Building Structural Damage & Marking Toolkit

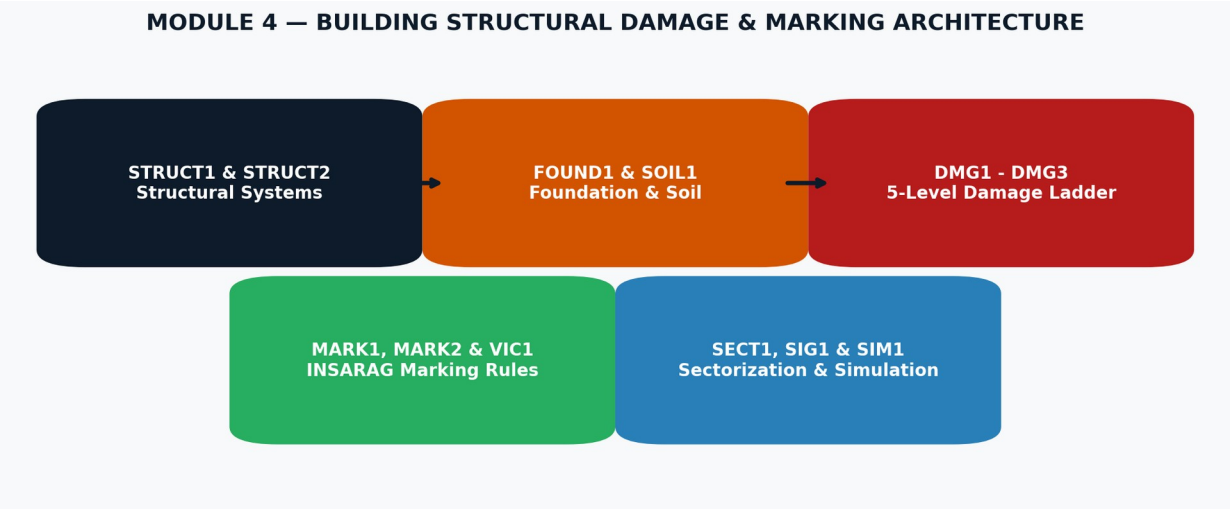
Module 4 - INSARAG Structural Damage Assessment & Debris Marking Systems



Preparedness is a practice.

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Training Scope & System Architecture



Structural System Classification

Classify reinforced concrete frame, load-bearing masonry, steel truss, and wooden structures under seismic loads.

INSARAG 5-Level Damage Ladder

Assess collapse severity from D1 (Slight Hairline Cracks) to D5 (Total Structural Collapse).

Worksite & Victim Marking Rules

Apply standardized 1x1m square symbols, team identifiers, hazard warnings, and victim counts.

TK-MAP — Toolkit Map & Operational Scope



Toolkit Module	Core Operational Focus	Target Participant Task
STRUCT1 & STRUCT2	Structural system & load-path classification	Match building type to failure mechanism
FOUND1 & SOIL1	Foundation settlement & soil liquefaction	Assess geotechnical risk on site
DMG1 - DMG3	5-Level damage ladder (D1-D5)	Classify building collapse severity
MARK1 & MARK2	INSARAG worksite marking layout	Construct 1x1m marking symbol on facade
SECT1 & SIG1	In-building sectorization & acoustic signals	Assign Sector A/B/C/D & execute signals

STRUCT1 — Structural System Classification



Structural System Type	Load Bearing Mechanism	Primary Seismic Failure Risk
Reinforced Concrete Frame	Monolithic beams, columns & shear walls	Soft-story collapse & shear column failure
Unreinforced Masonry (URM)	Load-bearing brick/stone walls	Out-of-plane wall collapse & diagonal shear
Steel Moment Frame	Structural steel beams with welded joints	Connection bolt shear & lateral buckling
Timber Frame Structure	Light wooden studs & roof trusses	Joint separation & foundation anchorage slippage

STRUCT2 — Structural Comparison Matrix



System Feature	RC Dual System	Unreinforced Masonry	Steel Frame
Ductility Level	High (Ductile details)	Low (Brittle response)	Very High (Elastic-plastic)
Collapse Pattern	Pancake or progressive	Total wall disintegration	Frame distortion without collapse
USAR Rescue Void Type	Structural voids between slabs	Crushed rubble (Small voids)	Large survivable void spaces

FOUND1 — Foundation & Soil Assessment



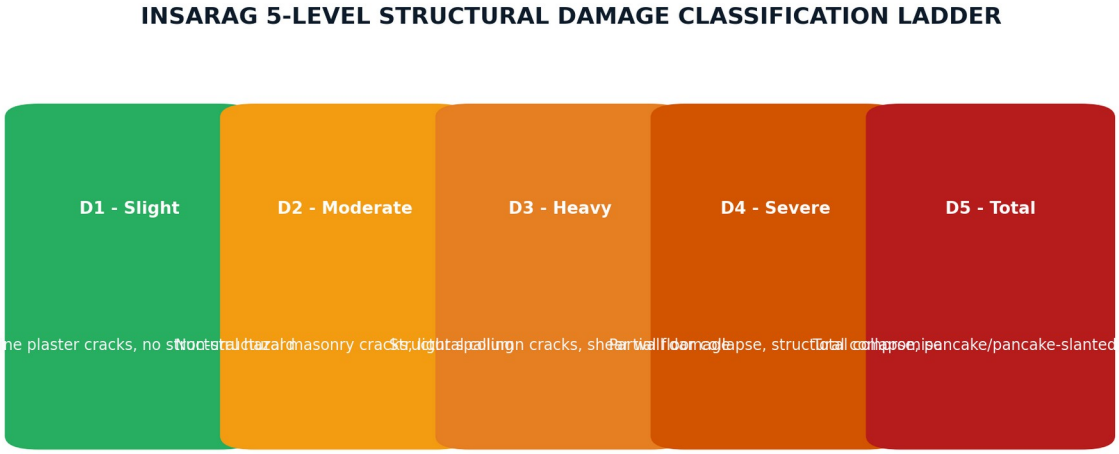
Foundation Type	Observed Geotechnical Defect	USAR Safety Action Needed
Shallow Isolated Footing	Differential settlement > 50mm	Underpin column base before shoring void.
Raft Mat Foundation	Ground tilt & soil liquefaction sand boils	Monitor inclination angle with tilt sensor.
Deep Driven Piles	Pile head shear failure at cap	Establish secondary safety zone around building.

SOIL1 — Soil Investigation & Liquefaction Match



Soil Category	Seismic Response Behavior	Structural Threat Level
Dense Gravel / Bedrock	Minimal amplification, low settlement risk	Low Threat (Stable foundation)
Saturated Fine Sand	High liquefaction risk during ground shaking	CRITICAL THREAT (Bearing capacity loss)
Soft Plastic Clay	Amplification of low-frequency seismic waves	High Threat (Resonance & tilt)

DMG1 — Five-Level Structural Damage Ladder



Damage Tier	Structural Condition Summary	INSARAG Marking Classification
D1 - Slight Damage	Hairline architectural cracks only	GREEN (Safe for immediate access)
D2 - Moderate Damage	Non-structural masonry cracks, minor spalling	YELLOW (Restricted access)
D3 - Heavy Damage	Structural column/beam cracking, wall displacement	ORANGE (Entry with shoring only)
D4 - Severe Damage	Partial floor collapse, severe structural tilt	RED (High hazard / Shoring mandatory)
D5 - Total Collapse	Complete collapse, pancake/pancake-slanted slabs	RED NO GO (Extreme hazard)

DMG2 — Partial vs General Collapse Decision Mat



Collapse Mechanism	Structural Void Characteristics	Tactical Breach Strategy
Pancake Collapse	Flat horizontal void spaces between concrete slabs	Horizontal breaching & crane lift
Lean-to Collapse	Triangular void space against load-bearing wall	Lateral side entry at wall base
V-Shape Collapse	V-shaped void near center beam failure	Top-down vertical shaft entry
Overhanging Collapse	Unstable cantilevered slab hanging over exit	Remove overhang before search entry

DMG3 — Damage Case Classification Cards



Case 1: Building 12 (North Sector)

D3 Heavy Damage — Ground floor column shear cracking, upper floors intact.

Action: Apply 1x1m INSARAG Orange Box; shore ground columns.

Case 2: Building 14 (East Sector)

D5 Total Collapse — Pancake slab collapse, high victim void potential.

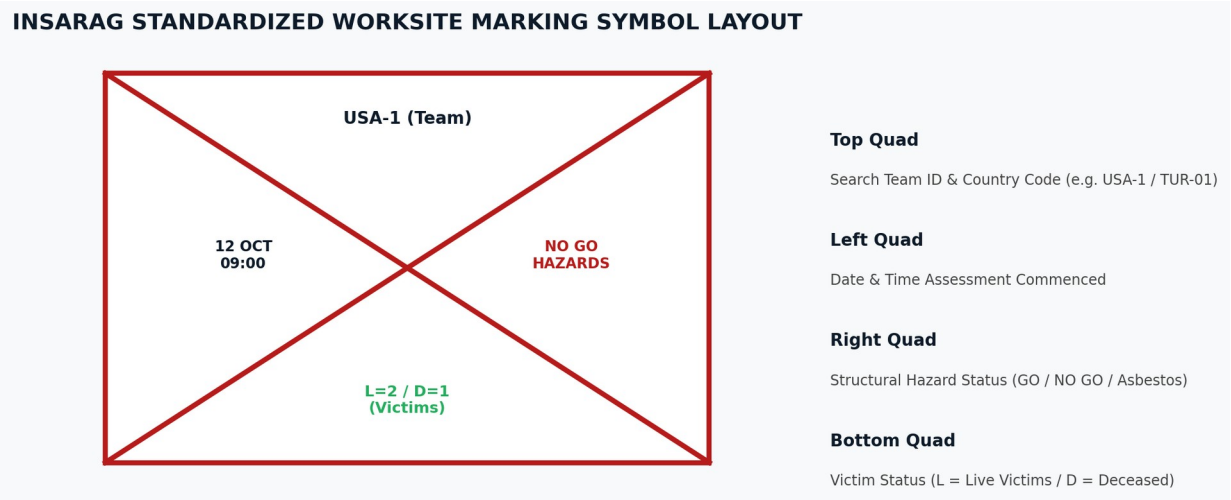
Action: Apply INSARAG RED Cross; deploy canine & acoustic search.

Case 3: Building 16 (West Sector)

D2 Moderate Damage — Non-structural wall cracking, gas leak isolated.

Action: Apply INSARAG Green Box; authorize rapid clearance.

MARK1 & MARK2 — INSARAG Worksite Marking



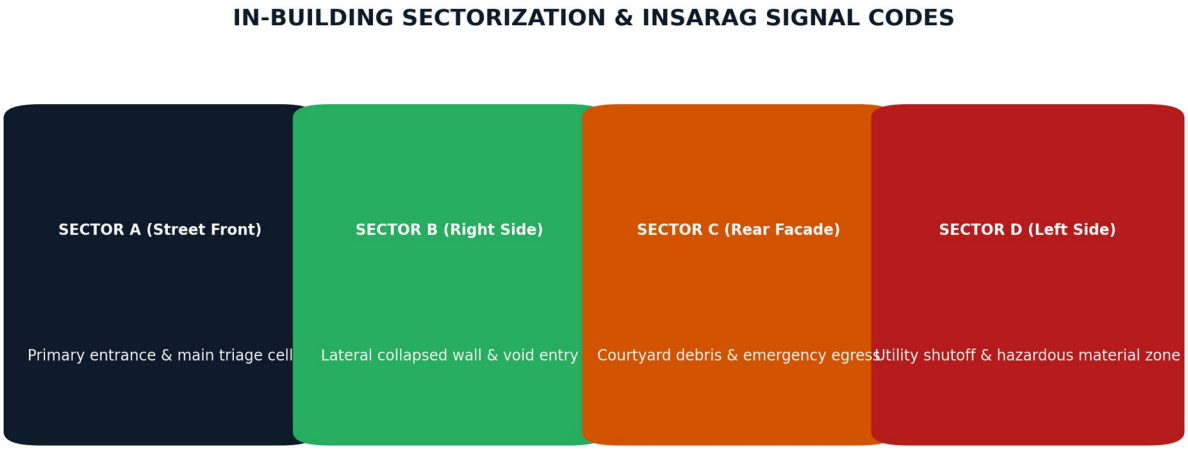
Marking Quadrant	Standard Information Required	Example Spray Paint Mark
Top Quadrant	USAR Team Identifier & Country Code	USA-1 / TUR-01
Left Quadrant	Assessment Date & Time Commenced	12 OCT 09:00
Right Quadrant	Hazard Information & Status	NO GO / ASBESTOS / GAS OFF
Bottom Quadrant	Victim Status Count (Live / Deceased)	L=2 / D=1 (Updated upon exit)

VIC1 & RCM1 — Victim Marking & Rapid Clearance



Victim Symbol	Meaning & Operational Context	Required Action
V	Confirmed live victim location (Acoustic/Canine)	Begin immediate deliberate extraction shoring.
V (Crossed out)	Live victim successfully extricated	Update bottom quadrant count on main mark.
F	Confirmed deceased casualty location	Mark location & report to Mortuary Affairs.
C	Completed search sector (No victims remaining)	Apply 1x1m clear box on main entrance.

SECT1 & SIG1 — Sectorization & INSARAG Signals



Acoustic Signal Code	Sound Pattern	Mandatory Action
EVACUATE	3 short blasts (repeated continuously)	Cease work immediately & evacuate structure!
CEASE OPERATION	1 long blast	Stop all power tools & listen for live victims.
RESUME OPERATION	1 long blast + 1 short blast	Resume search and rescue operations.

SIM1 — Fixed Simulation: Building 12 Structural Damage

Urban Earthquake: Structural Damage & Marking Coordination. Duration: 45-60 minutes. This fixed scenario is used unchanged across all three language versions.

Setting
A strong earthquake affects an urban district. Your multi-agency coordination cell receives pre-written observations for Buildings 12, 14, and 16.

Rule
No participant enters a real structure. All evidence is scenario data supplied by the facilitator.

Simulation video

Open the linked file in your browser or media player.



[OPEN VIDEO — CLICK TO PLAY]

AAR1 & OBS1 — After-Action Review & Rubric



Review Dimension	Expected Operational Benchmark	Observed Field Outcome	Required System Action
Structural Marking	1x1m INSARAG mark applied correctly	Quadrant entries omitted date & time	Mandate spray stencil kit for all units.
Damage Classification	Correctly differentiate D3 vs D5	Building 14 classified as D3 instead of D5	Conduct retraining on pancake slab criteria.
Emergency Signal	Evacuate within 60s of acoustic signal	All search teams cleared site in 45s	Maintain quarterly signal drill readiness.

EV1 & FAC — Facilitator Quick Guide & References



- INSARAG Guidelines (2020). Volume II: Preparedness and Response — Manual B: Marking System.
- FEMA P-154 (2015). Rapid Visual Screening of Buildings for Potential Seismic Hazards.
- ISO 22320 (2018). Security and Resilience — Emergency Management — Guidelines for Incident Management.
- UN OCHA / INSARAG (2019). Urban Search and Rescue Coordination Cell (UCC) Field Handbook.

Digital adaptation note: Each worksheet, damage ladder card, INSARAG marking symbol, and AAR rubric can be published as an independent web component under WP3. SIM1 is suitable for timed online scenario updates, role selection, and post-simulation reflection.

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WP3 | EDITION 2026