

Introduction

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- Roofs vulnerable to collapse by volcanic ash loading = hazard & risk
- EU Building regs Code: EN1991 snow loading only

Project aims & objectives

- Modify EN1991 for loading by volcanic ash



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Methodology 2: use numerical results to define *factor of safety (Fs)* for concrete roofs

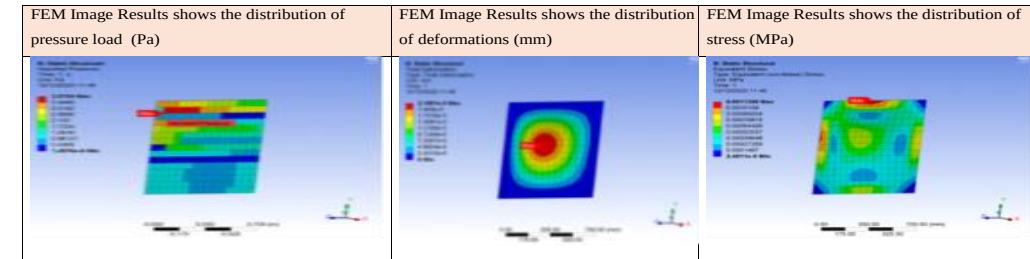
- **Known:** strength of concrete (MPa), geometry, $F_s = 1.5$, loading stress from models (σ , MPa), grain size, density
- **Unknown to solve:** displacement and resulting stress
- **Condition:** $\sigma \geq F_s = \text{failure}$



Methodology 1: Quantify stress on flat concrete roofs

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- Investigate collapse mathematically
- How? DEM & FEM numerical models
- Dimensions: 1 m x 1 m x 0.015 m
- 2 models: static (no wind), dynamic (wind effects)
- Particle number 80,000-160,000, density 1000-3000 kgm^{-3}



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Results

Model	Number Volcanic Ash Particles	Size (mm)	ρ (kgm^{-3})	X (ms^{-1})	Displacement (mm)	Max Stress (σ , MPa)	F_s (MPa)	Result
DEM Static	80,000	10	3000	0.0	0.25	14.4	1.8	Failure
DEM Dynamic	160,000	10	2000	1.0	0.21	10.4	1.8	Failure

Conclusions

- Both loading models exceed EN1991 code for F_s
- Dynamic model, *complex, time-varying stress distributions*