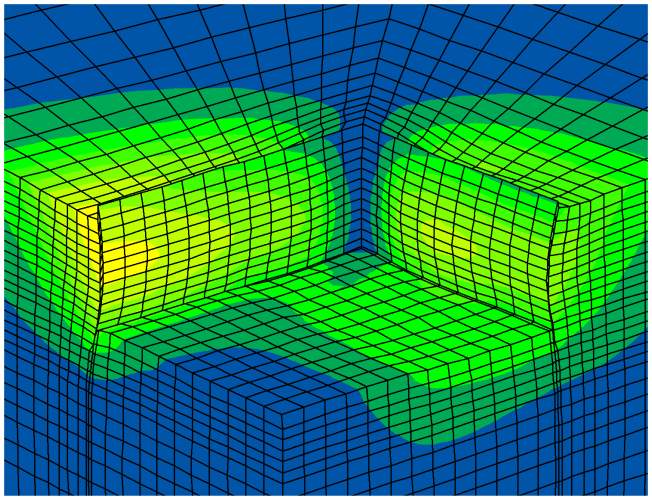
Sir Robert McALPINE Design Group



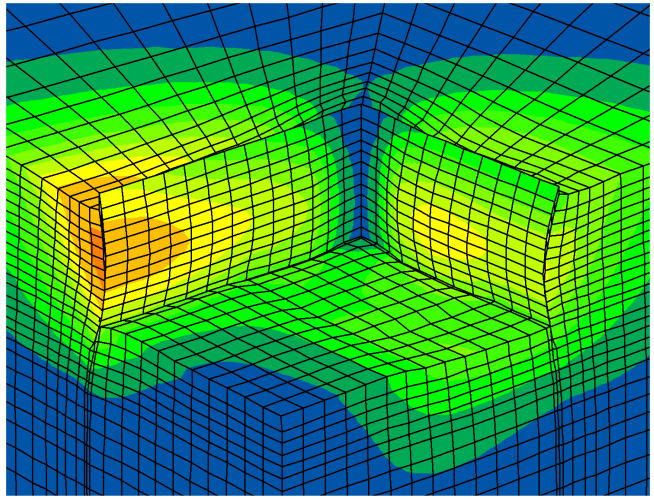
Sir Robert McALPINE Design Group



E = 800Cu/1600Cu
Maximum Displacement = 27.6mm



E = 600Cu/1200Cu
Maximum Displacement = 33.1mm

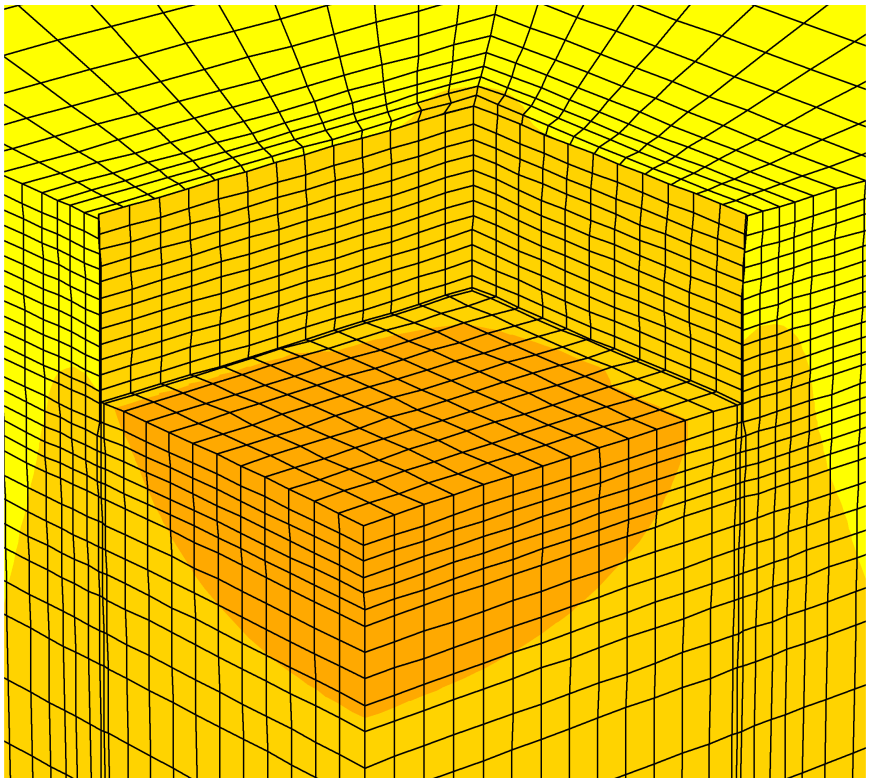


E = 400Cu/800Cu
Maximum Displacement = 42.0mm

Displaced shape and contours of displacement magnitude at 4.5 years

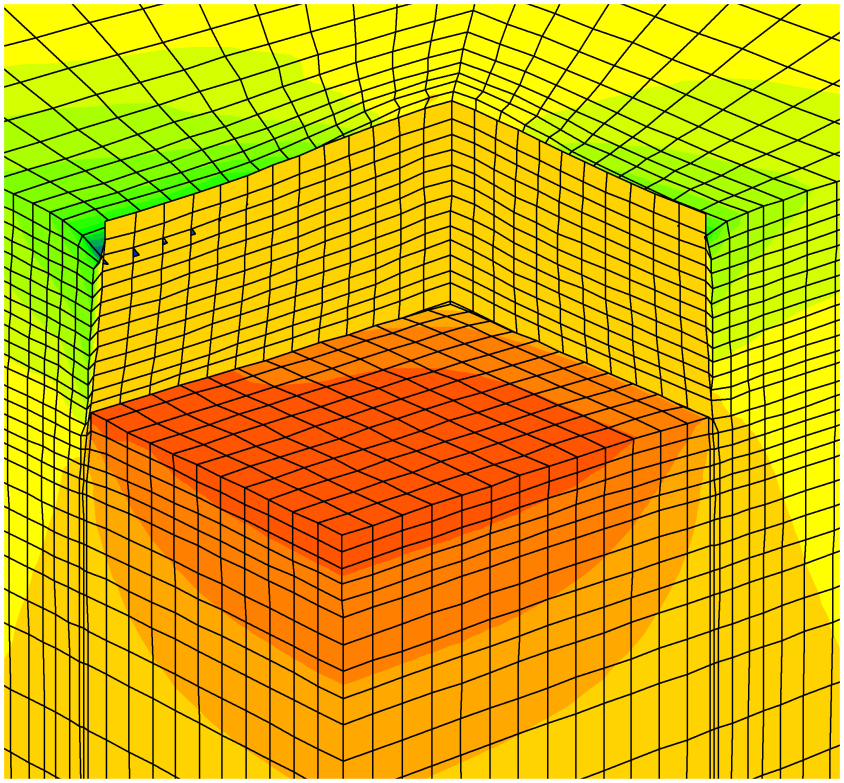
Sir Robert McALPINE
Design Group

Prop failure?



With slab and prop
-0.009/+0.019

-0.120 -0.080 -0.040 0 +0.040
Contour interval = 0.020



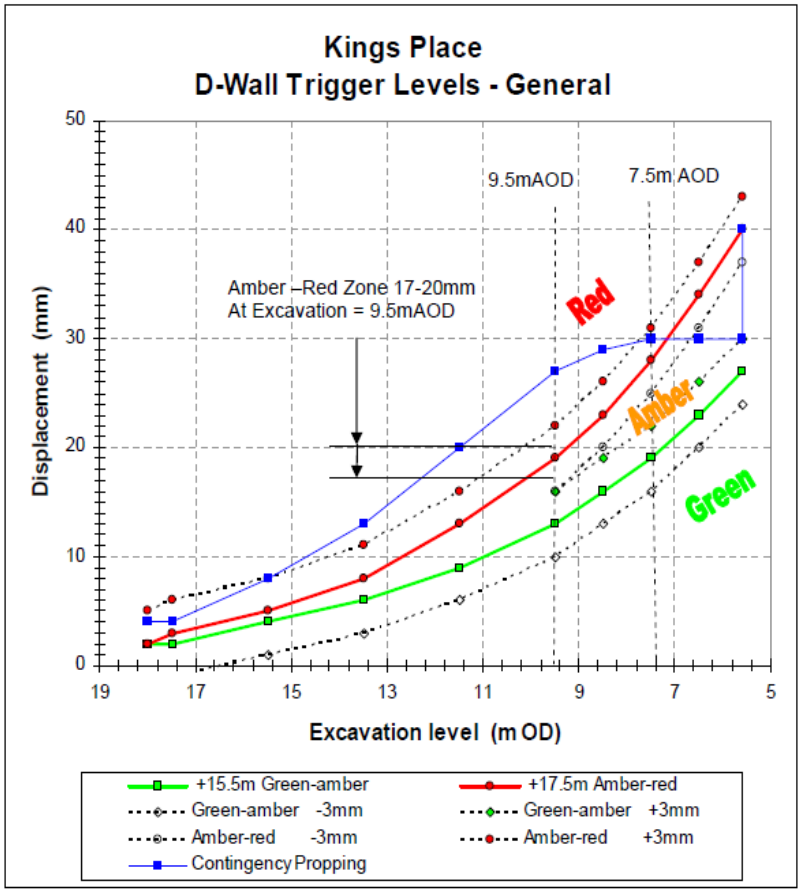
Without slab and
prop
-0.122/+0.040

Sir Robert McALPINE
Design Group

Monitoring considerations

- Limit criteria for adjacent property
- Primary monitoring system
- Trigger level definition
- System accuracy
- Contingency measures
- Frequency of readings
- Secondary monitoring system
- Key personnel
- Data dissemination

0	Hairline cracks of less than about 0.1 mm which are classed as negligible. *No action required.*
1	Fine cracks which can *be treated easily using normal decoration.* Damage generally restricted to internal wall finishes; cracks rarely visible in external brickwork. Typical crack widths up to 1 mm.



Sir Robert McALPINE
Design Group

Monitoring equipment

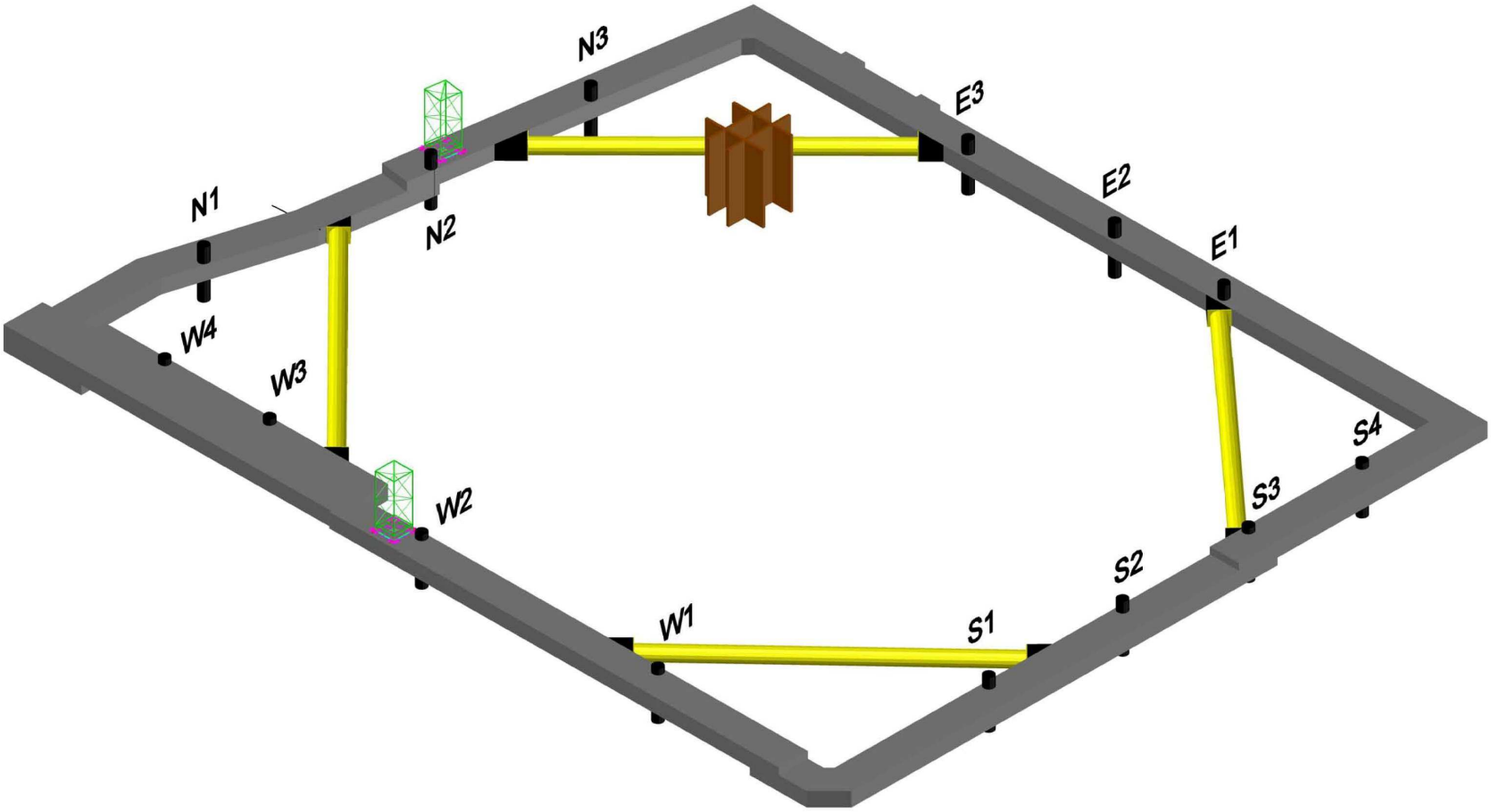
Primary monitoring
- Inclinometers
- Prisms
- Strain gauges
- Survey points
- Piezometers
- Tilt meters

Secondary system
- Reflector targets
- Prisms
- Survey points

Wish list
- Extensometers

Sir Robert McALPINE
Design Group

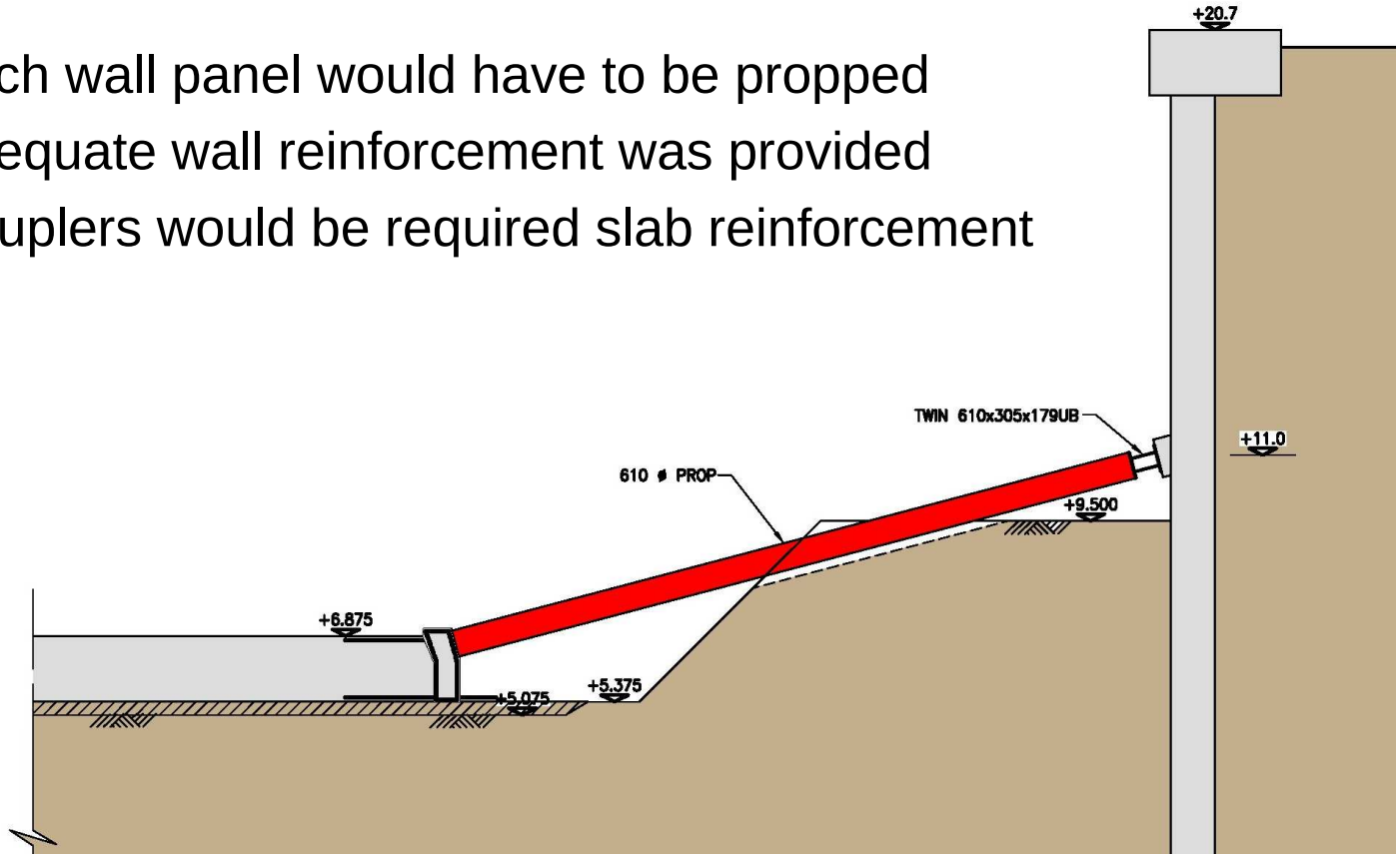
Wall monitoring locations



Sir Robert McALPINE
Design Group

Contingency propping

- Each wall panel would have to be propped
- Adequate wall reinforcement was provided
- Couplers would be required slab reinforcement



Sir Robert McALPINE
Design Group

Sir Robert McALPINE

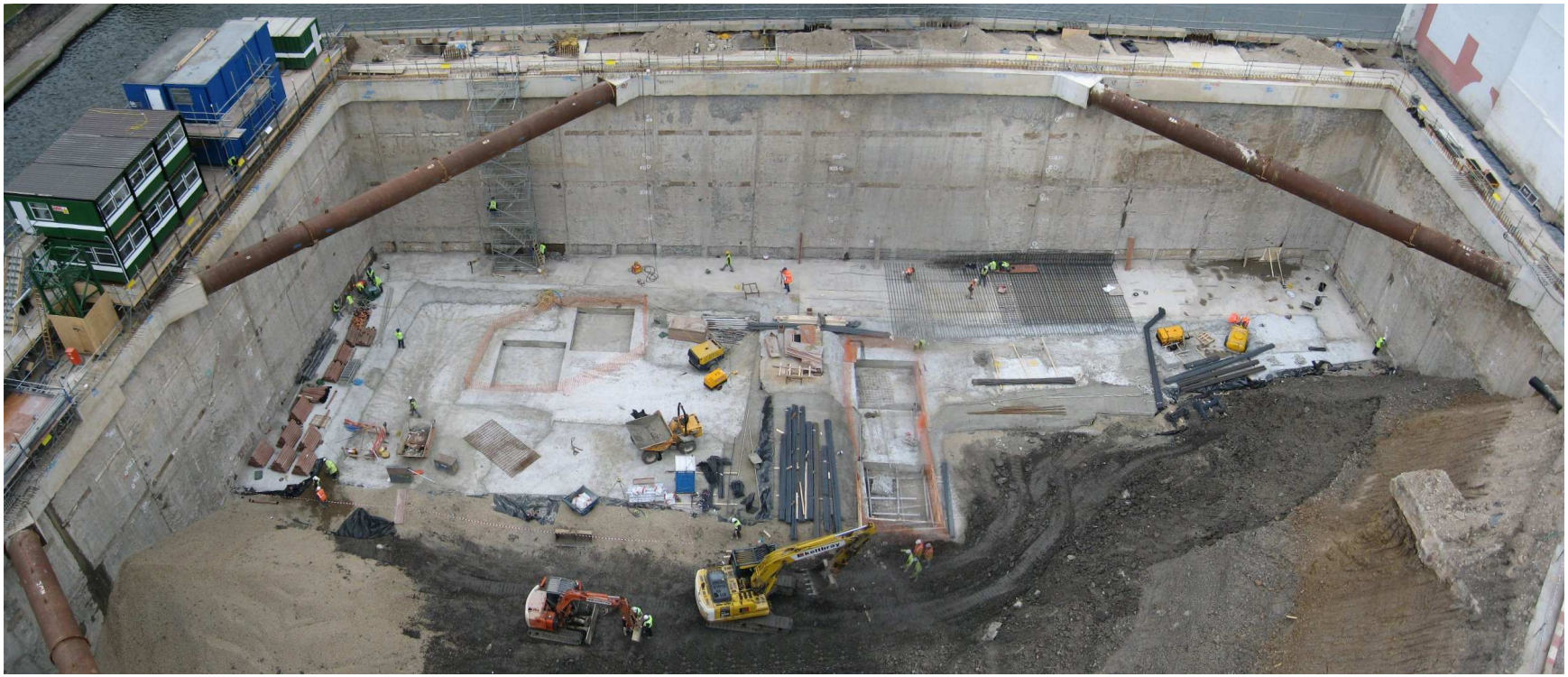
Design Group

Sir Robert McALPINE
Design Group

Sir Robert McALPINE
Design Group

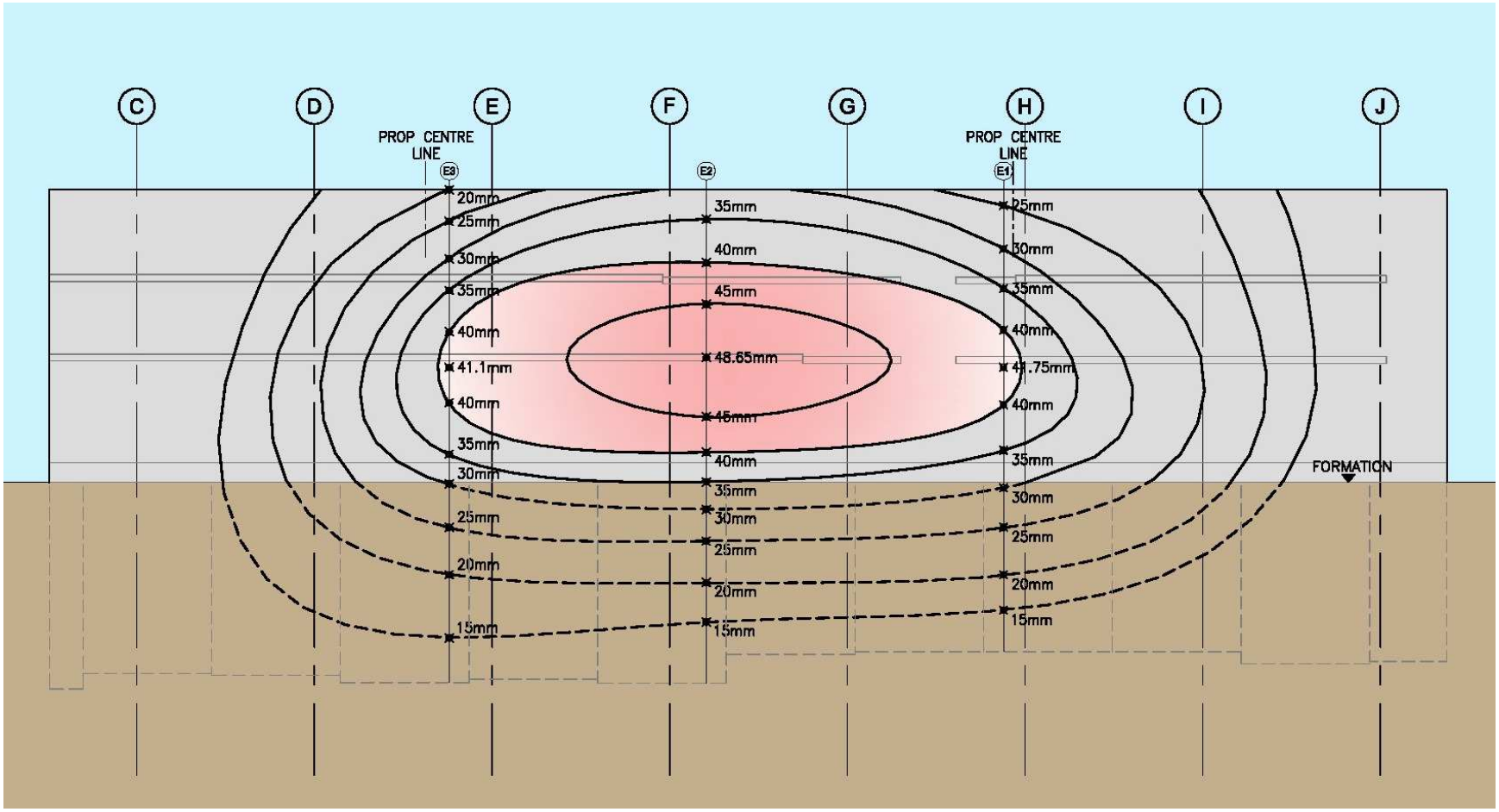
Sir Robert
McALPINE
Design Group

Full depth excavation of east wall



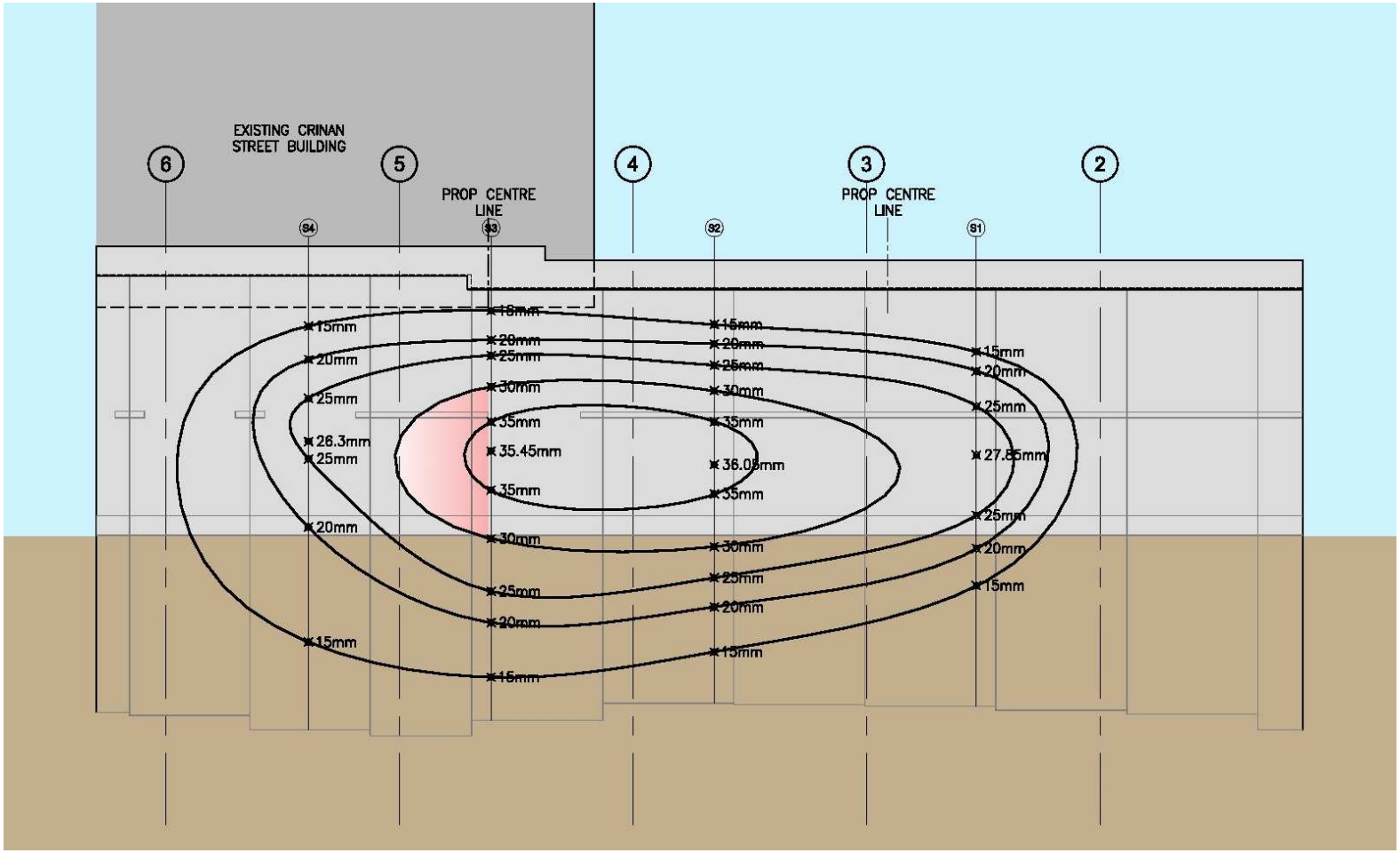
Sir Robert McALPINE
Design Group

East wall displacement



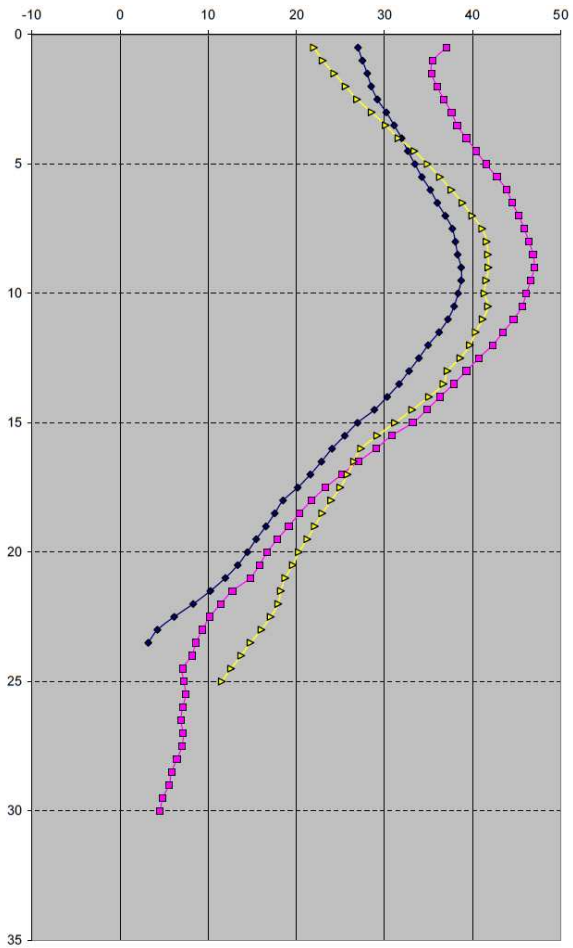
Sir Robert McALPINE
Design Group

South wall displacement

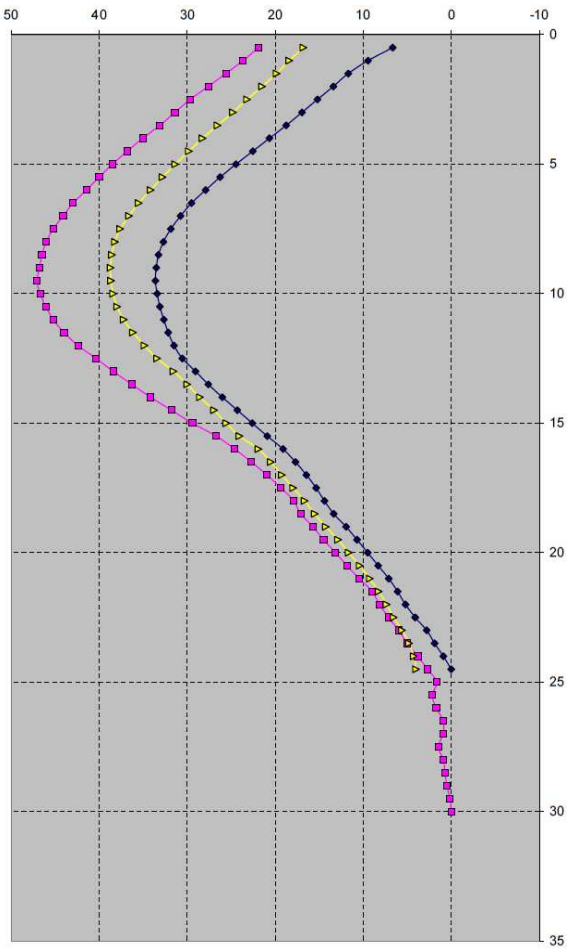


Sir Robert McALPINE
Design Group

Inclinometer results



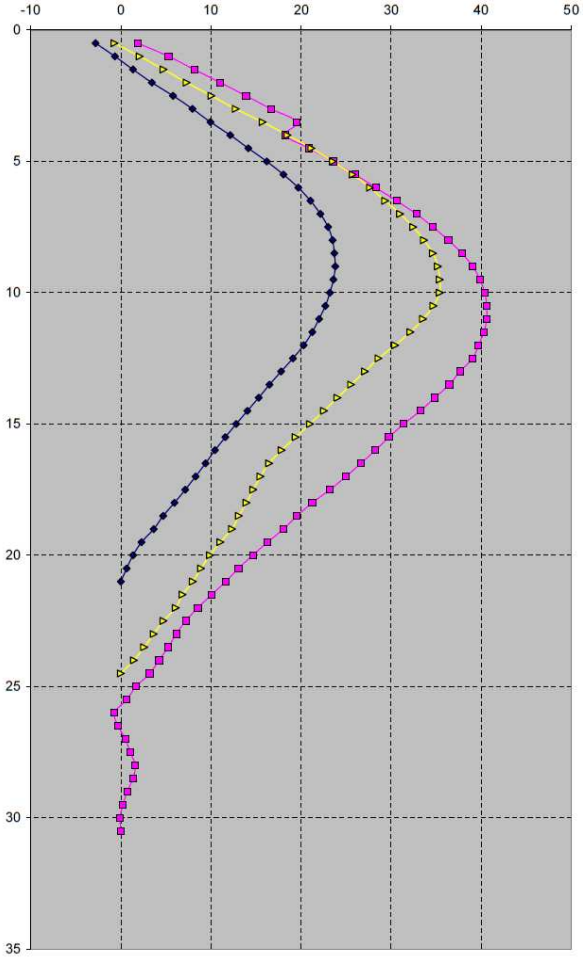
East wall



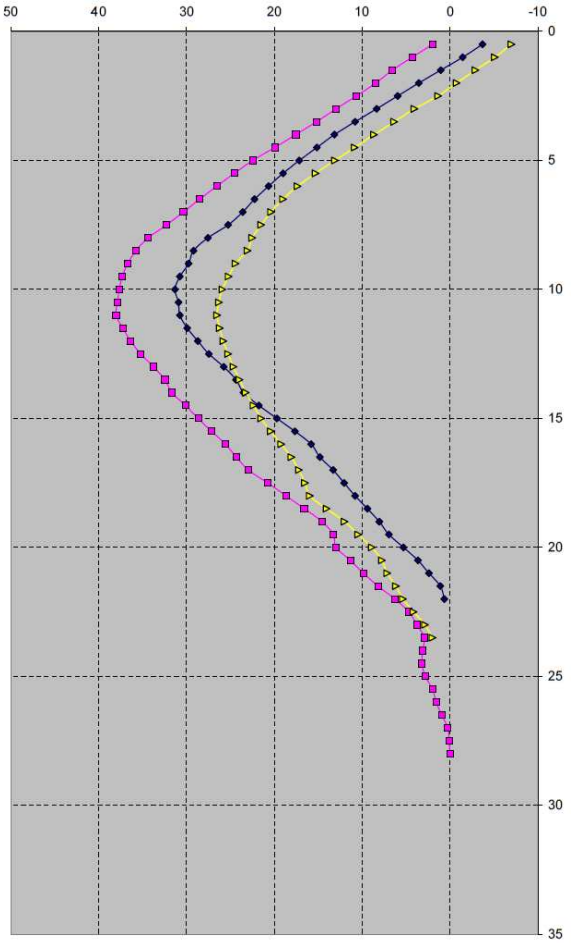
West wall

Sir Robert McALPINE
Design Group

Inclinometer results



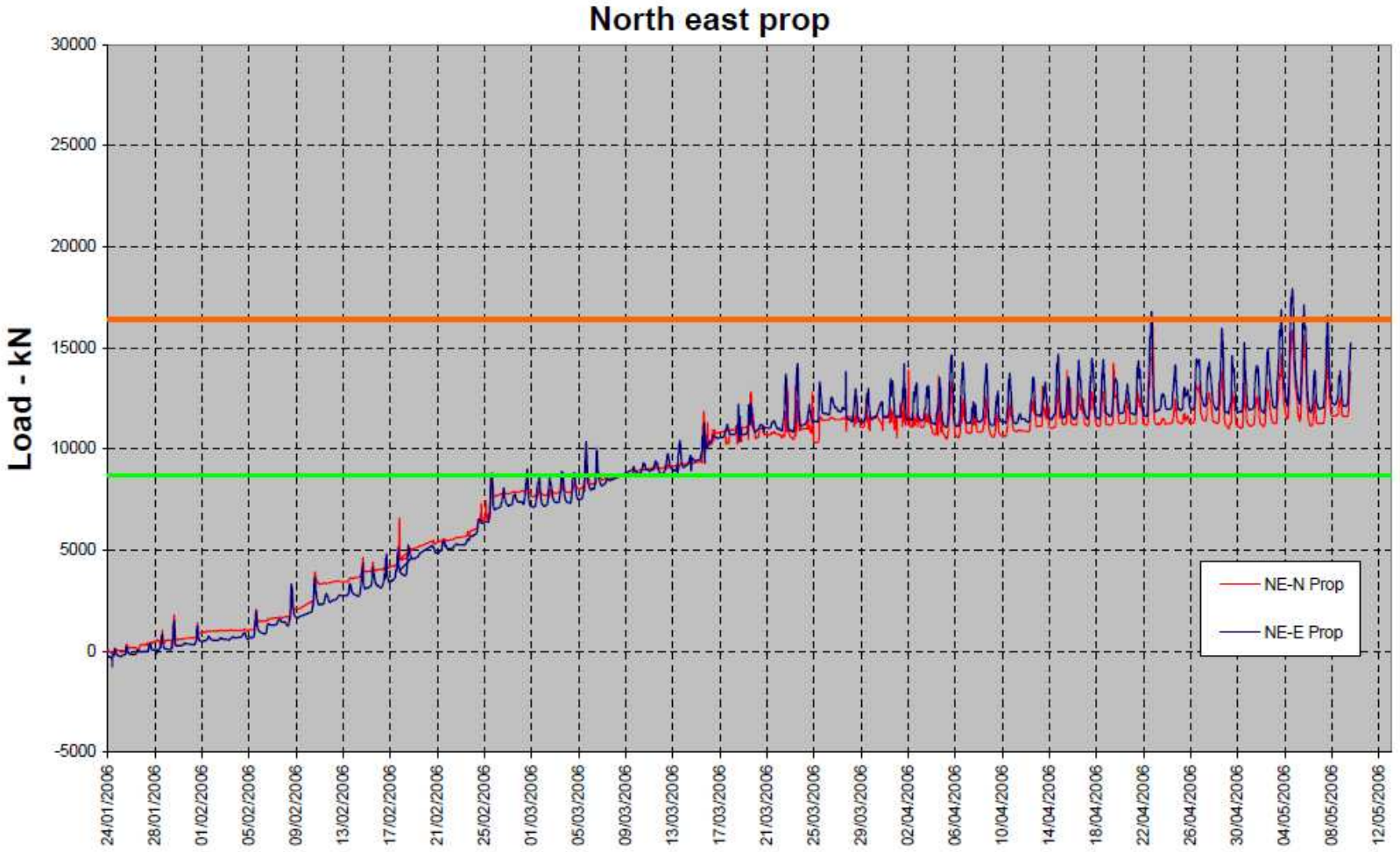
North wall



South wall

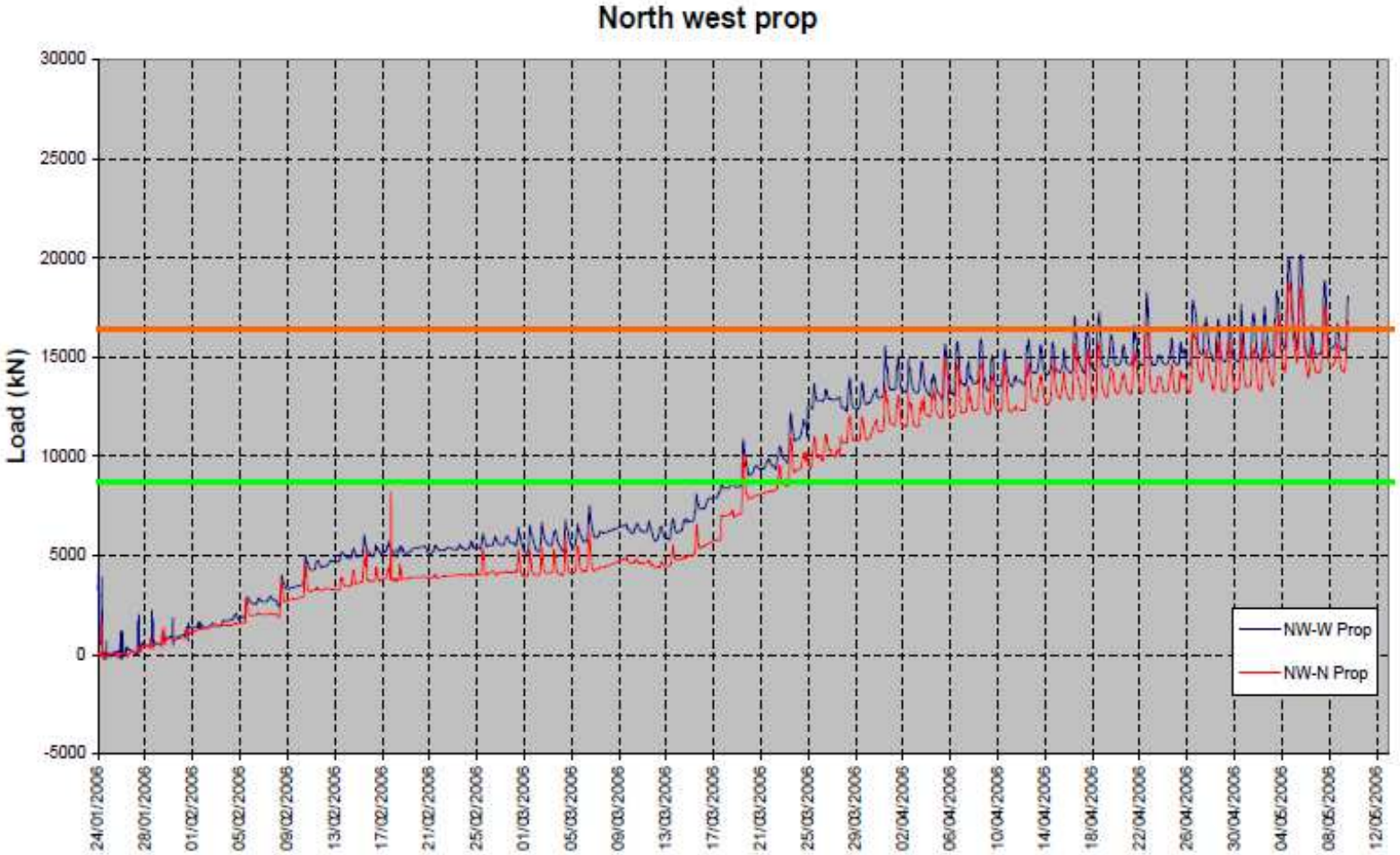
Sir Robert McALPINE
Design Group

Prop loads



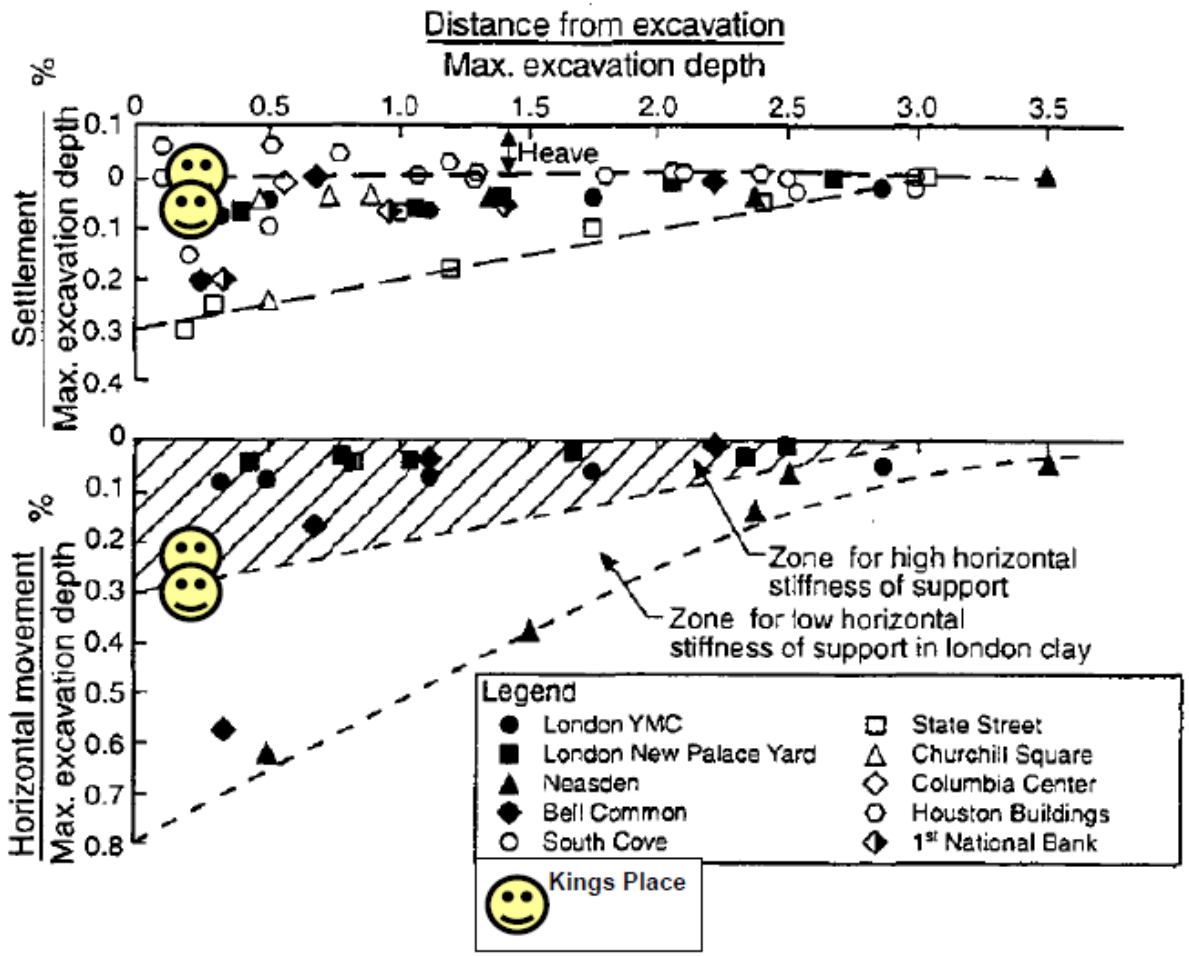
Sir Robert McALPINE
Design Group

Prop loads



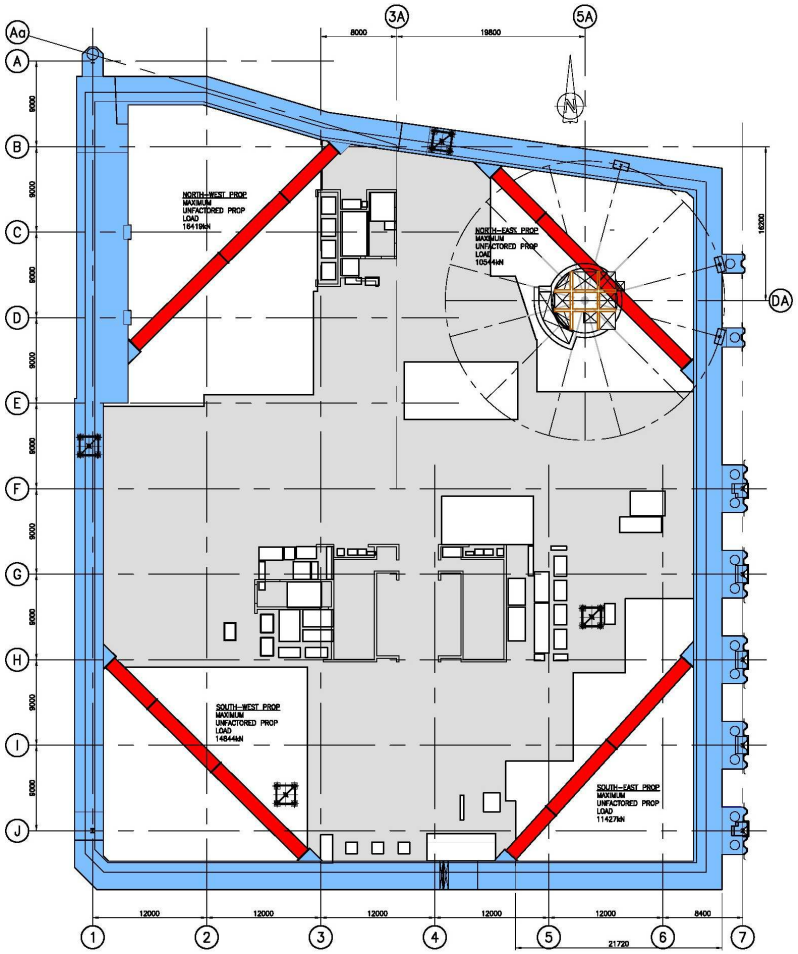
Sir Robert McALPINE
Design Group

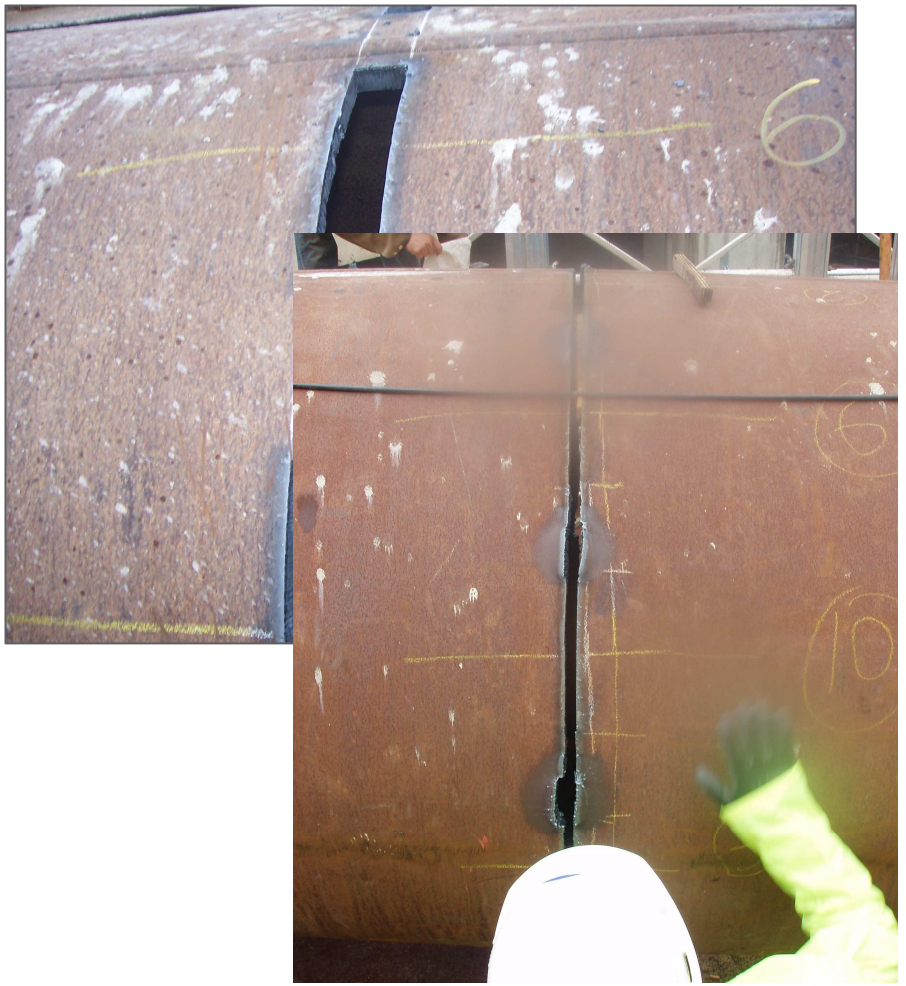
Comparative outcome



Sir Robert McALPINE
Design Group

Prop removal





Sir Robert McALPINE
Design Group

Lessons learned

General

- Minimising damage to adjacent property is the critical issue
- Real data informs the whole process
- Calculations must be ‘honest’
- Corners are stiff
- Excavation sequences can be used positively
- Data volumes need to be manageable

Kings Place specific

- High strain response due to relatively flexible wall
- Vertical movements on retained side less than predicted