Philip.Quainoo,
APG Student
Philip.Quainoo@Northampton.ac.uk

Supervisors:
Prof Stefan Kaczmarczyk
Prof Nick Petford
Dr Eiman Elbanhawy

A Revision to European Building Code EN for Static and Dynamic Roof Loading Volcanic Ash

University of Northampton

Abstract

This study aims at exploring the effects of both static and dynamic loading of volcanic ash on a building roof, by proposing a revision of the building regulations with the objective of making existing and future European buildings more resilient to volcanic ash loading on the buildings in the prone areas. Preliminary results show that there is a direct proportionality between deformations of the roof and the load due to weight of the impacting ash as demonstrated through simulation tests using a finite element method.

Previous Studies

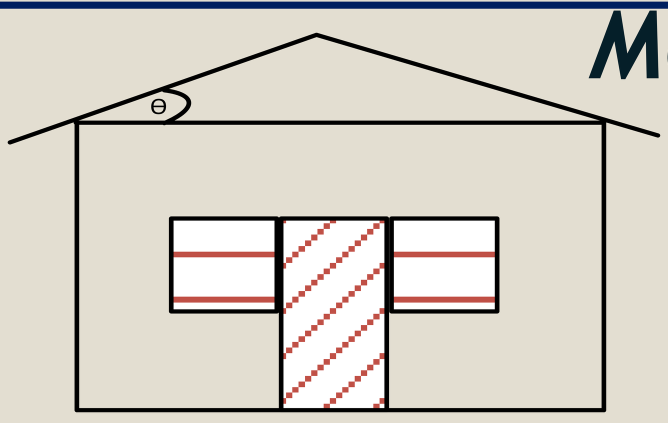
Density & load comparison, 100 mm (4 in) of snow and100 mm (4 in) volcanic ash (Johnston, 1997)

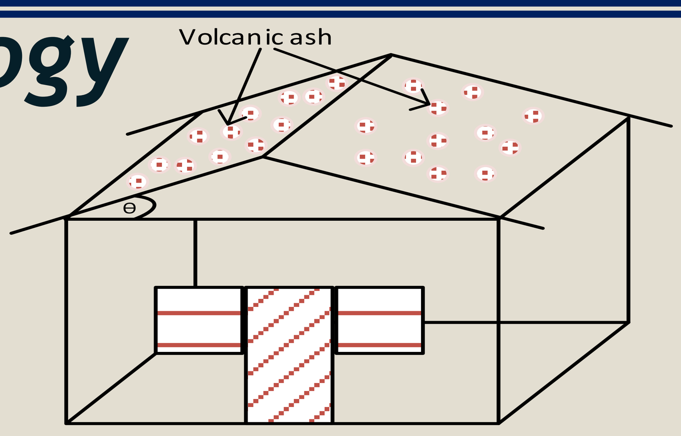
Description	Density kg/m3	Load kPa
New snow	50-70	0.05-0.07
Damp new snow	100-200	0.1-0.2
Settled snow	200-300	0.2-0.3
Dry uncompacted ash	500-1,300	**0.5**-1.3
Wet compacted ash	1,000-2,000	1.0-2.0



There have been a number of research projects carried out concerning the roofs of buildings in Europe, such as the effect of roof covering on the thermal performance of highly insulation roof, others explored roof exposure to tephra around the Vesuvius in Italy and also an experiment on the volcanic ash fall accumulation and loading on gutters and pitch roofs from laboratory empirical experiment. (D`Orezio et al., 2010, Spence et al., 2005, Spence et al., 2005).

Methodology





The diagrams illustrate the modelling part in more detail, which will be carried out in both 2D and 3D. The research follows a multi-method approach. Numerical modelling using the Finite Element Method (FEM) models and the Discrete Element Method (DEM) modelling tool is deployed to interrogate the volcanic ash effects loadings on a concrete flat roof within the current EN1991 code.

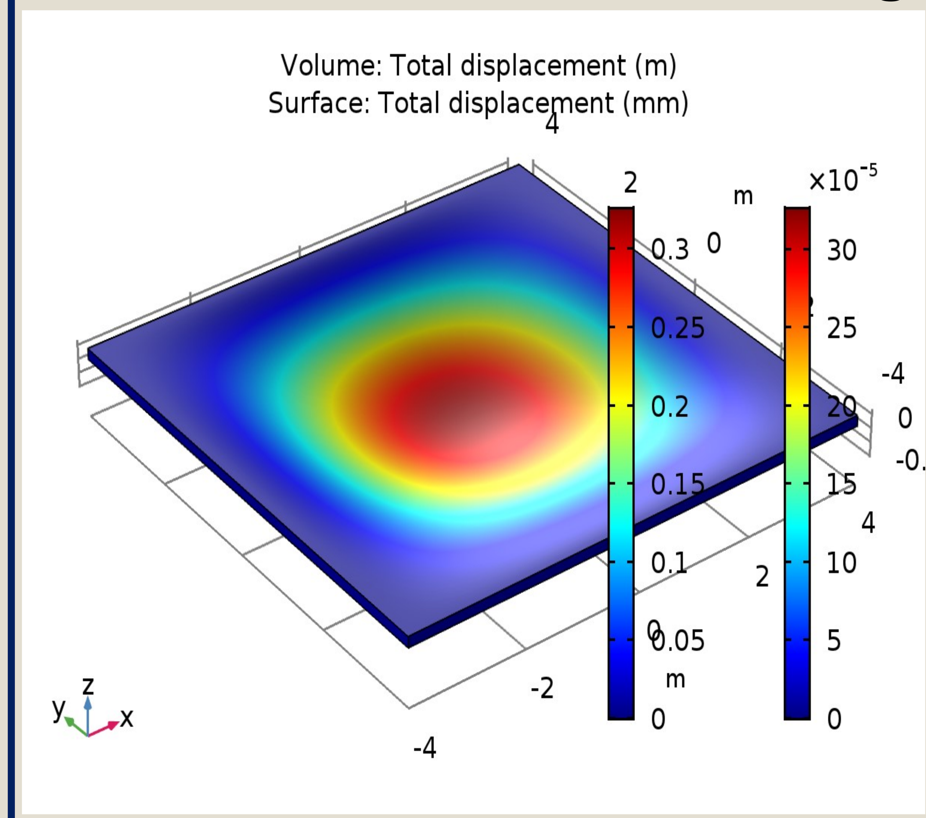
EN1991 Code

EN 1991-1-1:2002	**Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings.**
EN 1991-1-3:2003	**Eurocode 1: Actions on structures - Part 1-3: General actions - Snow loads**
EN 1991-1-4:2005	**Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions**

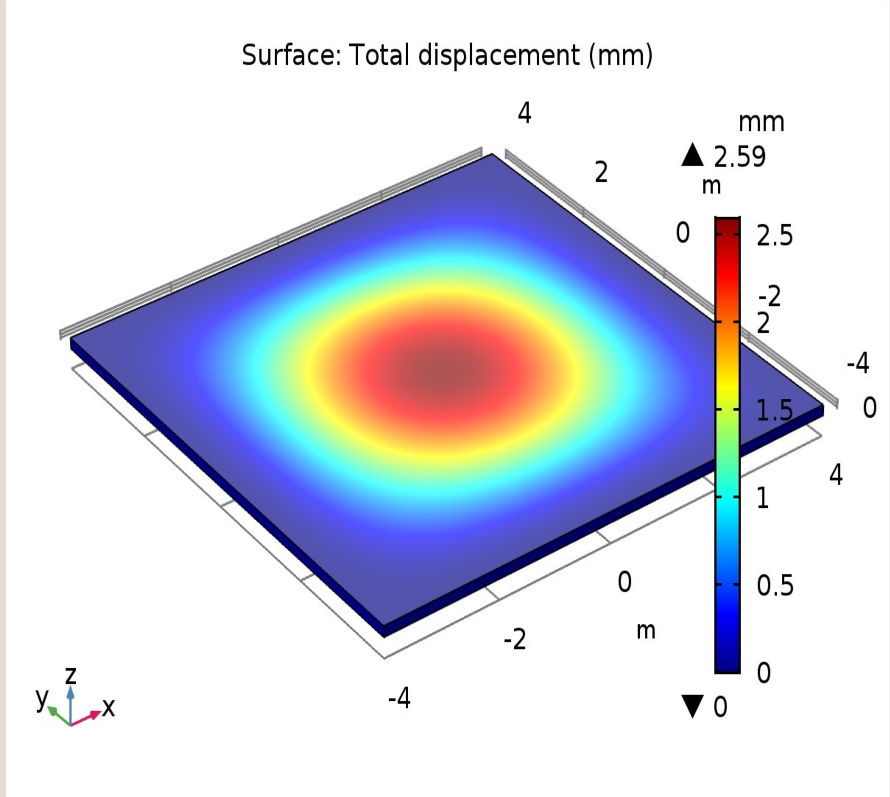
Results

A simulation test which has been conducted with a pressure of volcanic ash layer on a concrete flat roof shows deflection is inversely proportional to the thickness of the roof and its moment of inertia. For example, a pressure of 0.5 kN/m^2, 1.0 kN/m^2, 2.0 kN/m^2 on a flat concrete roof shows a deflection of 0.34 mm, 0.69 mm and 1.38 mm for 0.154 m thick concrete roof respectively.

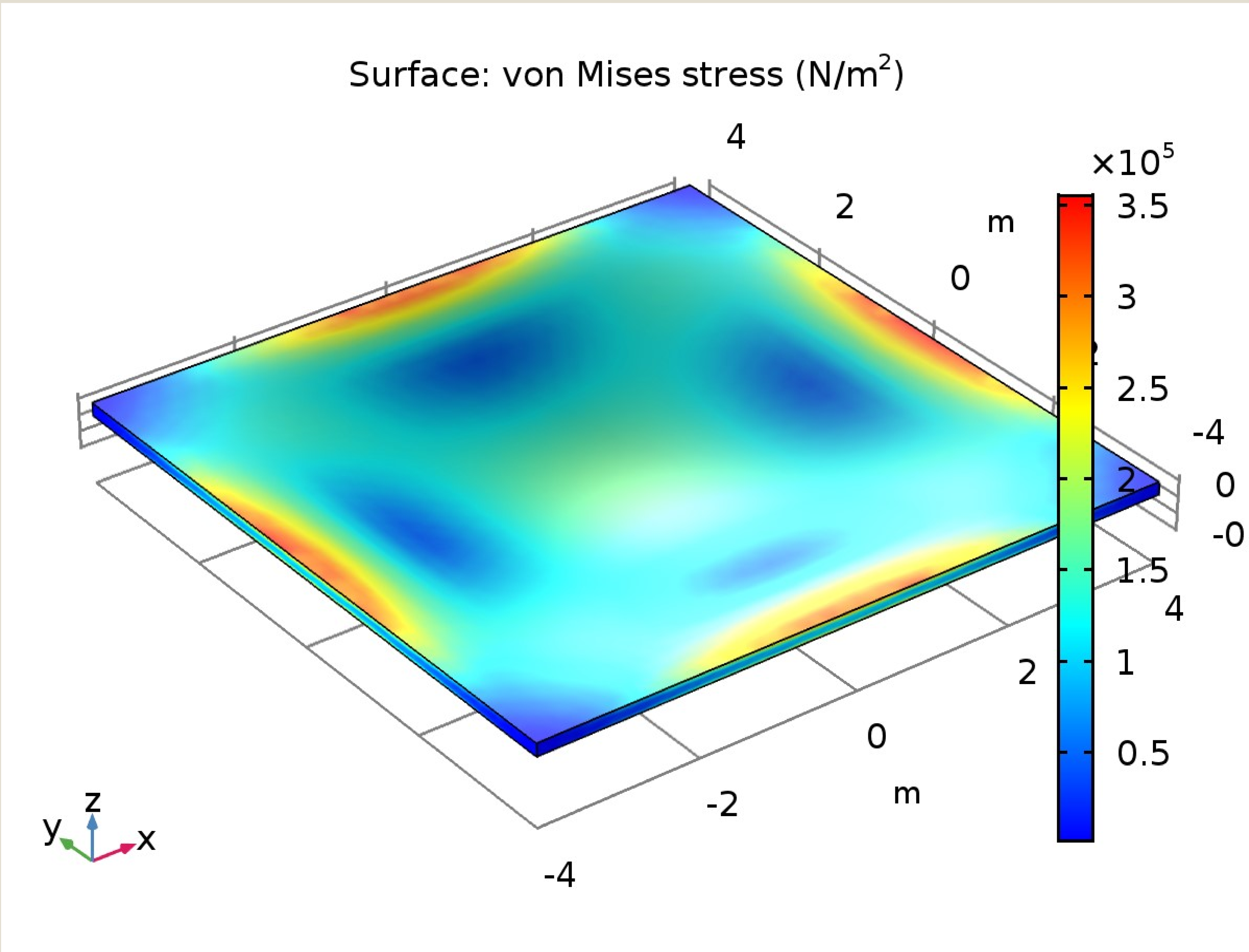
Effect of volcanic ash loading on buildings



Results of applying a pressure of 500N/m^2



Results of applying a pressure of 500N/m^2 (due to the ash load) combined with the roof self-weight.



The overall stress distribution on the roof

Summary

Further work will assess the effects of volcanic ash of changing density on various roofing materials to:

- Determine the stress levels
- Determine Maximum deflections
- Determine the nature of failure of the roof due to volcanic ash pressure

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