



國立臺灣大學
National Taiwan University



MarCE Lab.

CAE招生說明會

智慧土木結構研究團隊

吳日騰

(Rih-Teng Wu)

土木系結構工程組暨電腦輔助工程組 副教授

September 21, 2026

吳日騰

Rih-Teng Wu, Ph.D.

- Education

- ／ Ph.D. (2020) in Lyles School of Civil Engineering, Purdue University
- ／ M.S. (2019) in Electrical and Computer Engineering, Purdue University
- ／ M.S. (2014) in Structural Engineering, National Taiwan University
- ／ B.S. (2011) in Civil Engineering, National Taiwan University

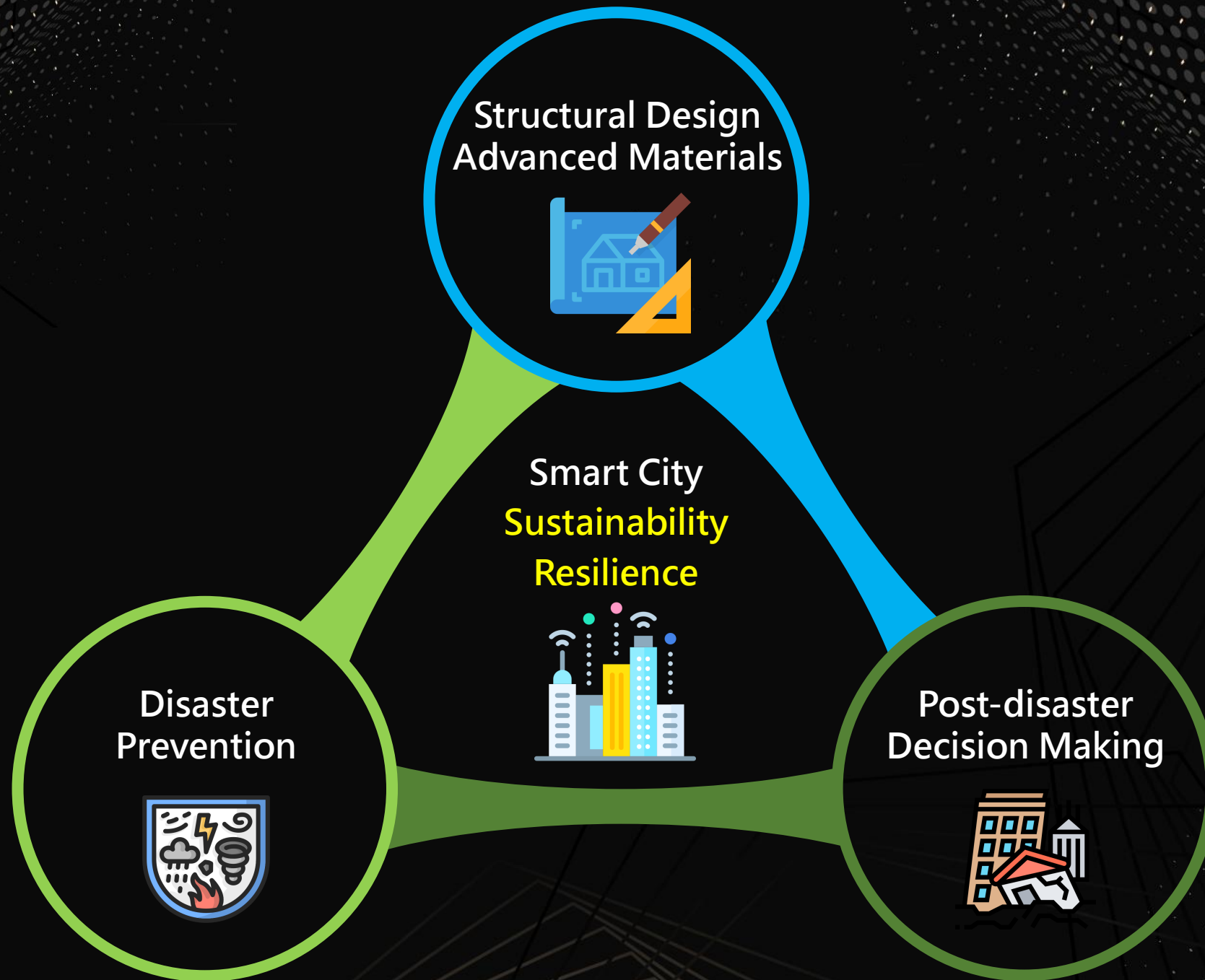
- Research Interests

- ／ Artificial Intelligence and Computer Vision
- ／ Structural Prognostic/Health Monitoring
- ／ Metamaterial Design and Discovery
- ／ Earthquake Engineering and System Identification



MarCE Lab.

Metamaterial design and discovery
Artificial intelligence in Civil Engineering
Resource-efficient learning algorithms



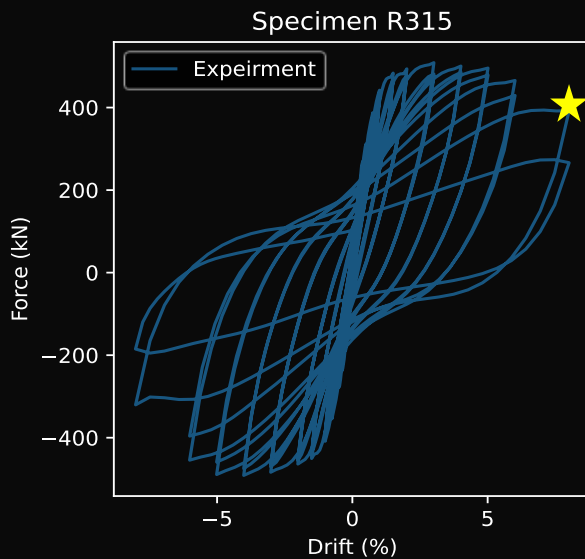
Bridge Prognostic Framework

Discrepancy!!!!

Experiment



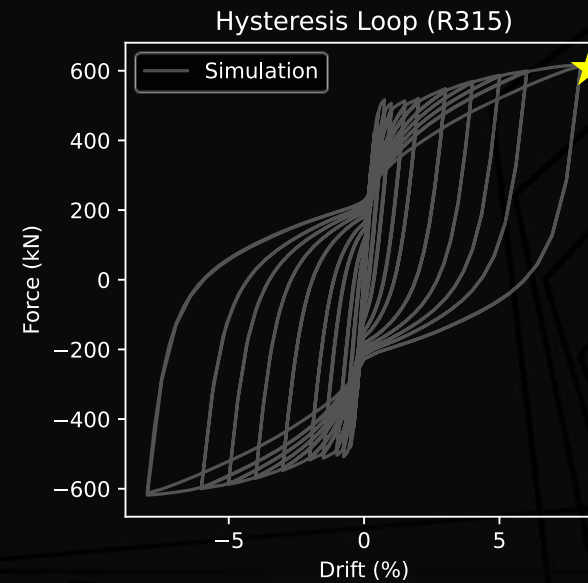
Simulation



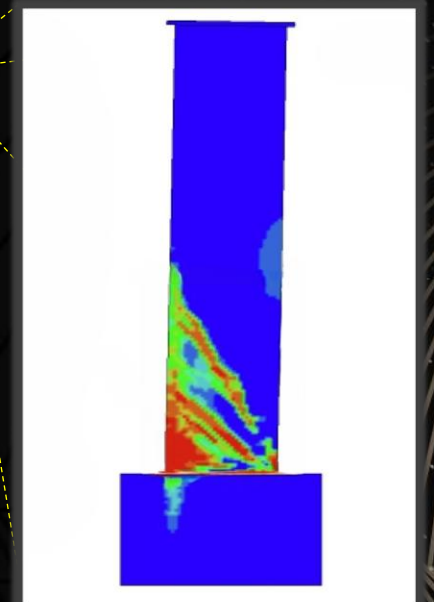
Experiment Hysteresis Loop



Damage Pattern



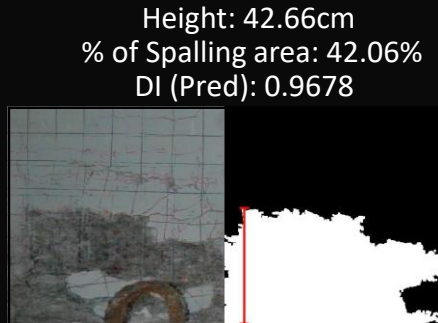
Simulated Hysteresis Loop



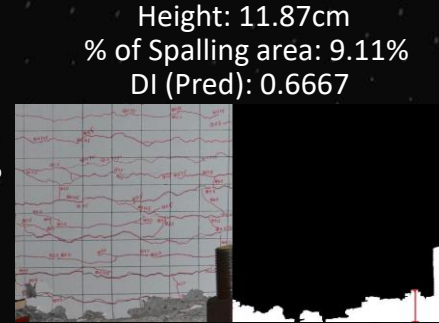
Simulated Damage Assessment [1]

Bridge Prognostic Framework (Cont.)

CTR1 Drift +6.0%
Cycle 3 SW Side
DI=0.9997
(Test)



CTR1 Drift +4.0%
Cycle 2 SW Side
DI=0.5876
(Test)

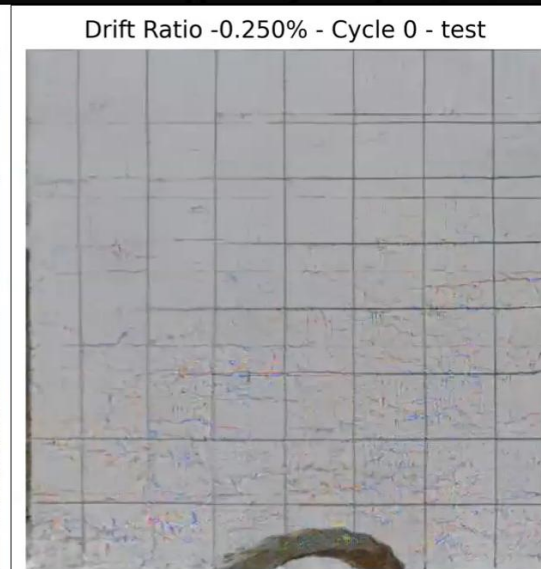
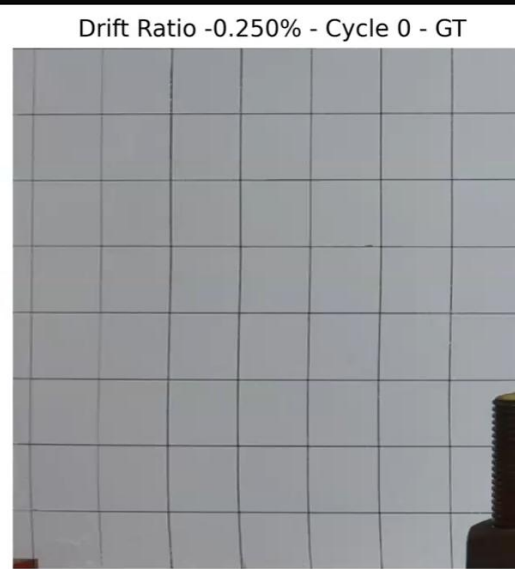
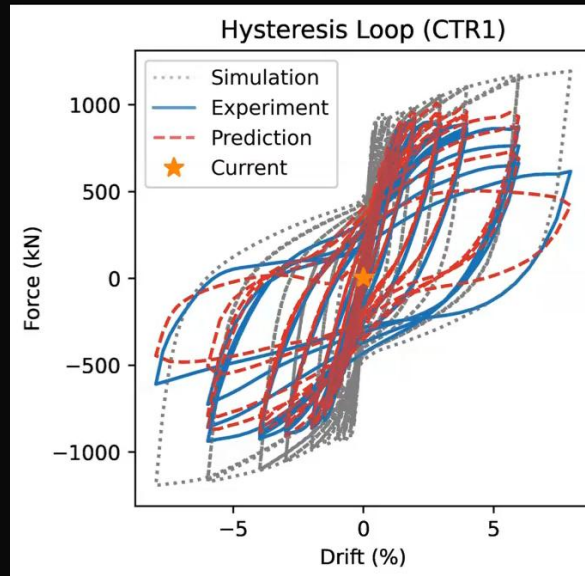


Hysteretic Behavior

Ground Truth

Synthetic Images

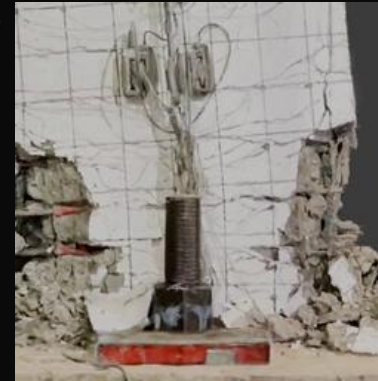
CTR1
(Unseen Design)



Bridge Prognostic Framework (Cont.)

Video Demonstration: Continuous 3D Reconstruction

Ground truth



AI prediction



RS307

RS330

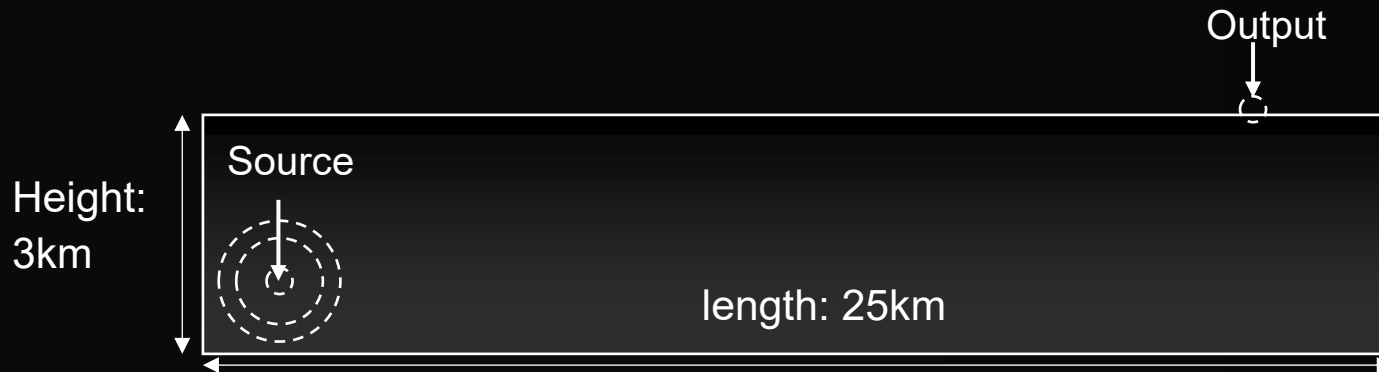
RS615

RS315 (test)

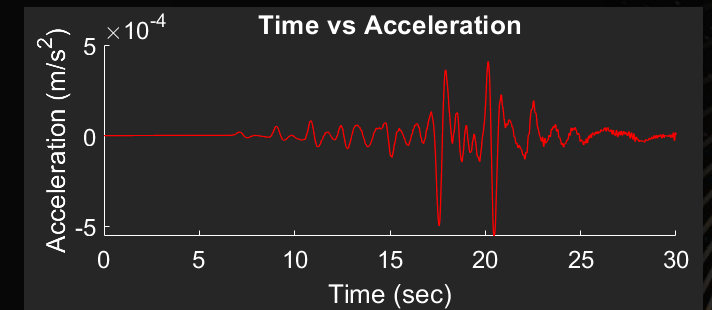
Seismic Wave Propagation

Seismic wave attenuation test

- A single-force point source will be placed at depth 2.5km.

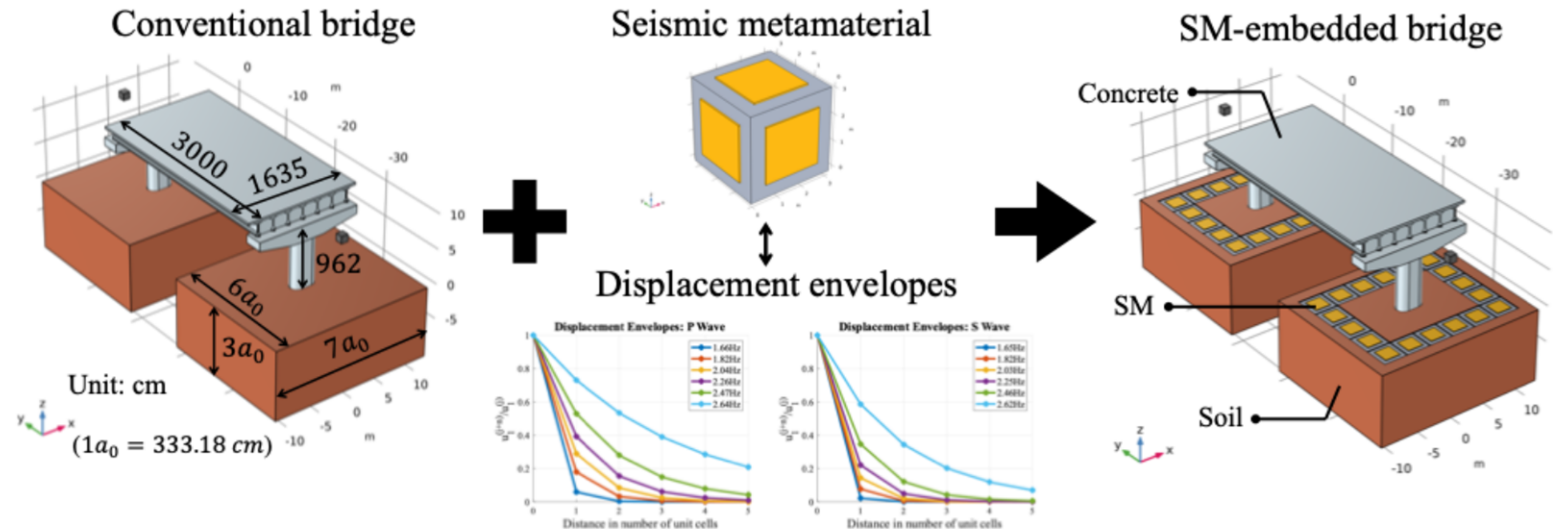


Seismic wave attenuation test
(One-sided metamaterials)

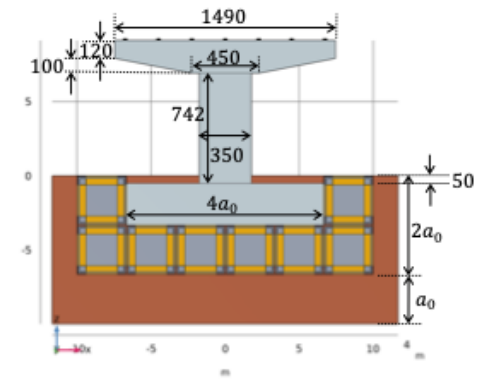


Seismic Metamaterial in Bridge Foundation

Integration of Seismic Metamaterials and Conventional Bridge Structures



(1) Shallow foundation



(2) Caisson foundation

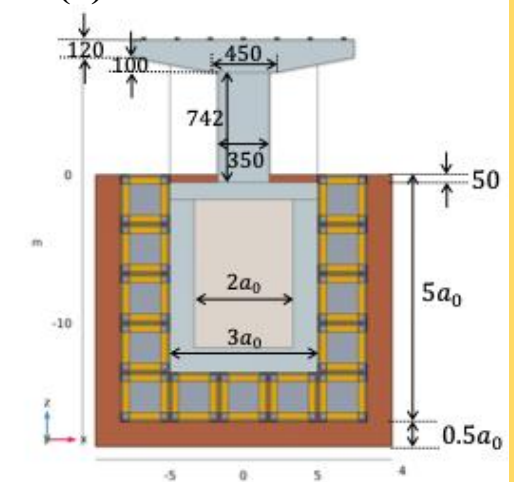
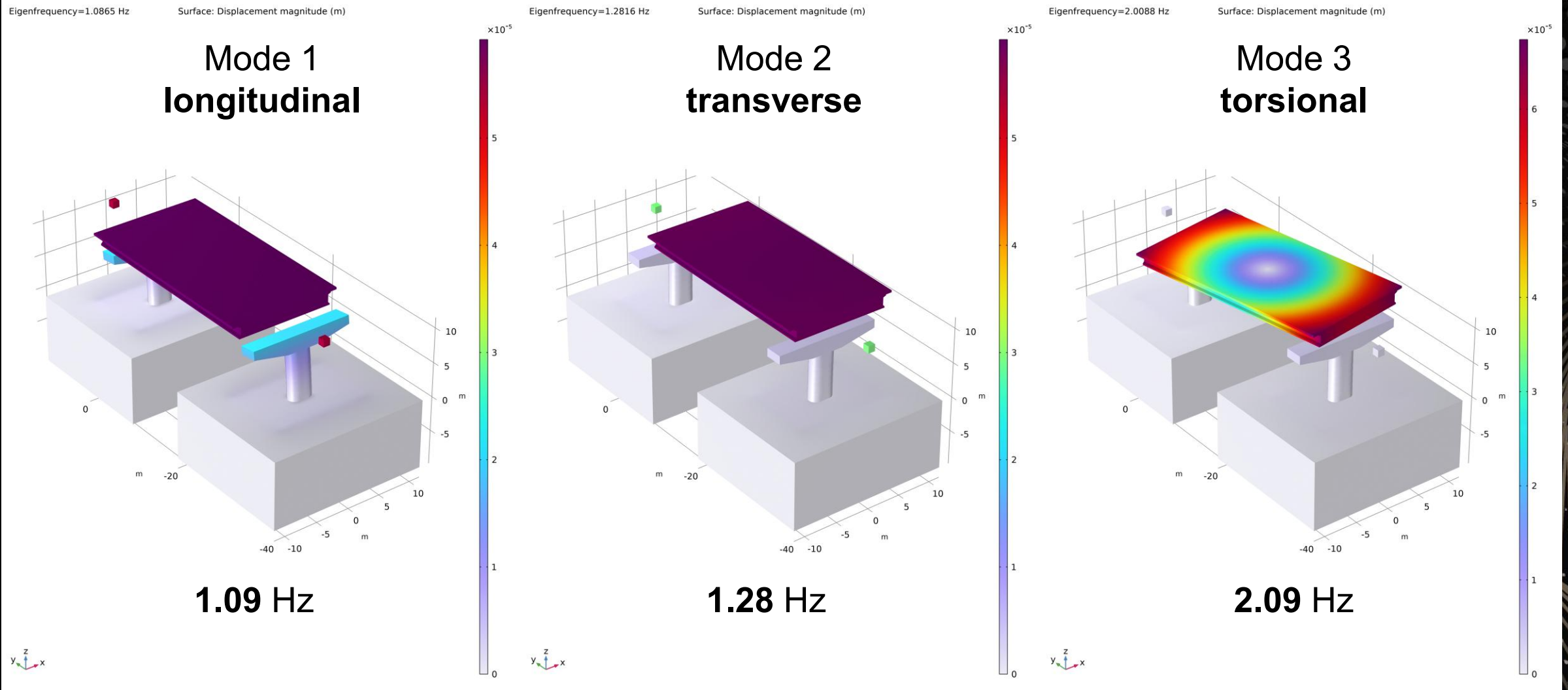


Table 1. Material Properties

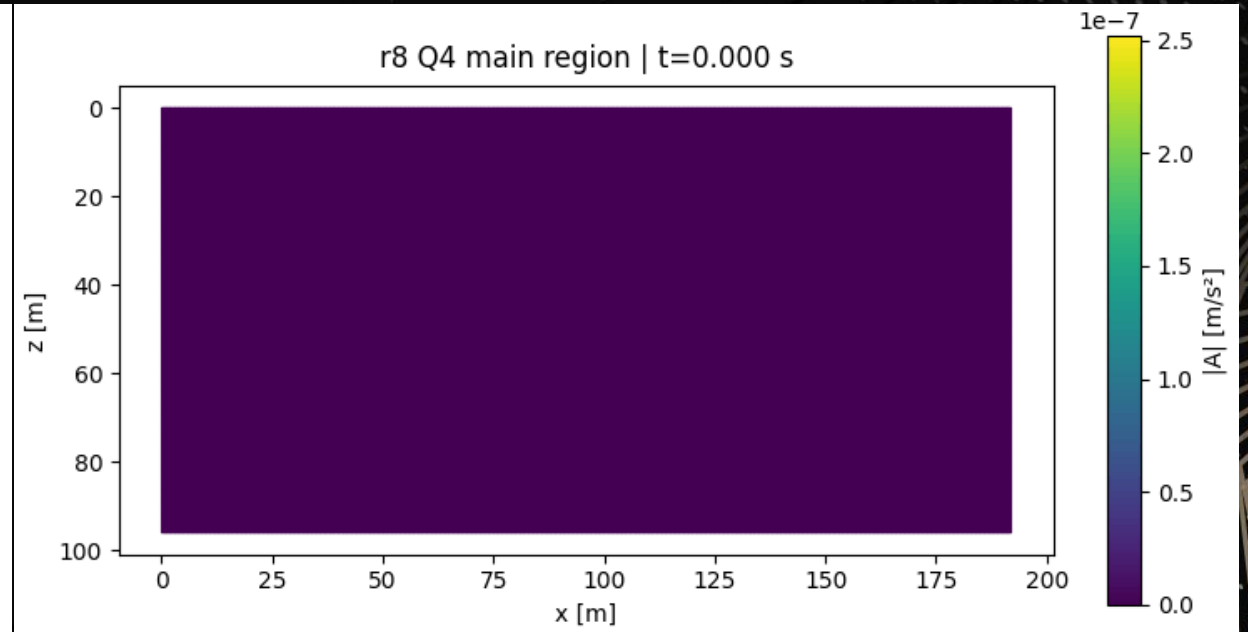
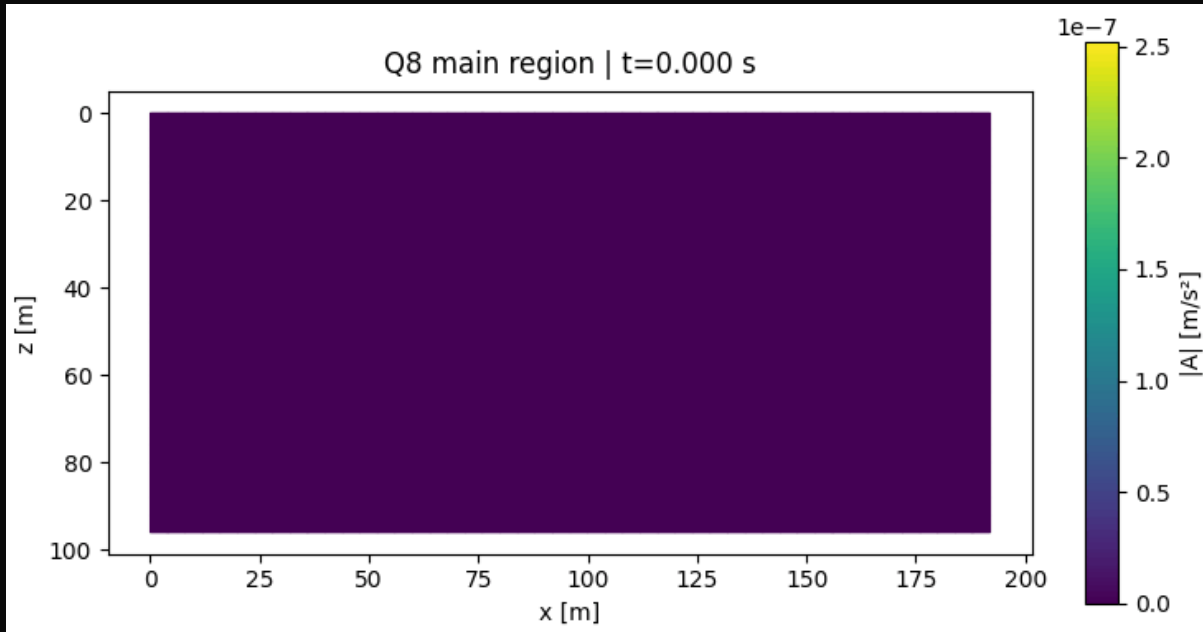
Material	Poisson's ratio	Young's modulus (Pa)	Density (kg/m^3)
Steel	0.300	210G	7850
Rubber	0.463	137k	1300
Concrete	0.200	30G	2500
Soil	0.300	100M	1800
Sand	0.300	100M	2000

Modal Analysis

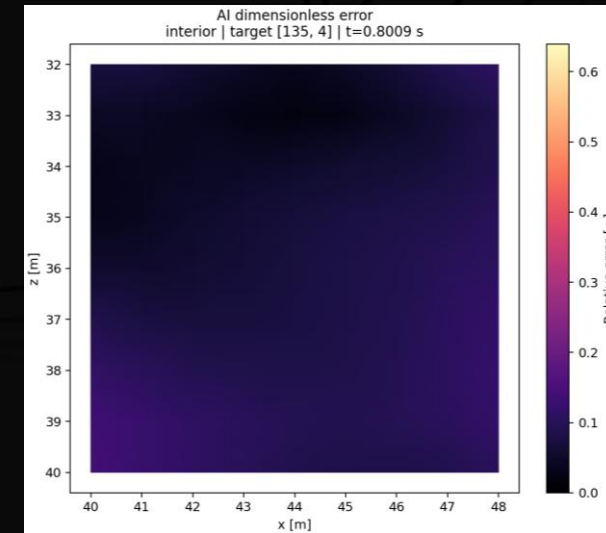
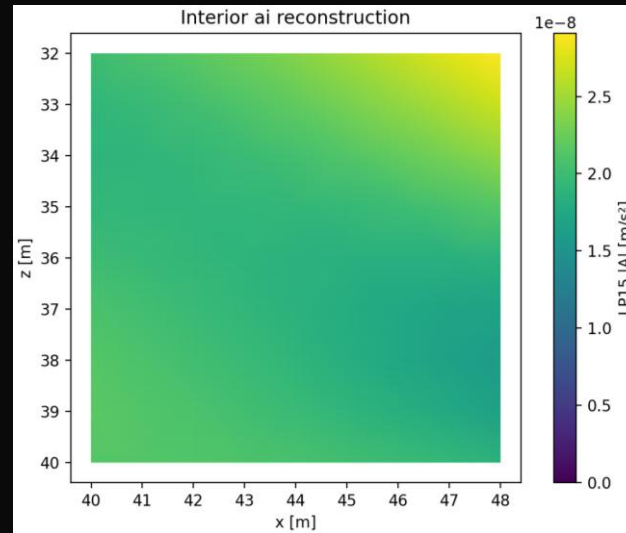
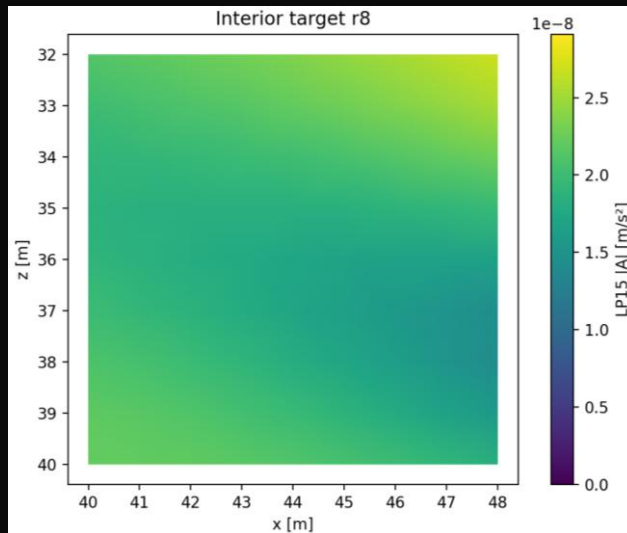
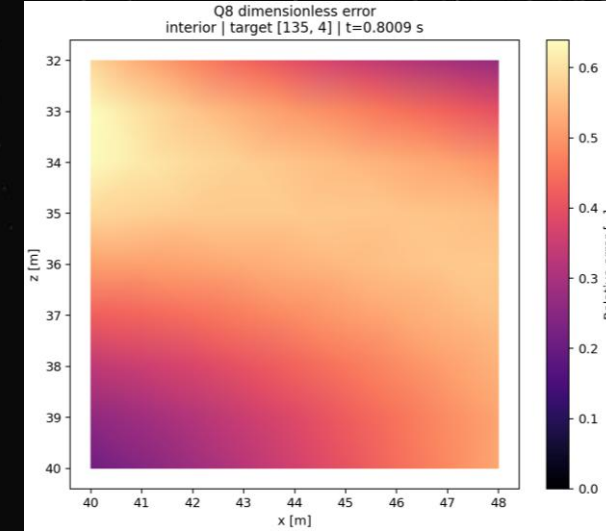
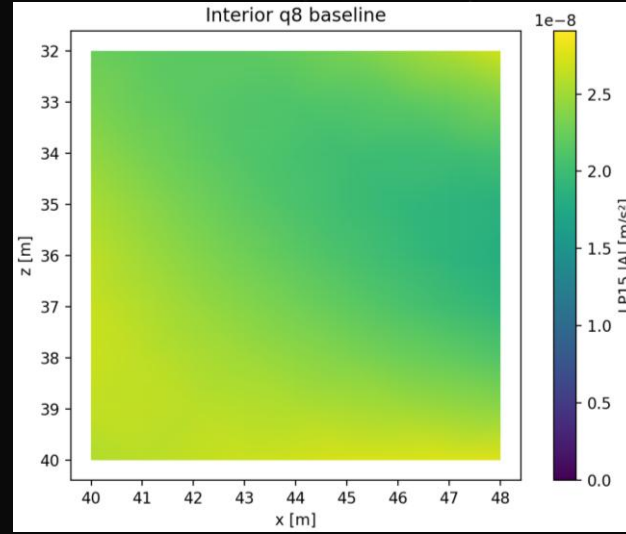
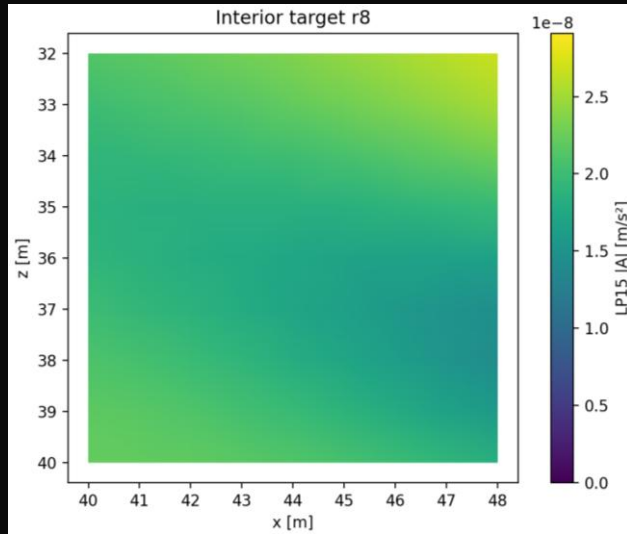


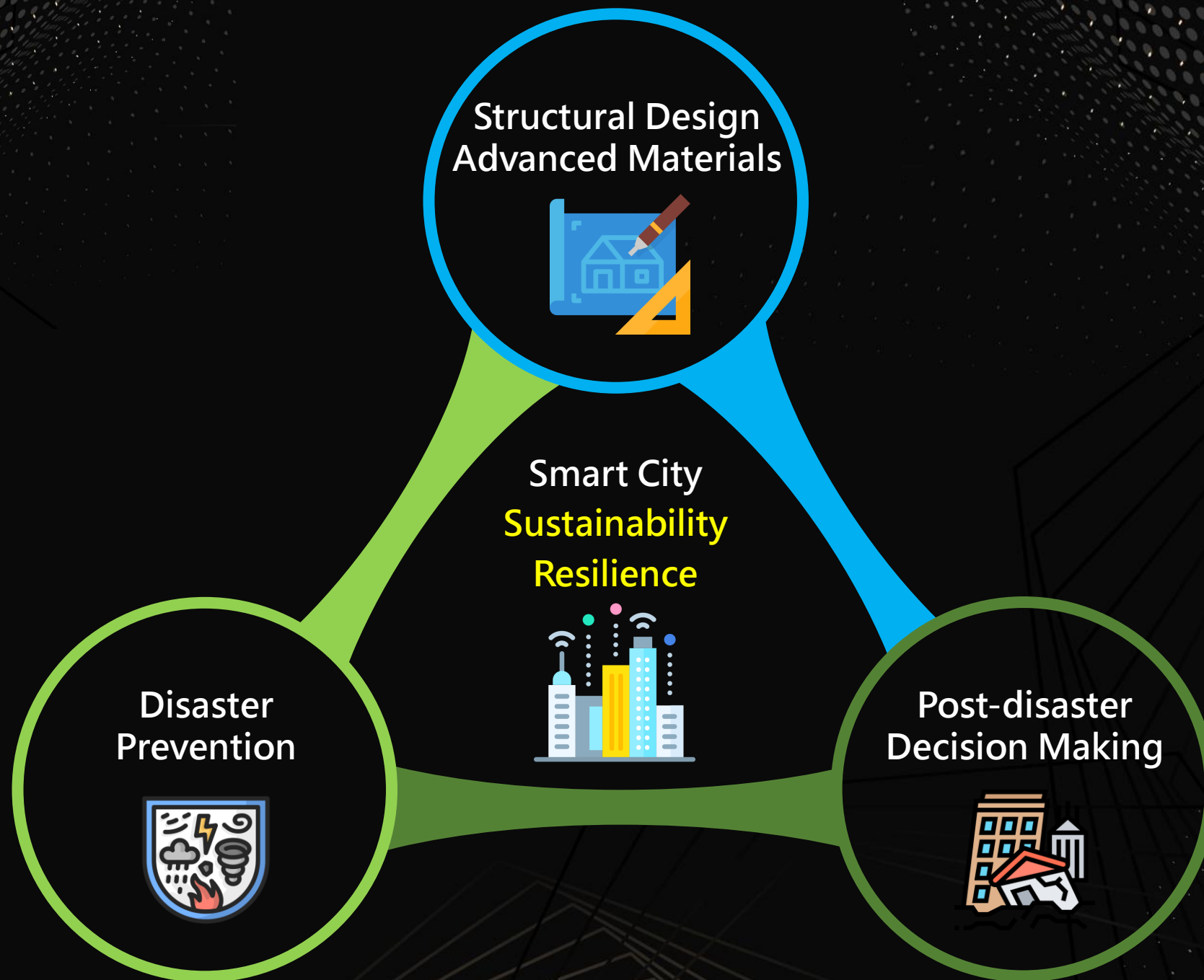
AI-accelerated Physics Engine

- Training data



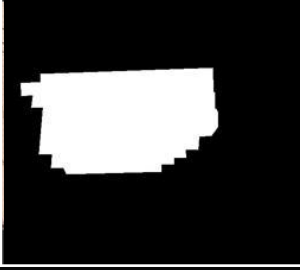
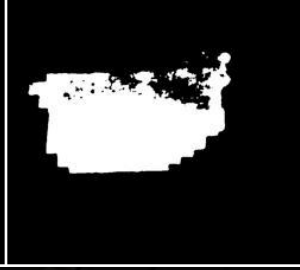
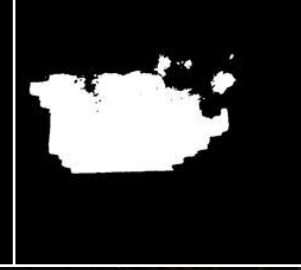
AI-accelerated Physics Engine (Cont.)



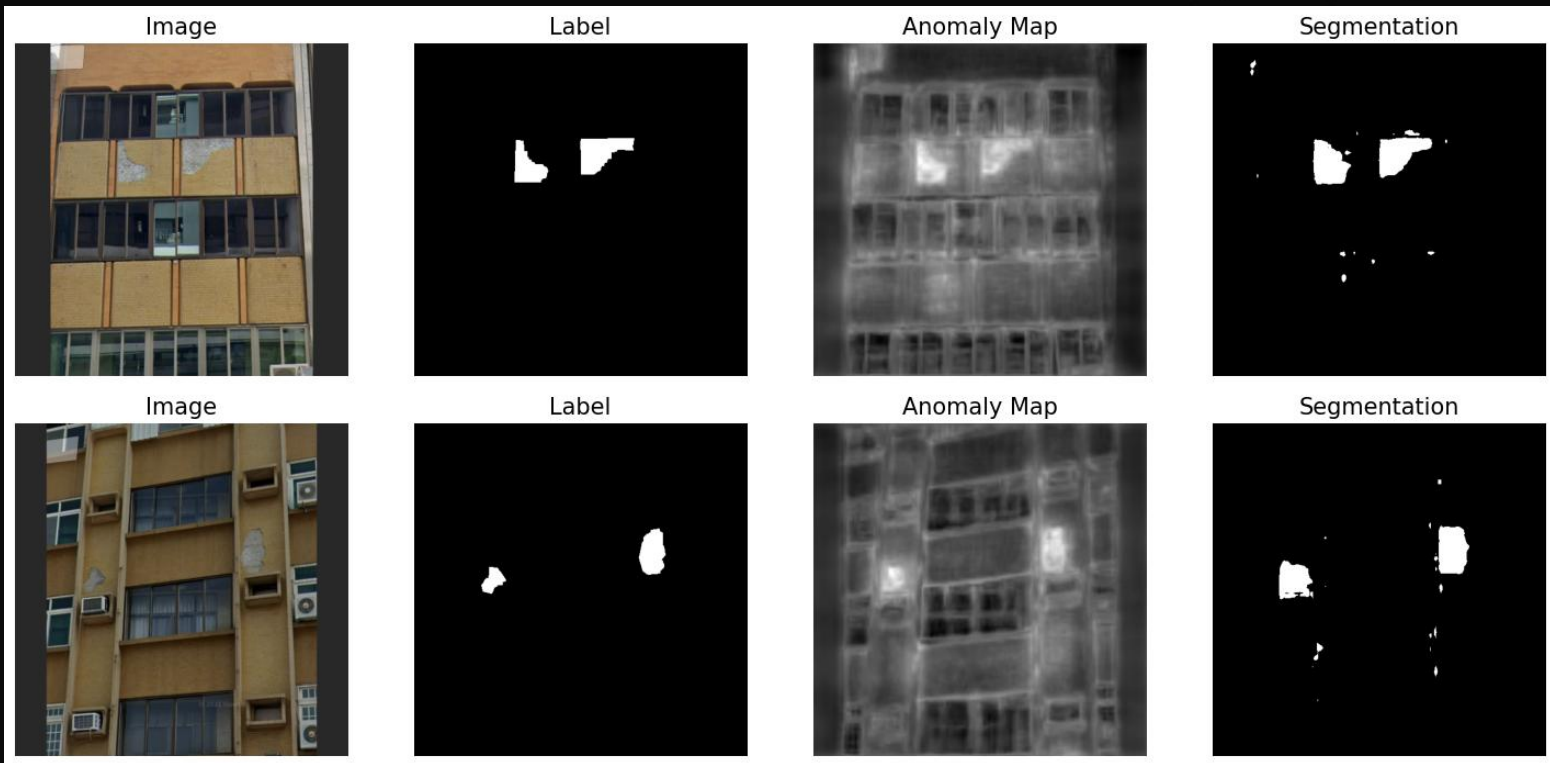


Supervised Tile Spalling Segmentation

- The multi-branch design makes model perform well in **large** and **small** spalling cases.

image	Label	MBF-UNet	U-Net	MA-Net	U-Net++	DLV3+
						
						

Unsupervised Tile Spalling Segmentation



Method	Metrics		
	AUC(%)	AP(%)	FPR(%)
	↑	↑	↓
Synthetic Supervised	80.3	11.9	55.3
RPL	76.3	5.8	61.2
*Ours	90.2	23.3	38.8
Ours (proposed)	94.7	52.4	29.5

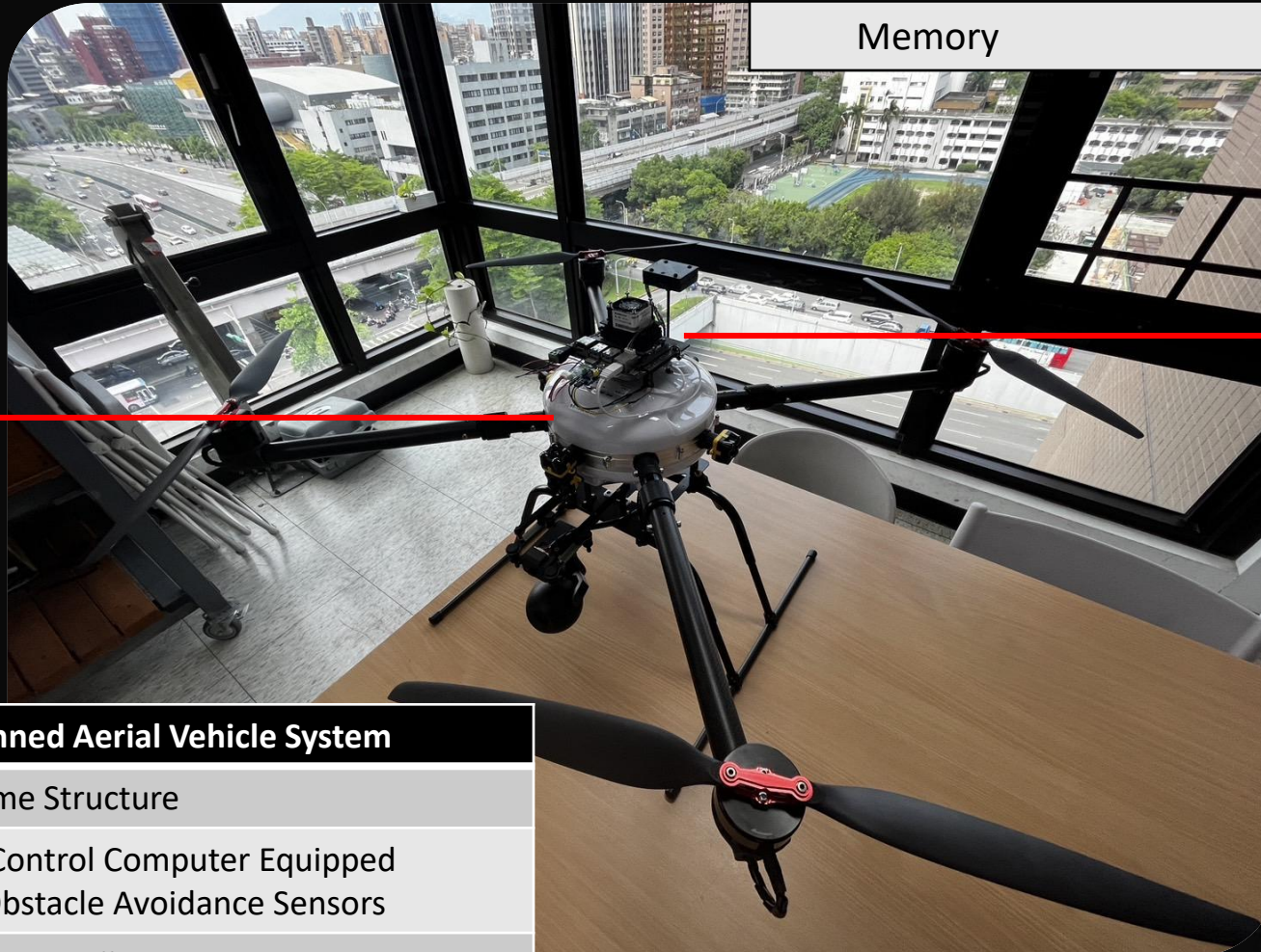
Method	Model Performance			Data Efficiency	
	AUC(%)↑	AP(%)↑	FPR(%)↓	Time (hr)	Cost (183 NTD/hr)
Supervised learning	98.8	88.8	3.7	200	36600
Proposed	94.7	52.4	29.5	1	183 (0.5%)

UAV Robotic Inspection

GPU	128 core NVIDIA Maxwell™
CPU	ARM® Cortex®-A57 MPCore 4core
RAM	4GB 64-bit LPDDR4
Memory	128GB

NVIDIA
Jetson Nano

AVIX-TECHNOLOGY
Quadcopter UAV



AXM-9009 Quadcopter Unmanned Aerial Vehicle System

Quadcopter Frame Structure

Open-Source Intelligent Flight Control Computer Equipped
with 5 Sets of High-Precision Obstacle Avoidance Sensors

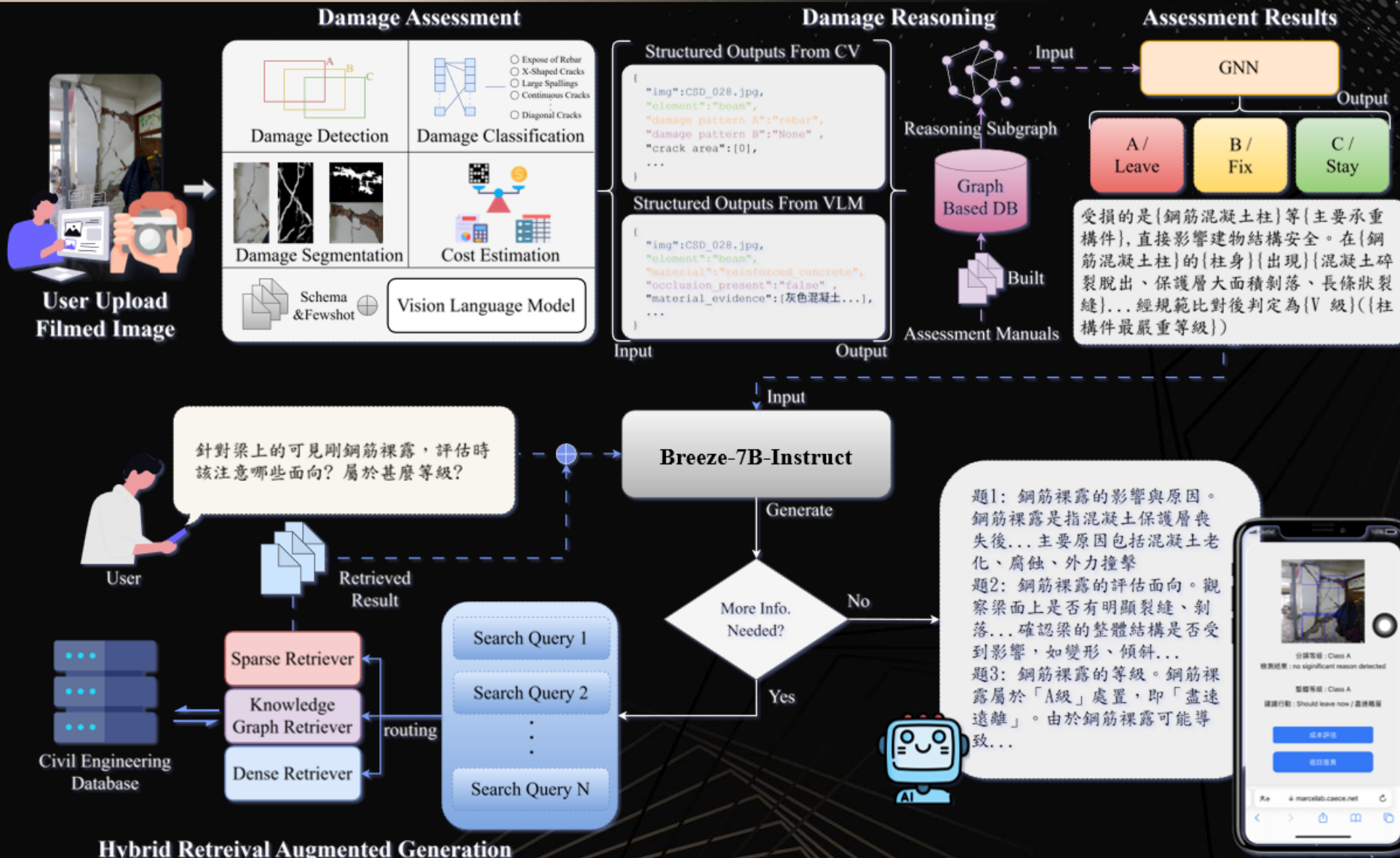
2.4G Remote Controller

5.8G Digital Video and Data Integrated Wireless Communication Module

UAV Robotic Inspection (Cont.)



安全耐震我的 AI APP



安全耐震我的 AI APP (Cont.)

Reasoning Prompt

步驟 1：逐一損害特徵、判定破壞機制 → damage_features
步驟 2：裂縫成因鑑別（地震 vs 既有） → damage_features
步驟 3：逐一損害特徵、給予 I~V 損害程度 →
damage_features
步驟 4：結構彙整 → members
步驟 5：跨結構關係的結構意義 → relationships
步驟 6：損害彙整 → assessment_inputs_summary

Reasoning Results

```
{ "member":  
  { "member_type": "column",  
    "damage_features.reasoning": "垂直裂縫與  
底部壓潰區域相關，可能為壓應力集中導  
致的裂縫。",  
    "member_damage_grade": "V",  
  }, ... }
```

安全耐震我的 AI APP (Cont.)

Q1

Pattern identification (n=308)

terminology · 「什麼是壁癌？蜂窩？」

Q2

Severity judgment (n=276)

grading rules · 「X形裂縫嚴重嗎？」

Q3

Element behavior (n=268)

element knowledge · 「樑的斜裂縫代表什麼？」

Q4

Repair & cost (n=147)

methods & prices · 「表面封閉法多少錢？」

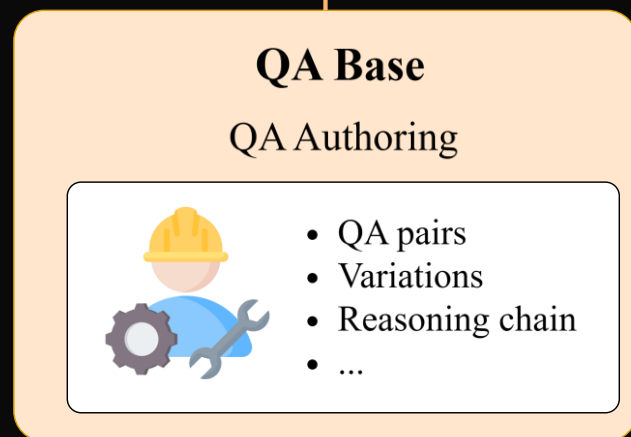
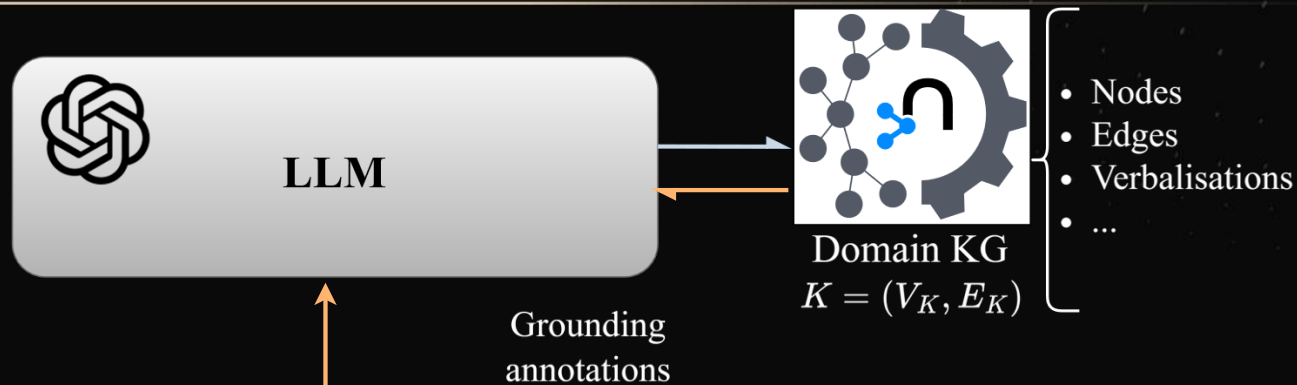
Q5

Cause & general (n=296)

causal chains · 「為什麼會軟弱層破壞？」

**Different Evidence Shapes
Required between each
question types**

安全耐震我的 AI APP (Cont.)



Splits Set

Example:

Q: 一樓的柱子出現 X 形的裂縫，需要離開嗎？

柱 —(出現)—▶ X型裂縫 —(研判為)—▶ 剪力破壞
—(評定為)—▶ 嚴重度 A 級 —(建議)—▶ 立即疏散

● nodes ■ edges ▶ Edge-triplets (1 hop)

Mapping Verbalizations

- 柱是承受垂直載重的主要結構構件
- X型裂縫是...

- 嚴重度 A 級代表嚴重受損，有立即危險，需要離開
- 柱子上出現X型...

Join Us!!!





MarCE Lab.

Metamaterial design and discovery

Artificial intelligence in **C**ivil **E**ngineering

Resource-efficient learning algorithms

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