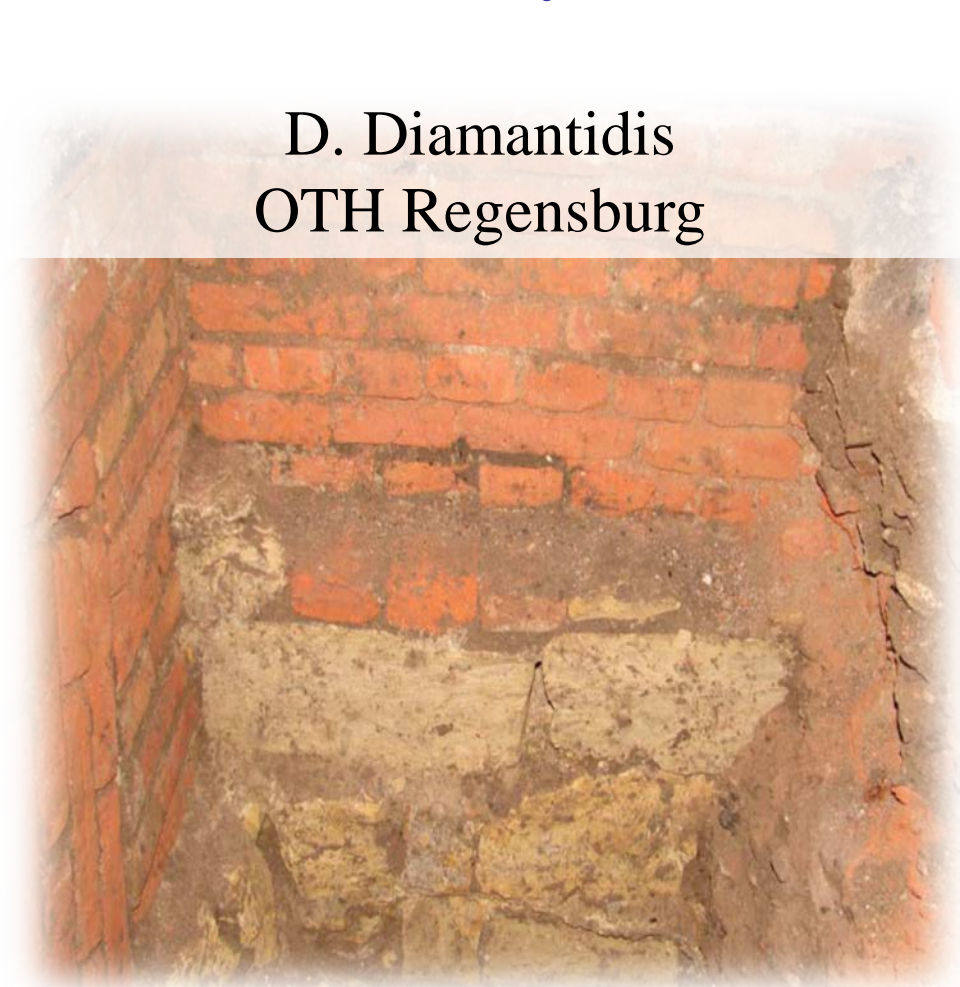


Optimising in-situ testing for historic masonry structures

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General overview

- Masonry construction - long history, scatter of properties (age, region-specific constituents, manufacturing)
→ crucial to obtain case-specific information
- For heritage structures, non- or minor-destructive tests (NDTs, MDTs) commonly applied along with a few DTs
uncertainty of spot monitoring?
- “In some cases, destructive tests may be necessary to calibrate NDT” - ISO 13822



Current status

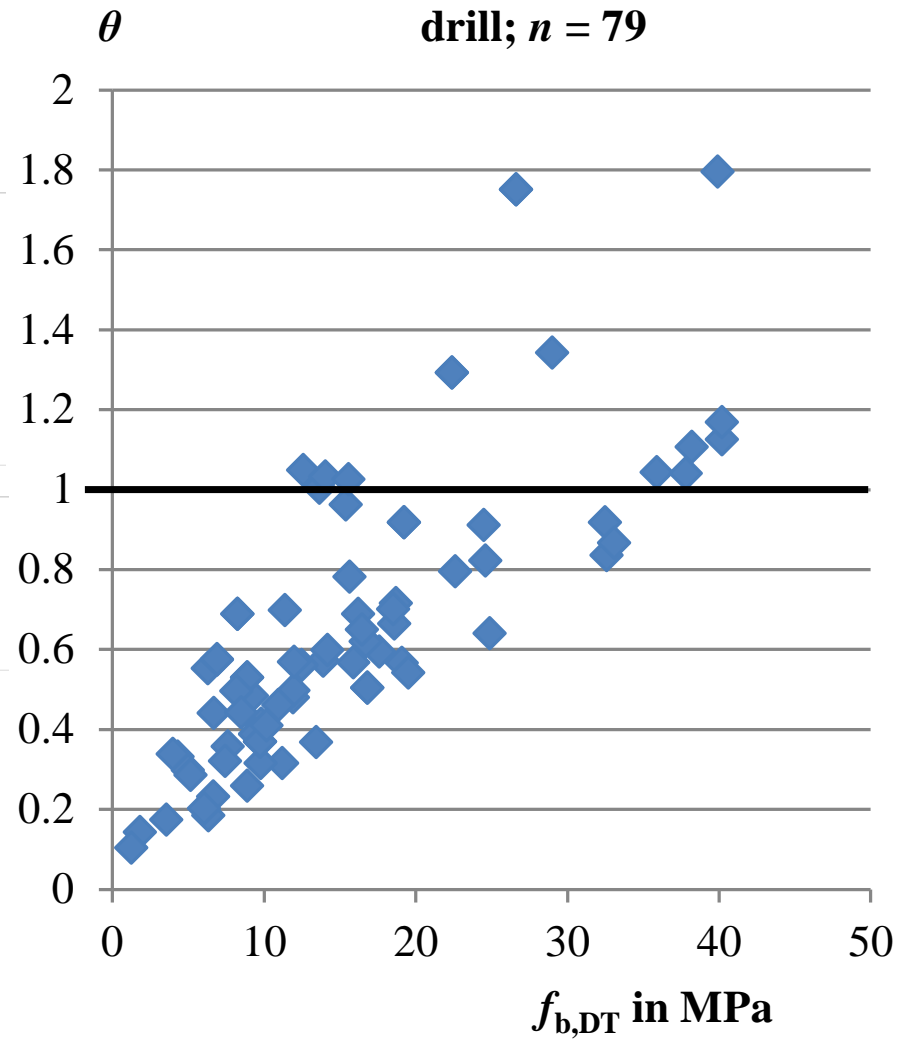
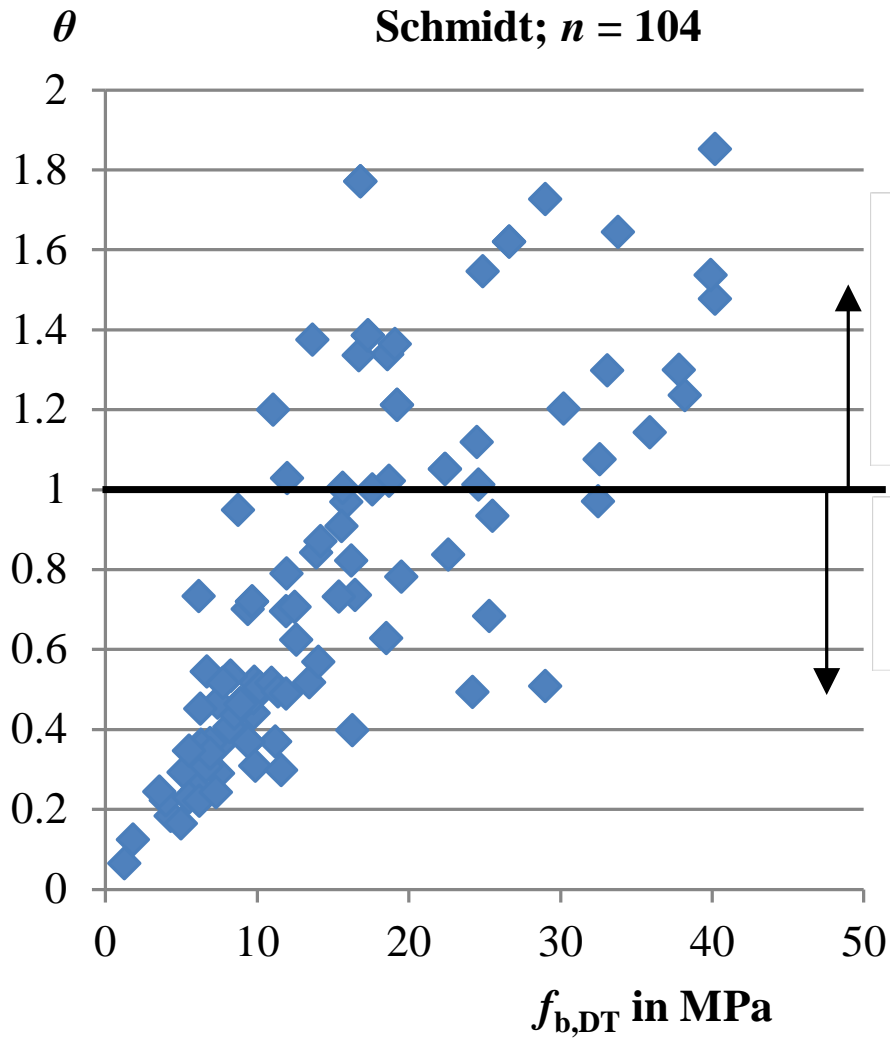
- Database of 14 historic stone and brick masonry structures from the 17th to the 20th century
- Schmidt hammer and modified drill tests verified by DTs of masonry units

Table 1: Basic information about the experimental database for strength of masonry units.

No.	Use of building	Built in	Masonry units	Number of measurements		
				DT	Schmidt*	drill*
1	vicarage	17 th	sandstone	3	3	3
2	church**	17 th	sandstone	11	11	11
			bricks	6	6	6
			pudding stone	1	1	1
3	printing works***	1930s	bricks	18	18	17
4	residential	end of 19 th	bricks	4	4	4
5	offices, storage	1890	bricks	6	6	3
6	monastery, barrack	1638	bricks	11	10	8
			marlstone	3	3	3
7	offices, archive	early 20 th	bricks	4	4	2
			marlstone	2	2	0
8	textile mill	second half of 19 th	bricks	6	6	4
9	boiler house	1959	bricks	4	4	1
			unspecified stone	1	1	1
10	water mill	1930	bricks	4	4	4
			unspecified stone	1	1	0
11	residential	1867	bricks	6	6	3
			granite	1	1	0
12	engineering works	1870	bricks	5	5	5
13	residential	1890	bricks	2	2	0
			marlstone	1	1	0
14	residential	1871	bricks	6	6	0

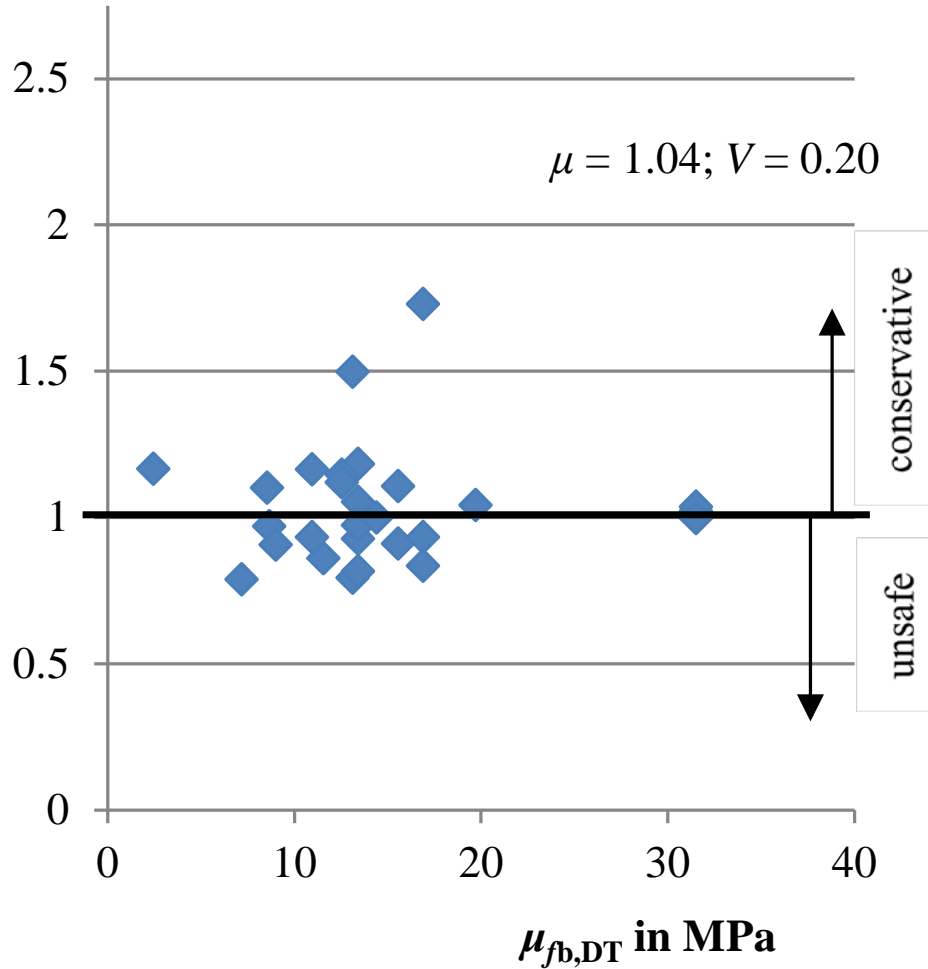
Current status

$$\theta = f_{b,DT} / f_{b,NDT}$$

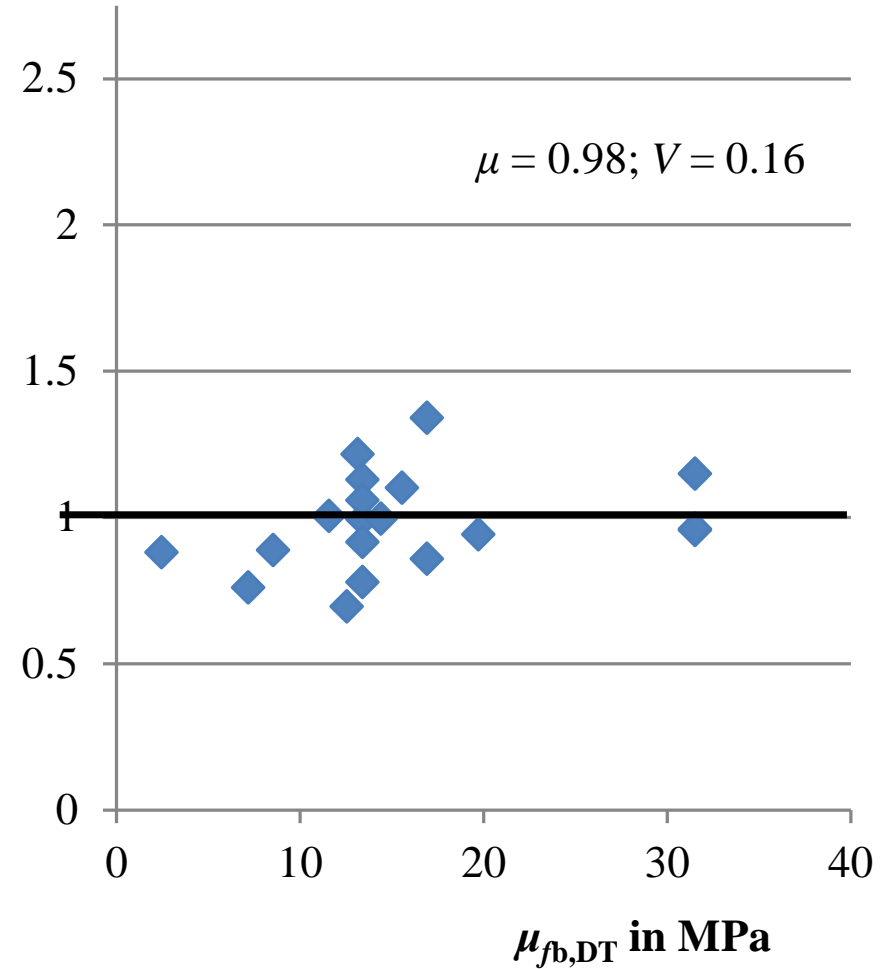


NDTs calibrated by 3 DTs

$f_{k,DT} / f_{k,Schmidt}; n = 27$

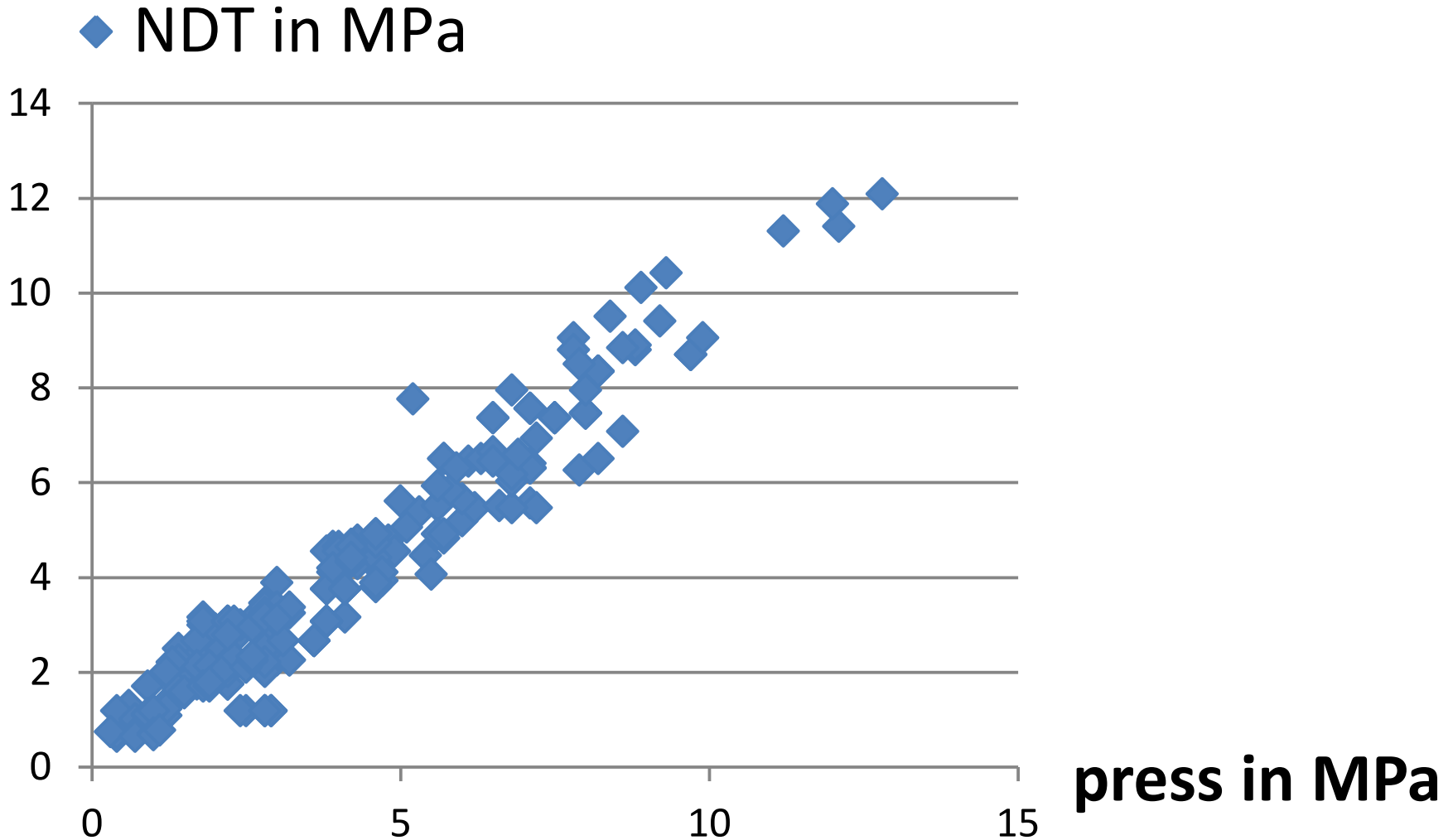


$f_{k,DT} / f_{k,drill}; n = 19$



Current status

- Database for NDT to estimate mortar strength (lower importance)



VoI analysis implementation

- *Appropriate method for survey*

Balance between related costs, uncertainty in outcomes and required precision.

- *Costs $\sim n$ NDTs + m DTs*

DTs may affect a cultural heritage value.

- *$\beta(n, m)$*

Assuming masonry compressive strength is a key parameter for reliability analysis.

- *Consideration of upgrade cost (if any)*

Upgrade may affect a cultural heritage value.

Optimum decision depends on how β_{real} is close to the target level (reason for assessment can be indicative).

Open questions

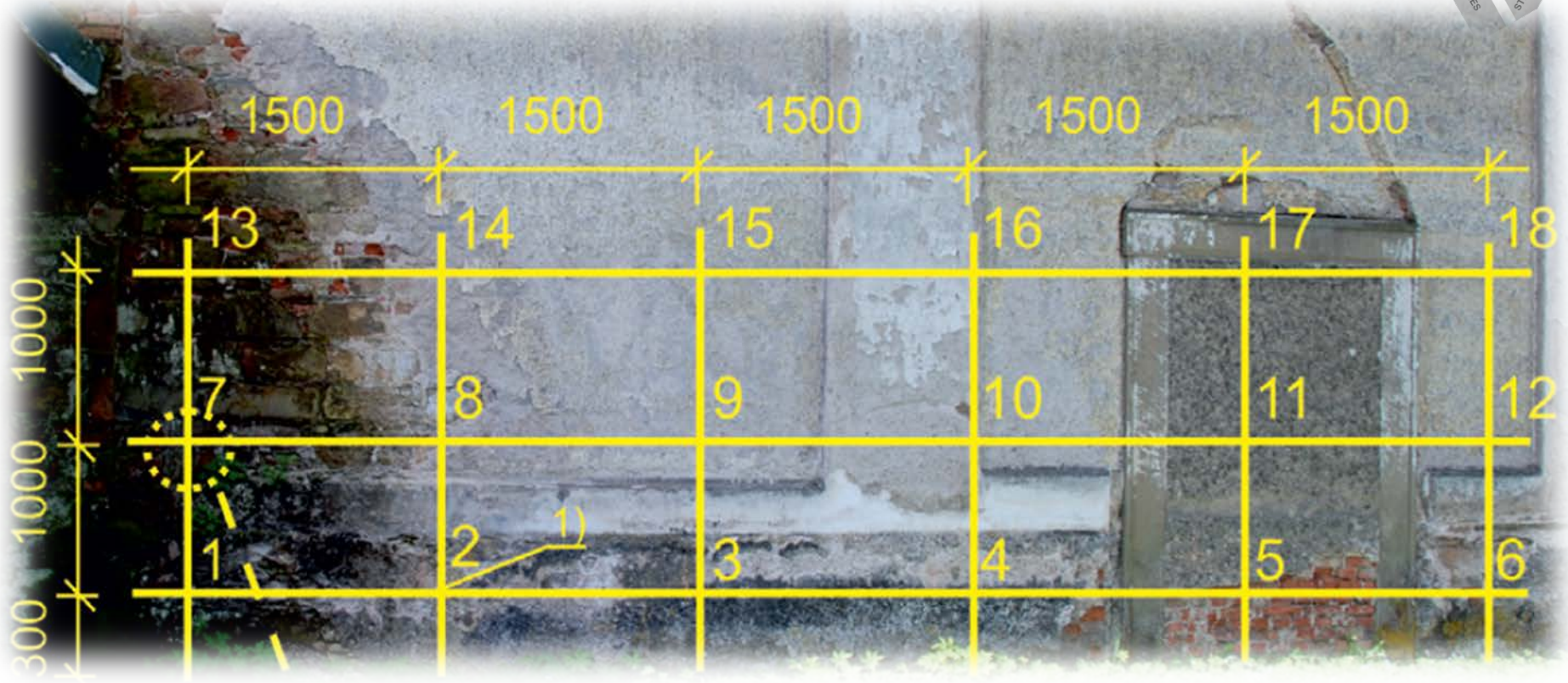
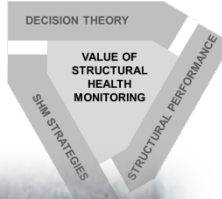
1. Calibration of NDTs by using the limited database?
All types of materials x materials individually – small samples.
2. Number of tests for components of different areas?
Spatial variability, degradation effects.
3. NDTs able to identify material non-homogeneity?
4. Distinction between preliminary and detailed assessment?
5. Quantification of related uncertainties for practical applications?

Synergies with other case study proposals

- Other TU1402 studies – to be discussed
- Similar database and needs for historic metal structures

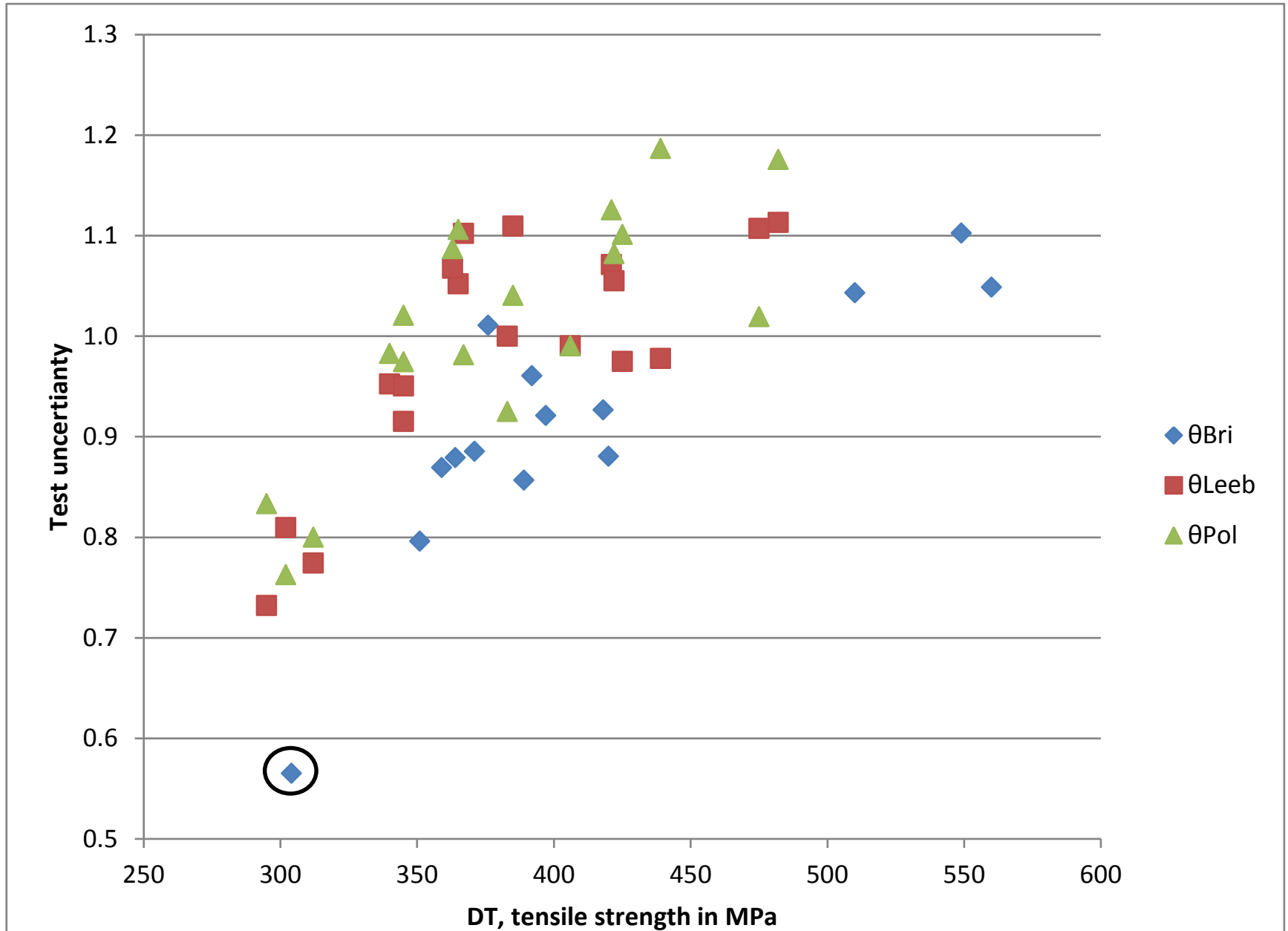


COST TU1402: Quantifying the Value of Structural Health Monitoring



Thank you for your attention.

NDT – historic metal materials - current status



NDT – historic metal materials - current status

1. Poorly calibrated methods – trends of θ with tensile strength
2. Limited dataset – indicative for methods with reduced test uncertainty?

	θ_{Bri}	θ_{Leeb}	θ_{Pol}
n	14	18	18
m	0.91	0.99	1.01
s	0.13	0.12	0.12
V	0.14	0.12	0.12

Open questions

1. Effect of a material type?

Wrought steel, different types of irons etc. – too small samples.

2. Number of tests for large structures?

Small spatial variability ($V_{fu} < 0.12$), need to detect defects.

3. NDTs able to identify material non-homogeneity?

4. Distinction between preliminary and detailed assessment?

5. Quantification of related uncertainties for practical applications?