X-RAY CT APPLICATIONS

DR ASADUL HAQUE
DEPARTMENT OF CIVIL ENGINEERING
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XMFIG is an ARC-LIEF funded facility (LE130100006)

Organisations involved:

- Dr Asadul Haque, Facility Manager & Chief Investigator, Department of Civil Engineering, Monash University

XMFIG Capabilities Feb 2018, Monash University. All images captured, processed & analysed by Dr Haque.
AN OVERVIEW OF X-RAY MICROSCOPY FACILITY AT MONASH

Key features:
• High spatial resolutions (0.7μ)
• Sample size < 100mm & Mass < 15kg
• In situ imaging capability
• Unconfined, one-dimensional and triaxial loading rigs

X-ray source (160kV, 10W)
Lenses (0.4x, 4x, 20x, 40x)

VersaXRM-520

Loading rigs

Triax-S (1.5MPa)
D=10mm, L=30mm

Triax-R (20MPa)
D=35mm, L=70mm

1D-compression (90MPa)
D=30mm, L=40mm

CT5000-Unconfined (5kN)
D=40mm, L=15mm
PITTING CORROSION IN STEEL

RESULTS

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<tr>
<th>Exposure (days)</th>
<th>Feret breadth 3D (μ)</th>
<th>Feret length 3D (μ)</th>
<th>Volume 3D (μ³)</th>
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<tr>
<td>0</td>
<td>775</td>
<td>3411</td>
<td>3.65 x 10⁸</td>
</tr>
<tr>
<td>30</td>
<td>790</td>
<td>6492</td>
<td>3.79 x 10⁸</td>
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Initial pit

30-day pit

3D-PIT GROWTH

Exposure (days)

Feret breadth 3D (μ)

Feret length 3D (μ)

Volume 3D (μ³)
COCONUT FIBRE REINFORCED SOIL

Fibre distributions

Fibre orientations-XZ

Grey-scale image

Void-fibre

[Image with fibre distributions and orientations]
PROPPANT SUPPORTED FRACKING

PROPPANT IN FRACTURED ROCK

LABELLED PROPPANT

LABELLED FRACTURE
A SAND PARTICLE UNDER UNIAXIAL LOADING

INITIAL IMAGE

LOAD-DISP. PLOT

POINT O

POINT A

POINT B

INITIAL-PEAK STATES

DISP. FIELDS-XDVC
DEFECTS IN FRP PIPES

RENDERED VOLUME

PLAN VIEW

SECTIONS XY-XZ-YZ

SECTIONAL VIEW: YZ

FIBRE

CRACK

SANDB

MONASH University
DEFECTS IN FRP PIPES

Grey Image

Resin-labelled

Fibre & Sand-labelled

Voids-labelled

Segmented

ROI-3D view
BASALT FIBRE REINFORCED POLYMER (BFRP) BAR

SEGMENTED FIBRE

FIBRE ANALYSIS-XFIBER

3D FIBRE ORIENTATION
CARBON FIBRE REINFORCED POLYMER (CFRP) BAR

GREY IMAGE

FIBRE ANALYSIS-XFIBER

SEGMENTED FIBRE

3D FIBRE ORIENTATION
CEMENT TREATED SAND UNDER UNIAXIAL LOADING

GREY IMAGE

SAND-CEMENT-VOID
(initial image)

SAND-CEMENT-VOID
(peak load)

CRACK

SECTIONAL VIEW
MICROSTRUCTURAL EVOLUTION IN CEMENT TREATED SAND

- 7-days curing (cement vol.=10.8%)
- 14-days curing (cement vol.=11.1%)
- 30-days curing (cement vol.=14%)

VOID
CEMENT
SAND
ACID SULPHATE SOIL STABILISED WITH LIME-GGBS

Flocculated structure
MICROSTRUCTURE OF COFFEE ROASTER

**Greyscale image**

- **Voids**
- **Coffee grounds**
- **Pore network**

**EqDiameter distributions (% particles)**

- 30-100: 10%
- 100-200: 42%
- 200-300: 26%
- 300-400: 14%
- 400-500: 6%
- 500-600: 2%

**Porosity distributions**

- **Top**
- **Bottom**
ZEBRA FISH FOR BIOMEDICAL SCIENCE RESEARCH

GREY IMAGE

SKELETON

MUSCLE-FIN

SKELETON-MUSCLE

ROI
MICROSTRUCTURE OF MILK GRANULES
EFFECT OF COOLING ON HEATED CONCRETE

GREY

SLOW (Porosity=3.5%)

QUICK (Porosity=4.4%)

Largest 100-pores

QUICK COOLING

SLOW COOLING

Volume 3D (voxel) vs Pore Index

SLOW (100-pores)

QUICK (100-pores)
DURABILITY OF CONCRETE
SILTSTONE ROCK SUBJECTED TO COOLING

SLOW COOLING

QUENCHING

POROSITY VARIATION

Slice No.

0 1 2 3 4 5

Porosity (%)

GREY-SLOW

GREY+VOIDS

XY-VOIDS
3D PRINTED LATTICE STRUCTURE

- Grey image
- Labelled volumes
- Separated
- Joint
- Grey
ADDITIVE MANUFACTURED METAL PART

Grey image

Porosity distribution

Slice No.

Porosity (%)

Voids-labelled

100-Large voids

Metal 1

Metal 2

Pore

XY-Grey

XY-Voids

Ortho Slice 248

Ortho Slice 248

Slice 411 (Porosity=6.24%)

Slice 300 (Porosity=4.53%)

Slice 77 (Porosity=1.72%)

100 microns

MONASH University
DEFECTS IN BOTTLE CAP

- Plastic cap
- Metal cap
- Thin resin

GOOD RESIN

BAD POROUS RESIN

1000 microns
REFERENCES & CONTACT DETAILS

- AVIZO v.9.4.0 (2017). Image processing software with XFIBER and XDVC add-ins.

Contact details:
- Dr Asadul Haque, Department of Civil Engineering, 23 College Walk, Monash University 3800.
  PH: (03) 9905 4974; E: Asadul.Haque@monash.edu; www: XMFIG