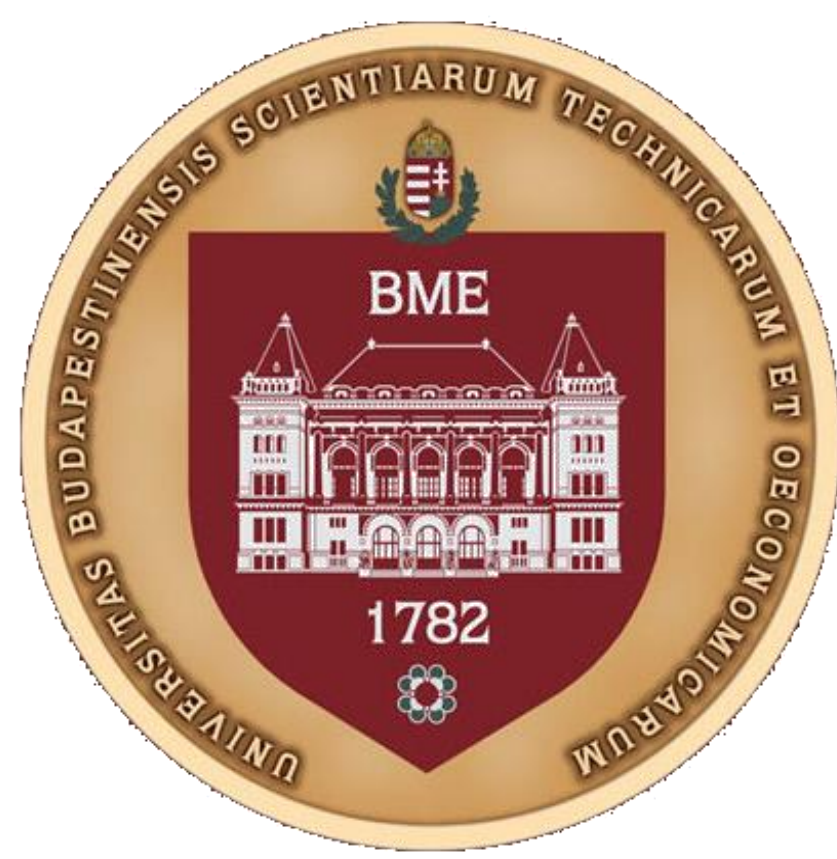


On the elastic gradient of metal matrix syntactic foams

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Introduction

Closed cell, high strength metallic foams, as ceramic hollow sphere reinforced metal matrix syntactic foams (MMSFs) are promising materials to build lightweight structural parts. The application of these composites can range from energy absorbers to structural materials. If MMSFs were used as structural parts, the most important property is the elastic gradient.

The relevant standard (ISO 13314:2011) includes the measurement of the structural stiffness, but as structure dependent property it's validity is limited. The elastic gradient is necessary in order to conduct proper design calculation.

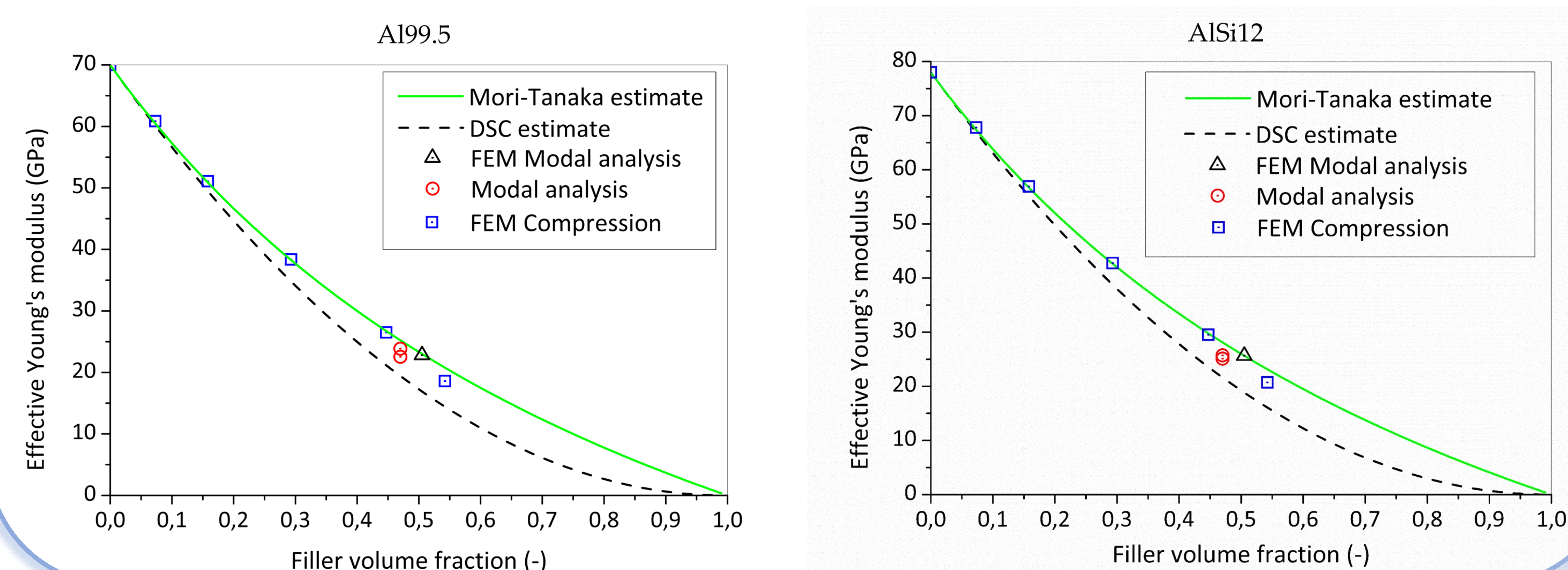
Results

Compression test results were significantly different from the three other methods.

The stresses inside the material were really small in the modal analyses, which is mandatory in case of measuring the effective Young's modulus.

	Young's modulus (GPa)		Effective Young's modulus (GPa)	
	Bulk Al99.5	Bulk AlSi12	Al99.5-Globocer	AlSi12-Globocer
1. specimen	72.29	77.86	22.54	25.72
2. specimen	69.81	79.06	23.86	25.11

Both the compressive and modal tests were simulated with FEM.



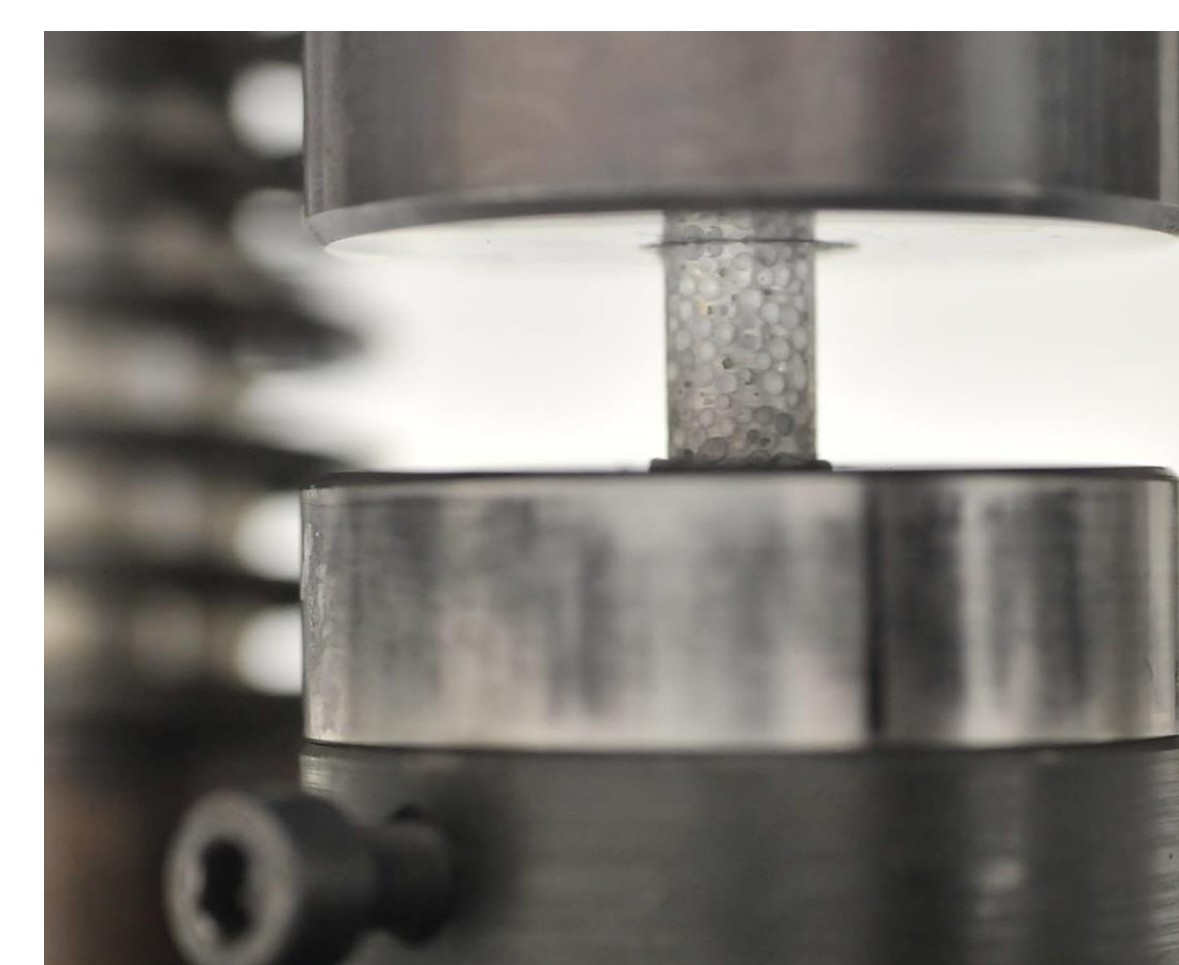
Materials and Methods

Matrix: Al99.5 and AlSi12

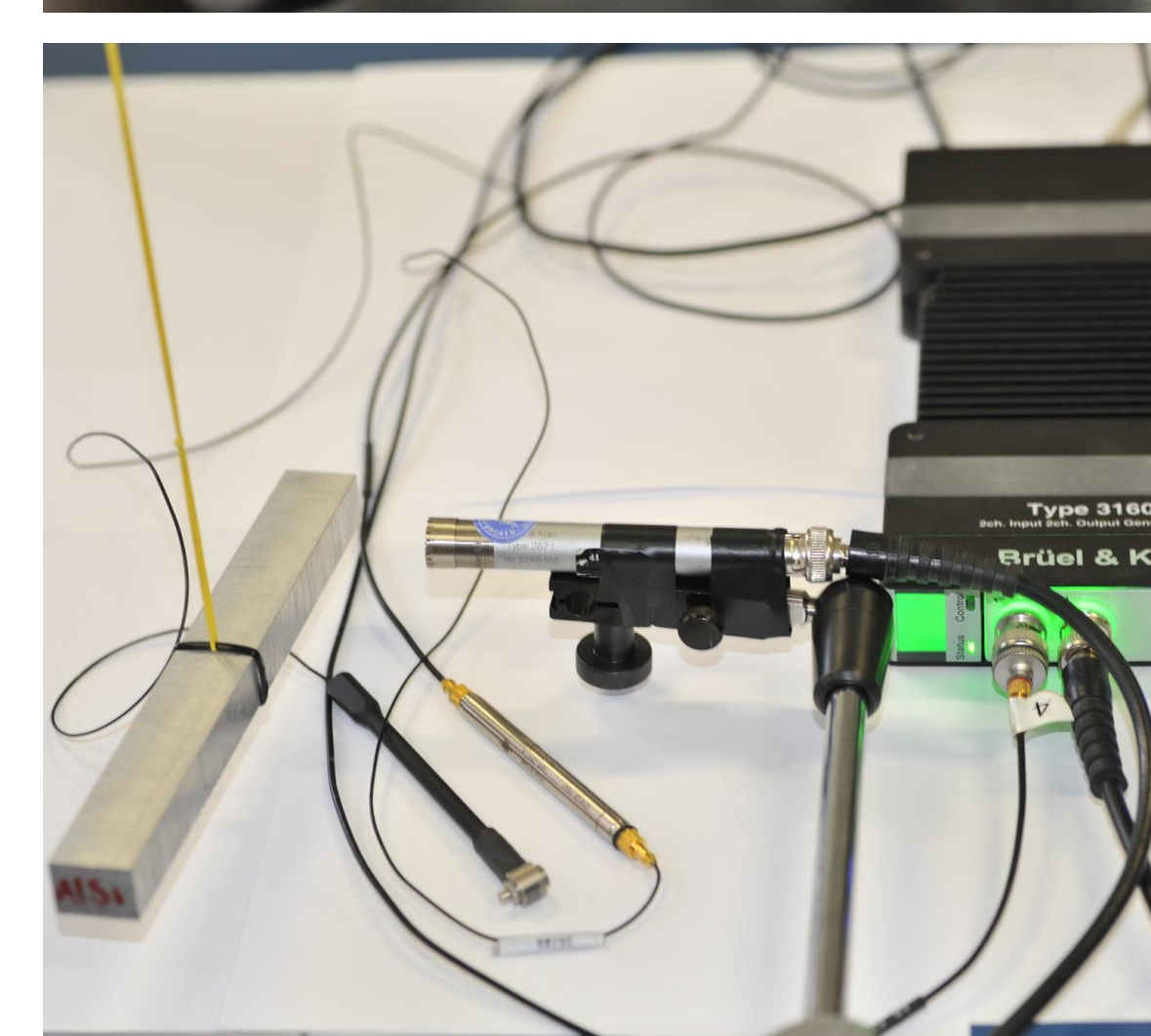
Filler: Globocer (ceramic hollow sphere, Hollomet GmbH)



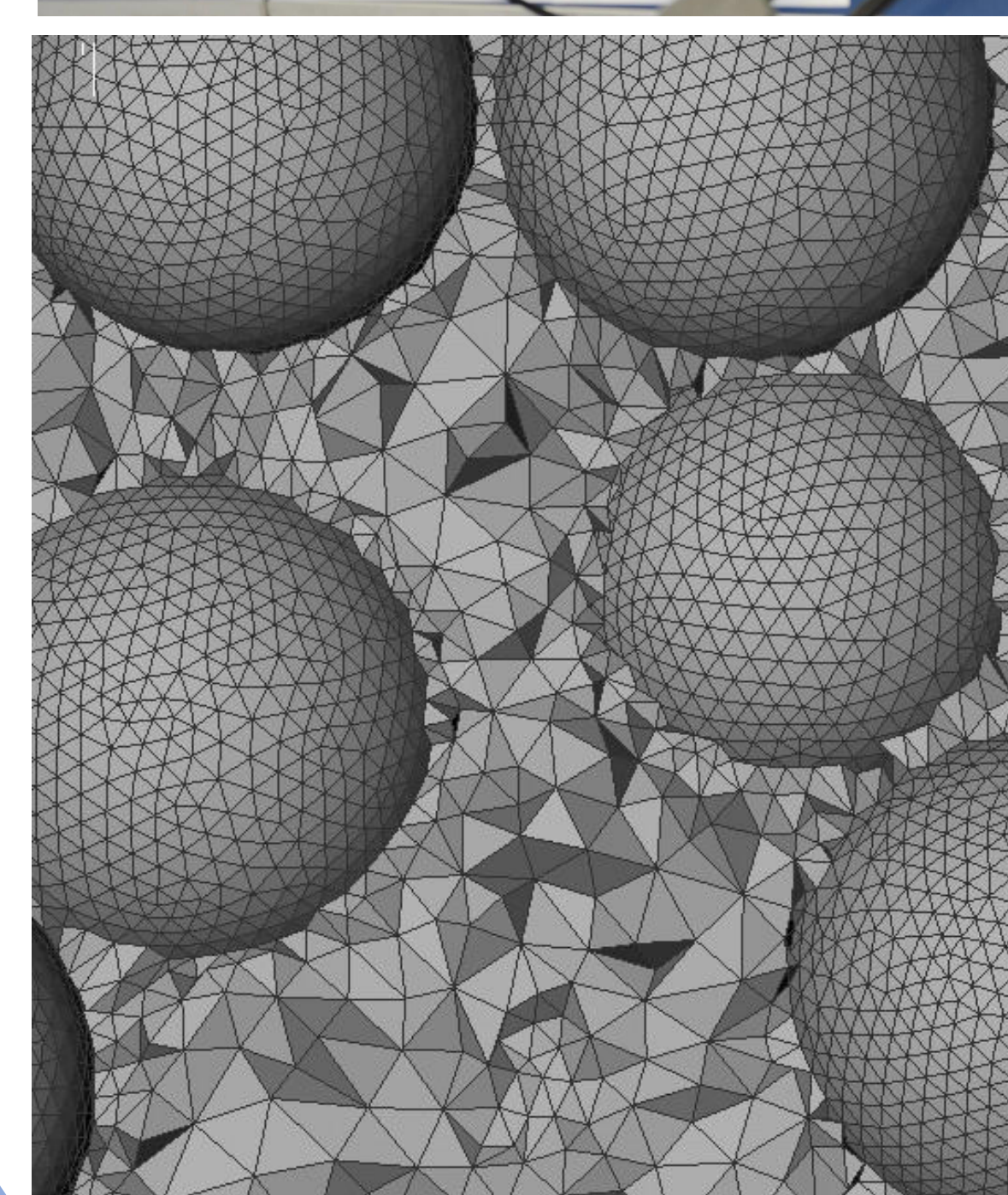
Four different, but widely used methods:



1. Compression test
Cylindrical sample, quasi static conditions, extensometer, up to 4000 N



2. Modal analysis
Bar shaped samples, impact hammer, microphone, 1st and 2nd natural frequencies, Timoshenko beam theory



3. Finite element method
Randomly placed spheres, full model, linear elastic properties, compression and modal analysis

4. Analytical calculations
Mori-Tanaka and differential self consistent estimations

Conclusions

The modal analysis, the FEM and the analytical models were gave the same results. This proves that the effective Young's modulus was successfully determined.

This result also means that the compression test is not suitable to measure the elastic gradient and has certain limitations.

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