

Numerical POD Study for the MOI

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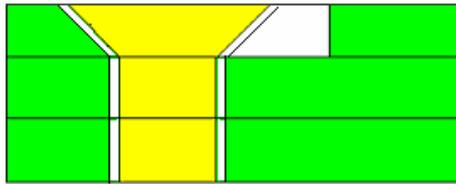
**Model-Assisted POD Working Group
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Model-Based POD Study

- Numerically based
 - Generate MOI images using finite element calculations
 - Vary crack size
 - Vary frequency for Surface/subsurface cracks
 - Vary threshold (MOI sensitivity)
 - Create numerically generated test panels
 - Conduct POD studies
 - POD vs crack length
 - POD vs threshold
 - POD vs S , Skewness factor
 - Determine minimum value of S for desired POD
- Verify on actual samples and modify as required

POD Database Generation

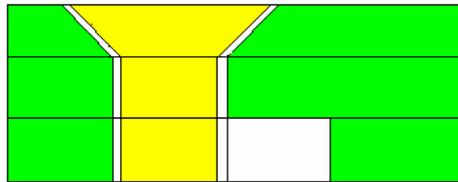
Three Defect Classes



(a)

(a) Defect Class I

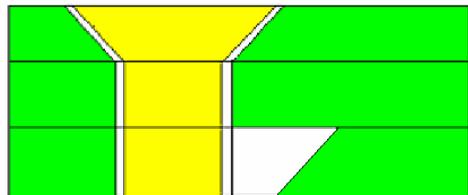
First layer rectangular crack



(b)

(b) Defect Class II

Third layer rectangular crack



(c)

(c) Defect Class III

Third layer wedge crack

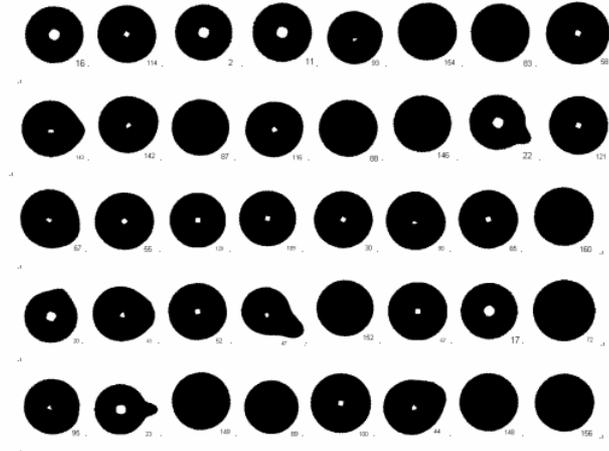
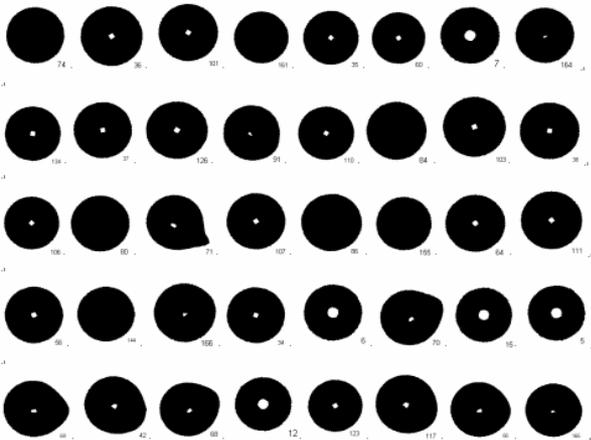
POD Database Generation

Create a library of numerically generated defects at different frequencies and thresholds

Defect Class	Frequency (kHz)	Threshold (Gauss)	Crack Size (mm)
I	50	0.7,1,1.5,2.5,4	0~3.5
II	1.5, 3, 5	0.7,1,1.5,2.5,4	0~8
III	1.5, 3, 5	0.7,1,1.5,2.5,4	0~8

Image Panels

- Each Database has five image panels printed on 8.5"×11" paper
- 40 binary images per page, at 1" center to center distance
- About 40 defect images make up 25% of total sample base and distributed randomly
- Each crack is located along horizontal and along $+30^\circ$ or -30° to the horizontal



POD and PFA definition for each crack

$$POD_{cs} = \frac{\sum_{i=1}^N D_i}{N} \times 100\% \quad PFA_{cs} = \frac{\sum_{i=1}^N D'_i}{N} \times 100\%$$

N is the total number of recruited ‘inspectors’

D is the ‘inspector’ decision

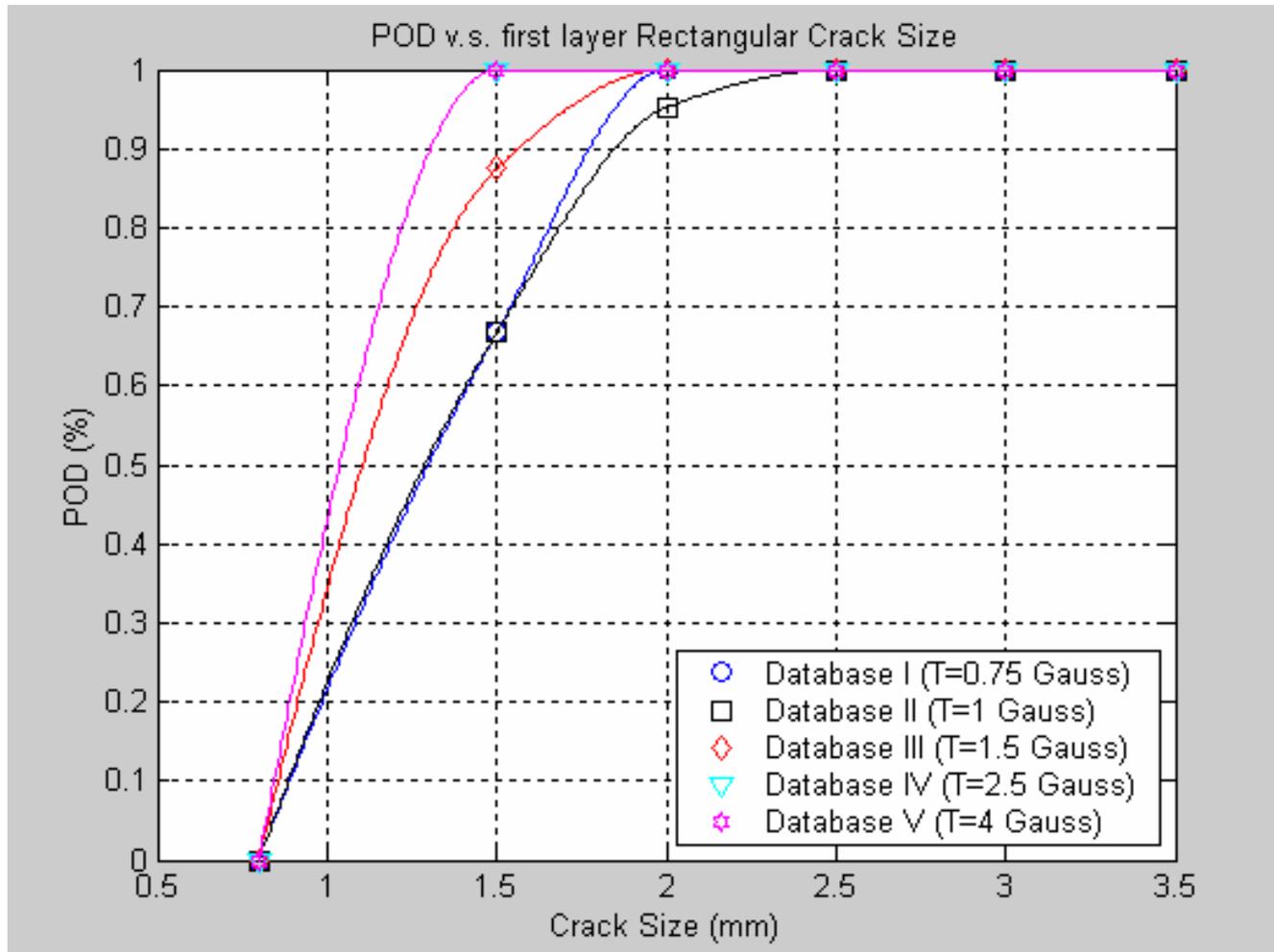
$D_i = 1$ defect was detected

$D_i = 0$ defect not detected

$D'_i = 1$ a false call made by ‘inspector’

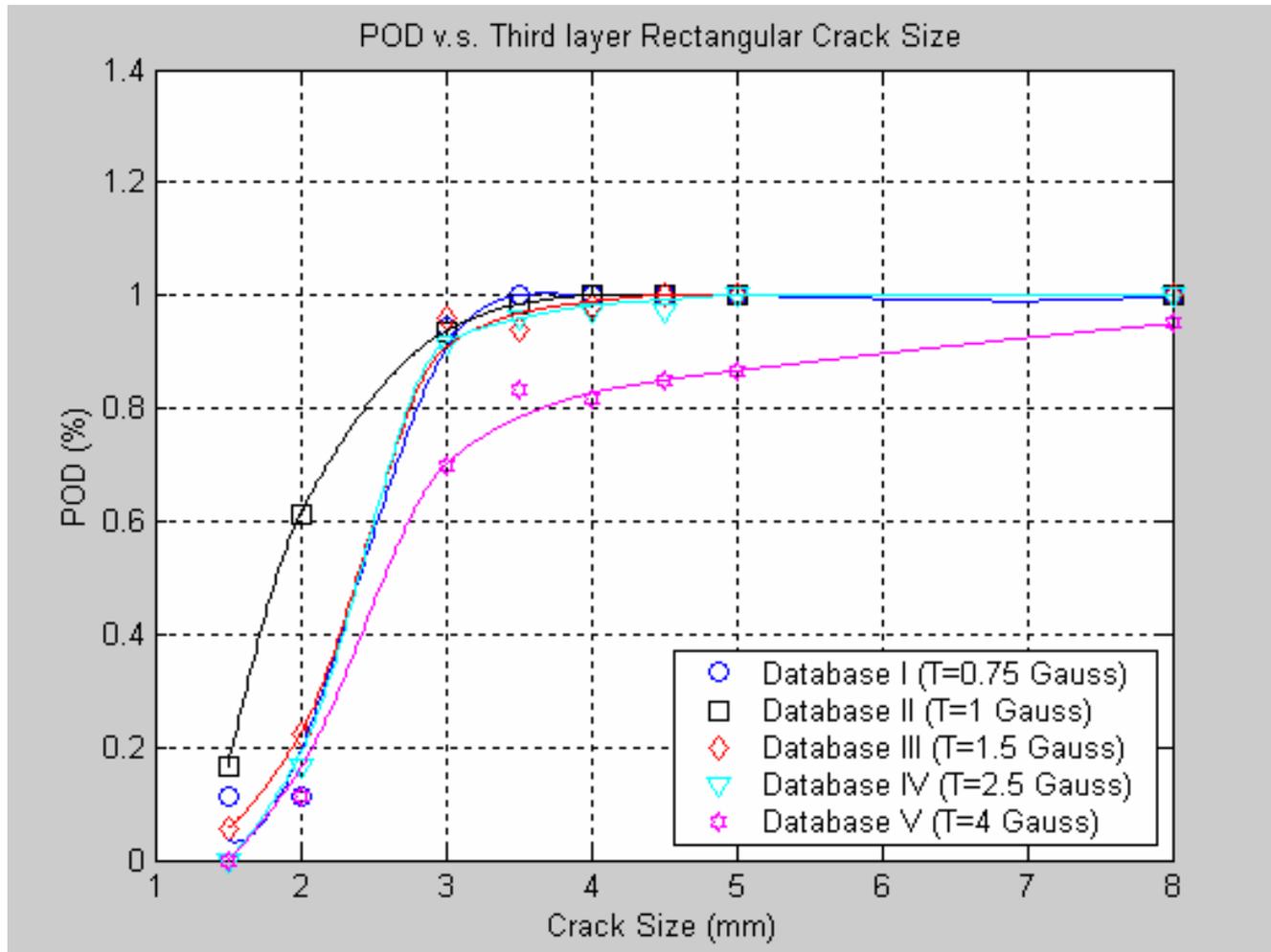
POD versus 1st layer rectangular crack size

PFA=0.0516



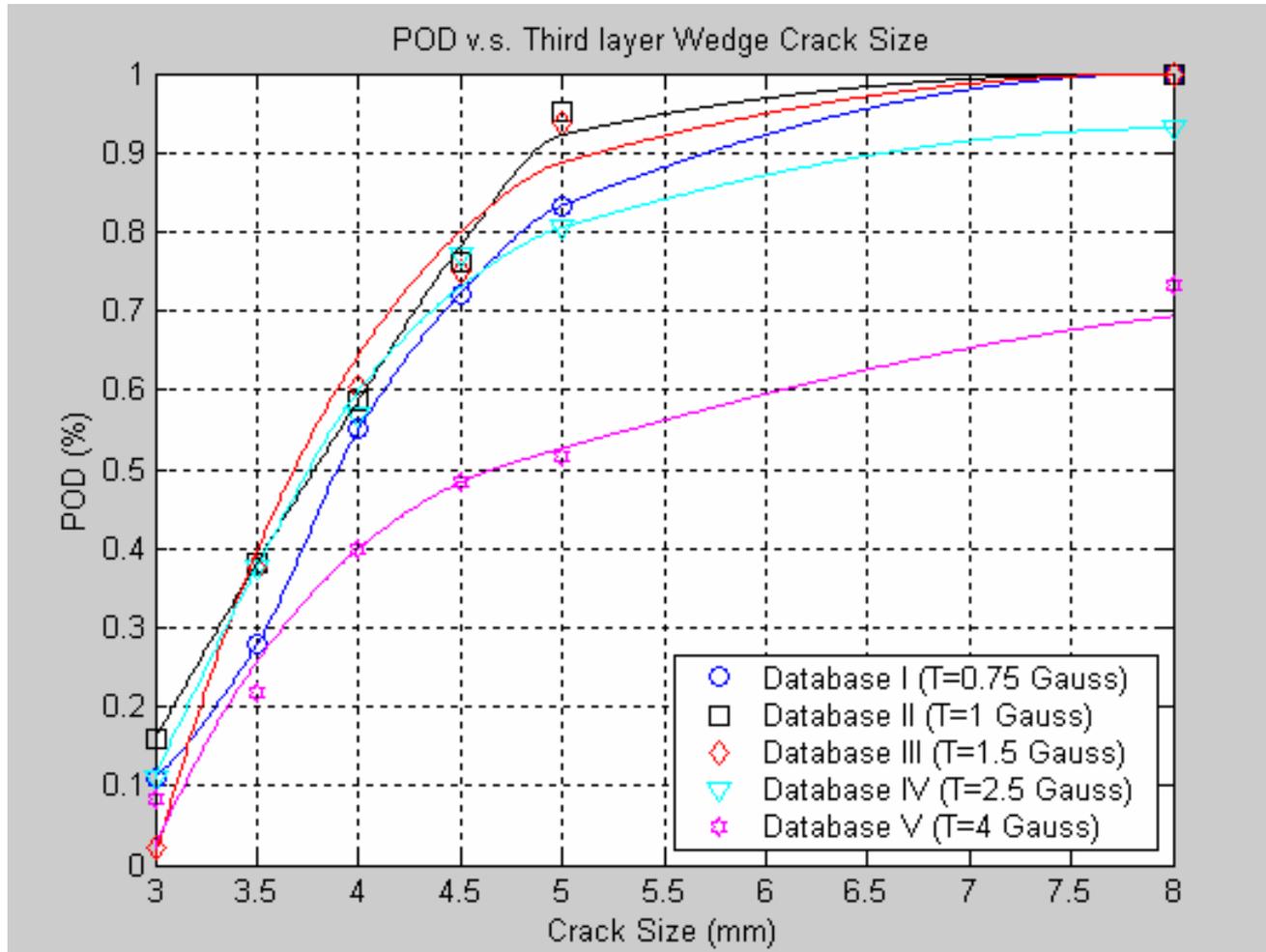
POD versus 3rd layer rectangular crack size

PFA=0.1528



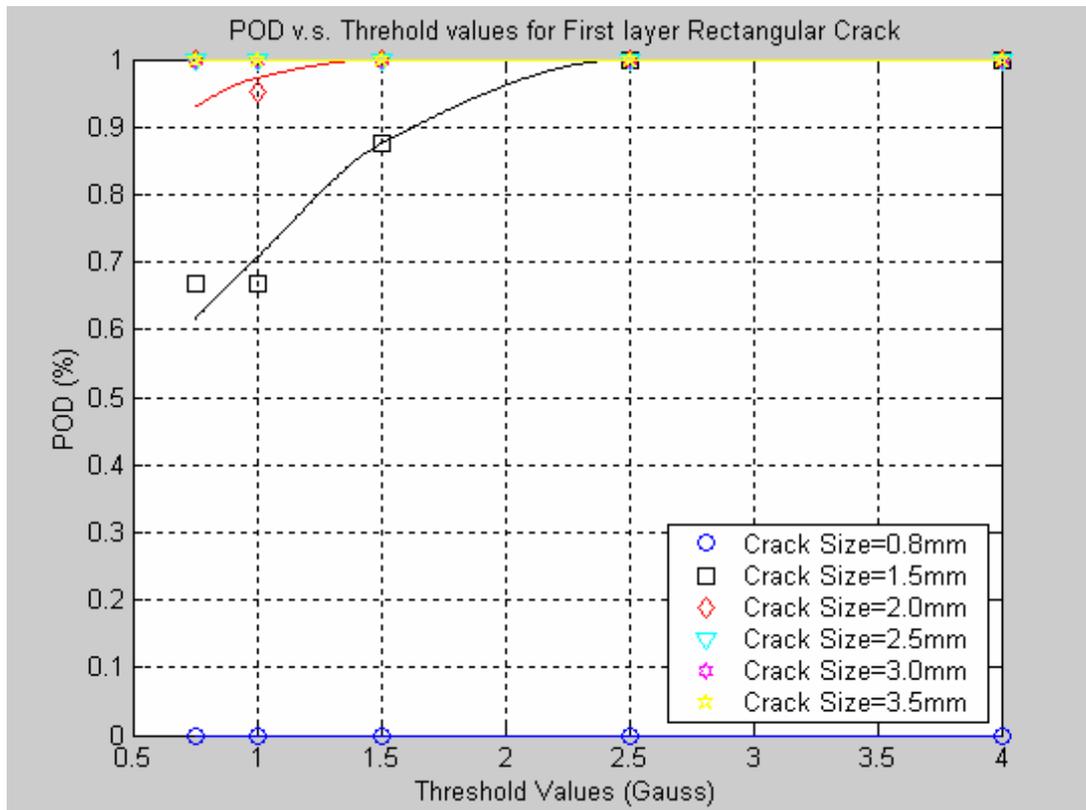
POD versus 3rd layer wedge crack size

PFA= 0.0321



POD v.s. Threshold

First Layer rectangular crack



0.8mm crack 1.5mm crack



(a) T=1.0 Gauss



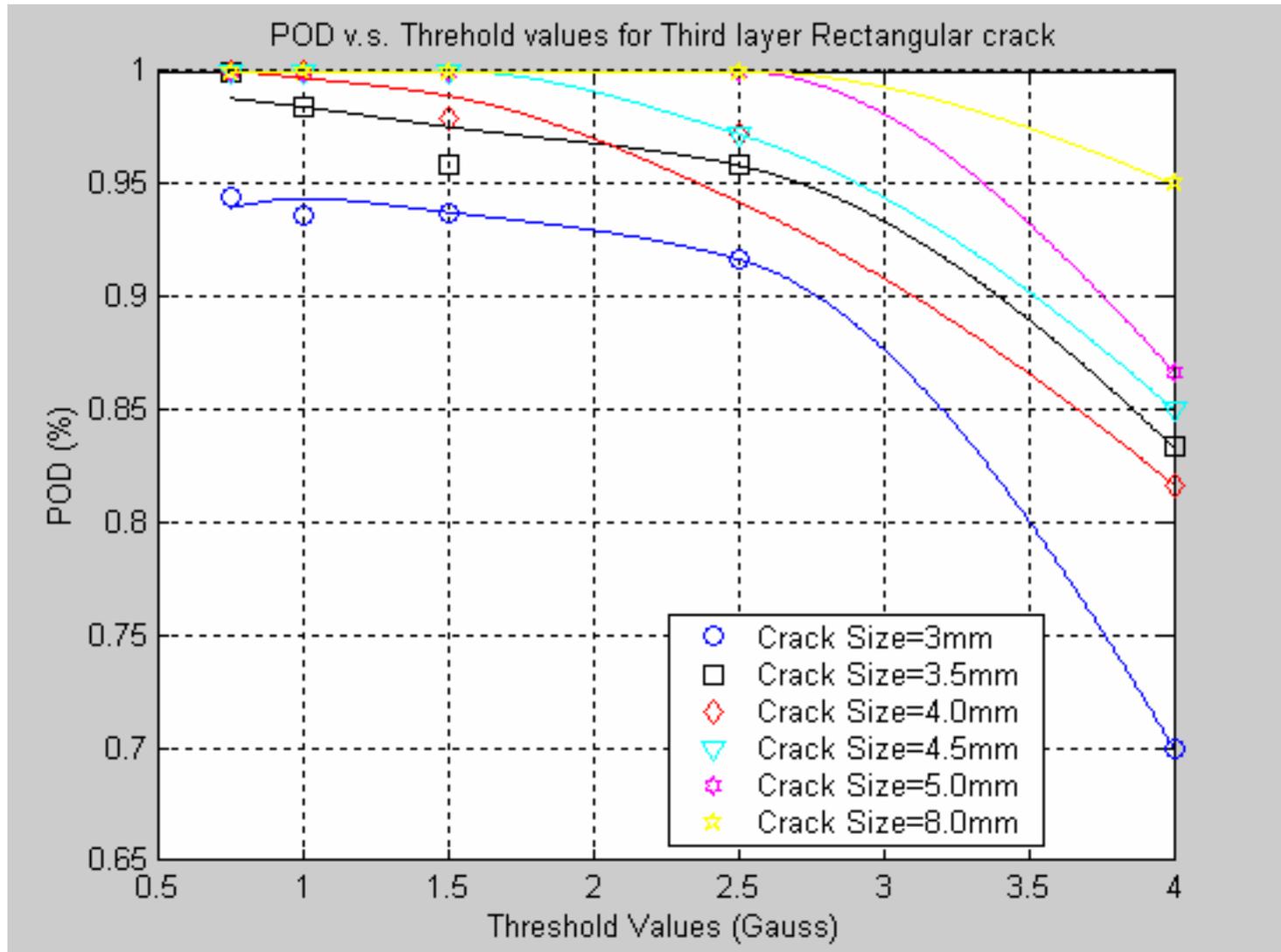
(b) T=2.5 Gauss



(c) T=4.0 Gauss

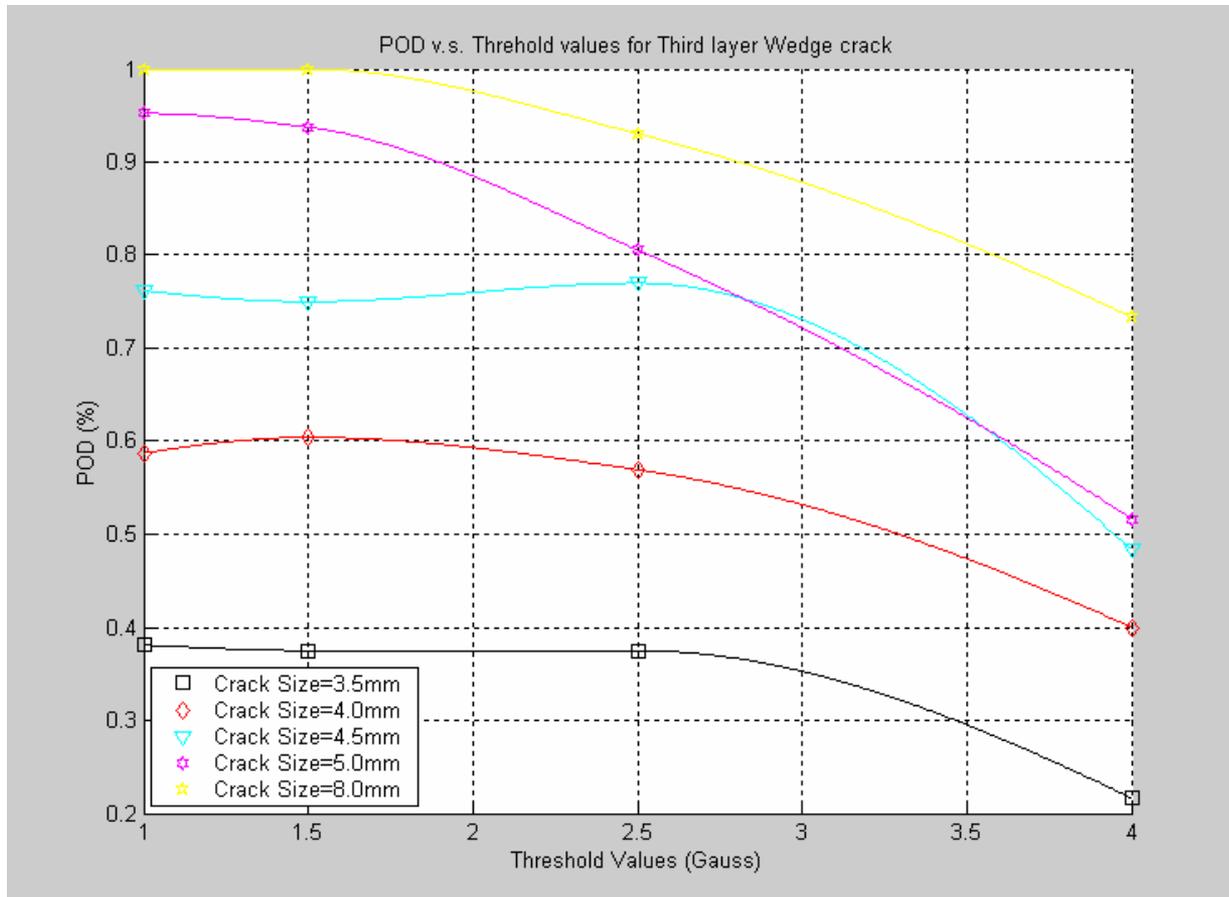
POD v.s. Threshold

Third Layer rectangular crack

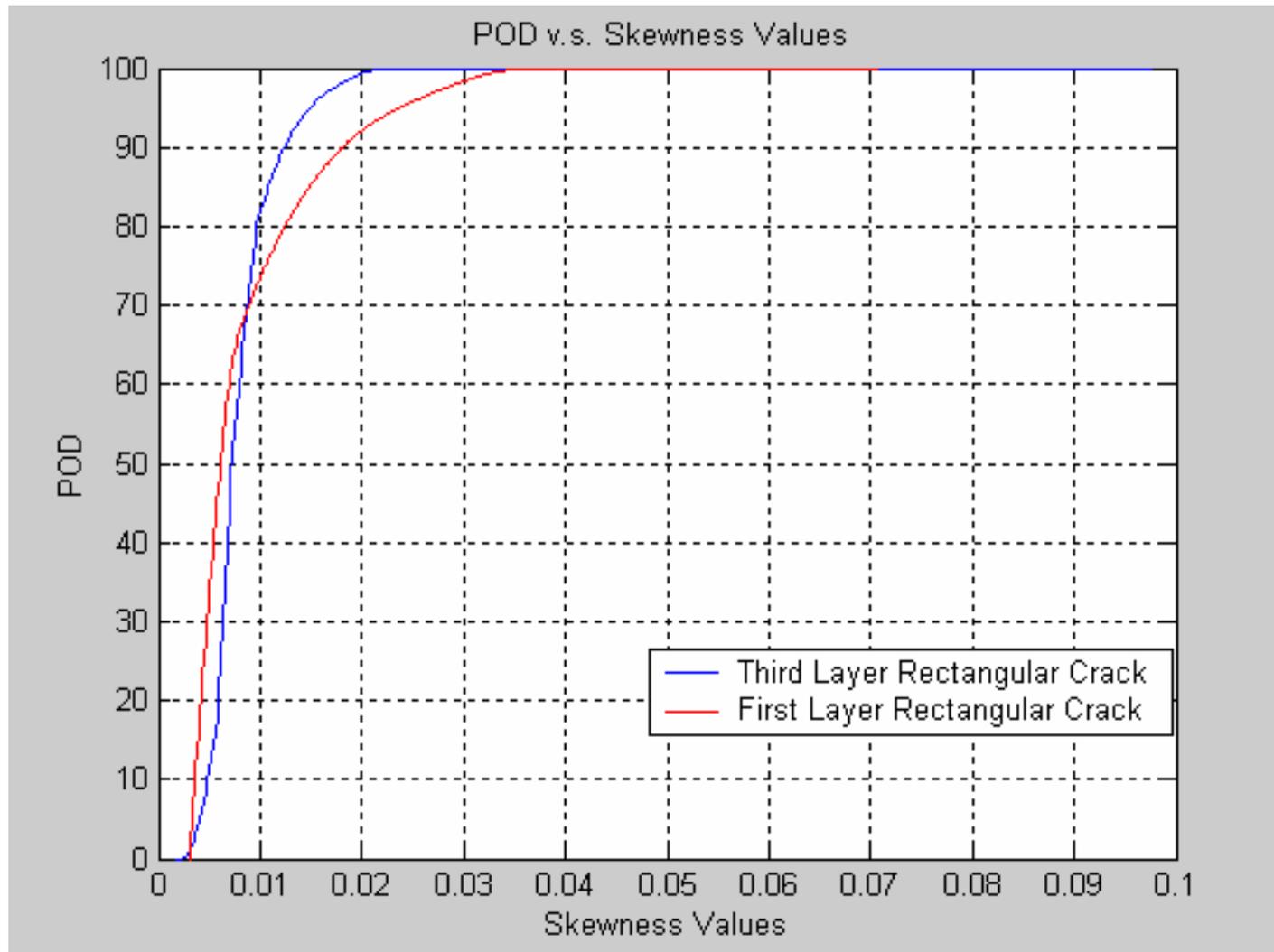


POD v.s. Threshold

Third Layer Wedge crack



POD v.s. Skewness (T = 1.0 Gauss)



Summary

- MOI images generated numerically
- Skewness factor developed for quantification of defects
- Test panels created from numerical database
- POD tests conducted using test panels and volunteer inspectors
- Additional tests will be conducted on real samples to calibrate numerically generated parameters