

# TESTS ON WELDED GIRDERS

IMPERFECTIONS  
STABILITY BEHAVIOUR  
LOAD-BEARING CAPACITY  
NUMERICAL MODELLING

Gábor JAKAB, PhD Student, BME

László DUNAI, Professor, BME

Robert T. Macdonald, Principal Eng., Lindab Butler Ltd.



# Background

## I-shaped plate girders with single-sided fillet weld

### LINDAB-BUTLER:

Effect of single-sided fillet weld on

- imperfections
- different failure modes

### BME:

Fabrication simulation – virtual fabrication

Behaviour simulation – virtual tests

**EXPERIMENTAL BACKGROUND IS NECESSARY**



# Programme

## 11 Large specimens (Length: 5970 mm)

- Imperfections
- Load bearing capacity
- Stability phenomena



Effect of imperfections

Effect of single-sided fillet weld

welding



# Specimen

Specimen	Flange	Web	Weld	Length
L1	150x6	250x4	Single	5970
L2				
L3				
L4	150x6	600x4		
L5				
L6	200x10	600x4		
L7		250-		
L8		600x4		
L9	150x6	600x4	Double	
L10	200x10	600x4-8	Single	
L11		600x4		
S1	200x10	600x4	Single	2970
S2	150x6			
S3				



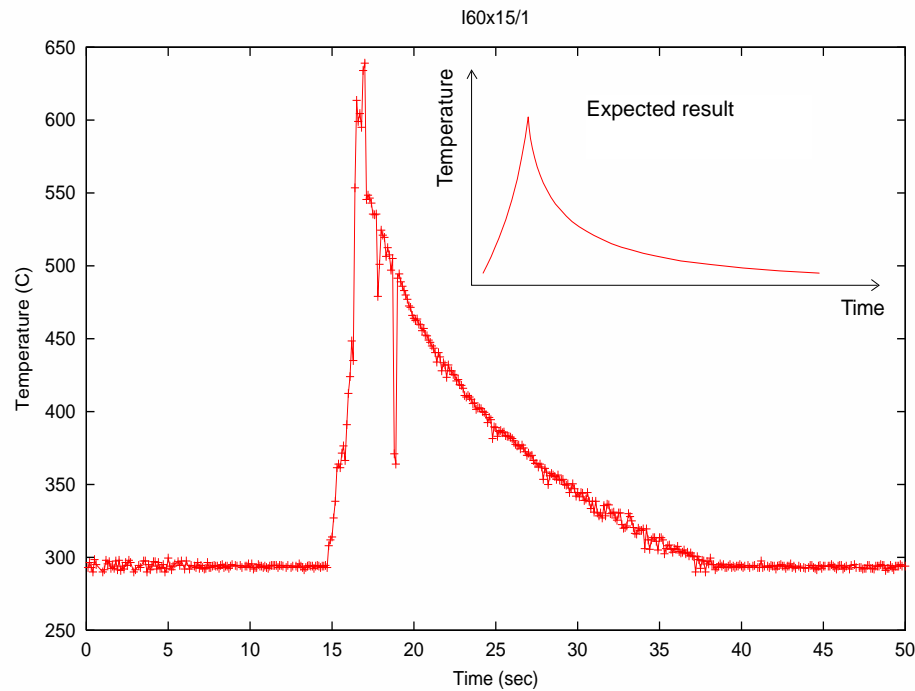




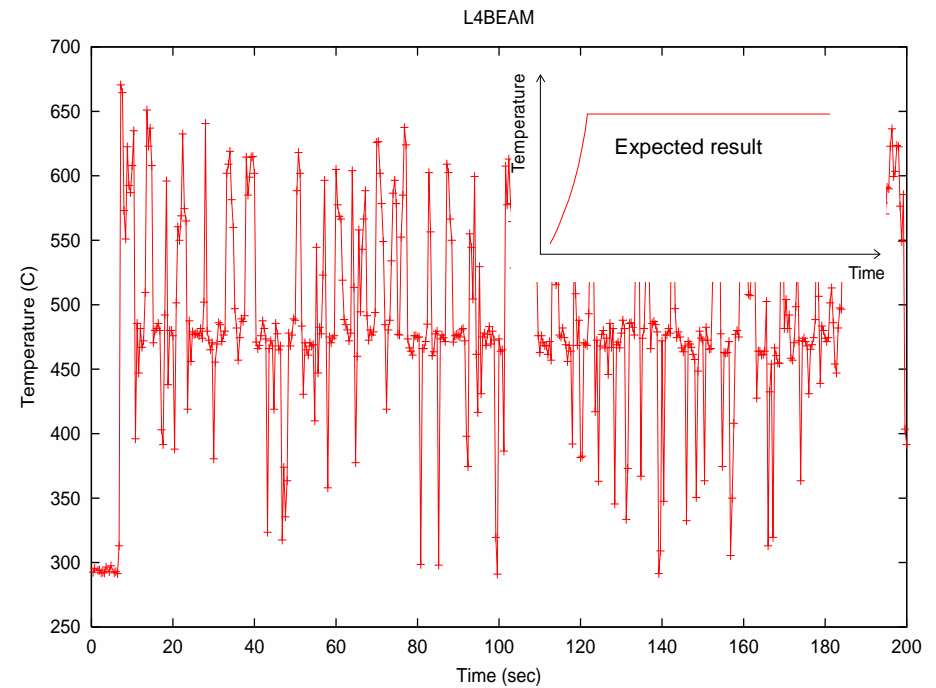
# Temperature measurements



# Measurement results

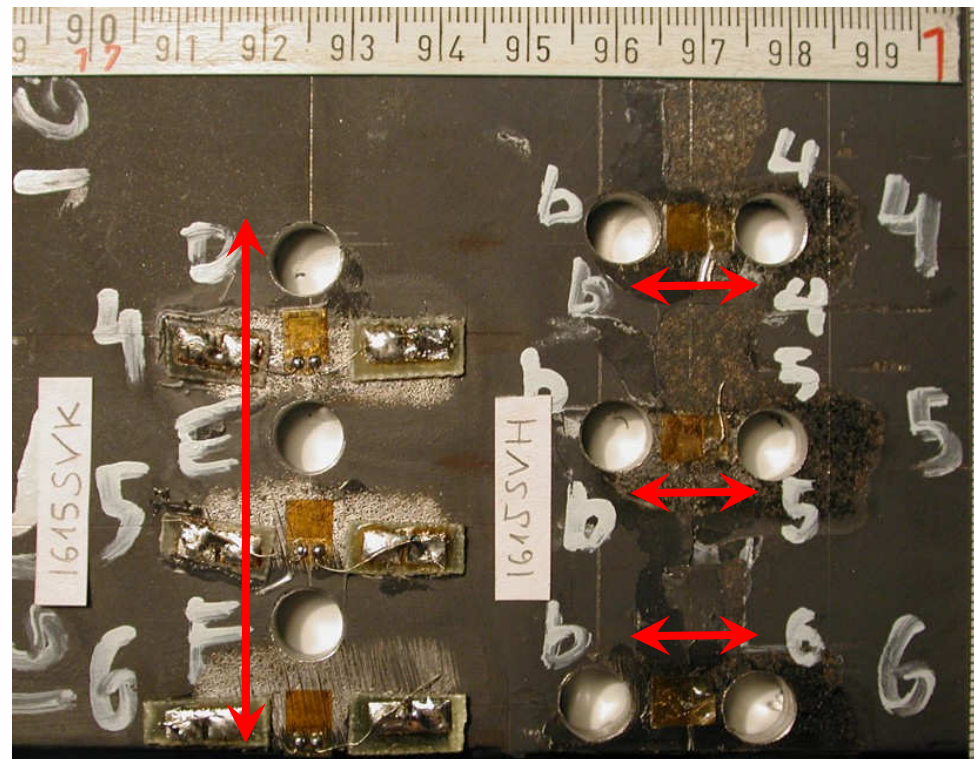


MOVING CAMERA

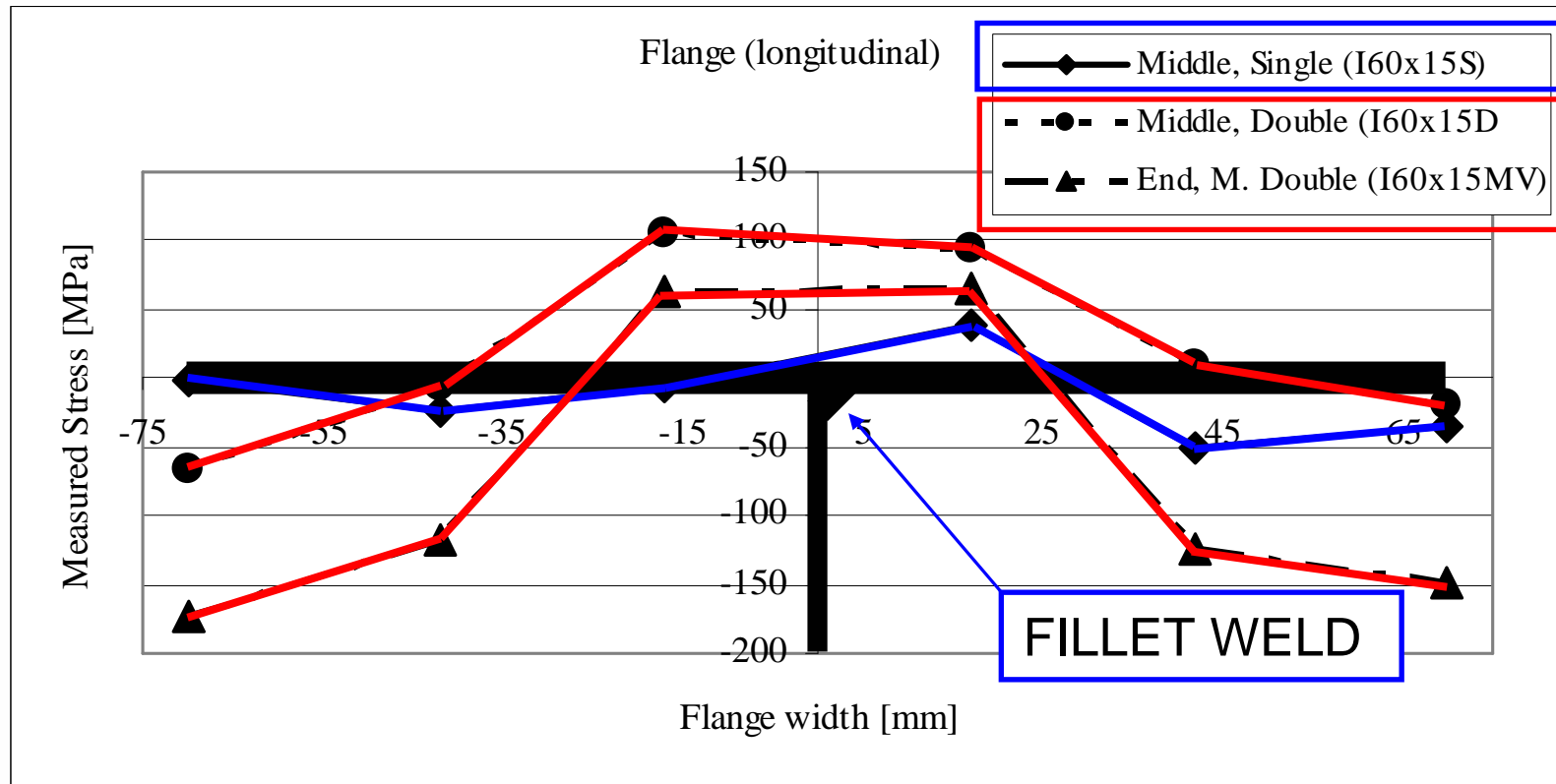


FIXED CAMERA

# Residual stress measurements



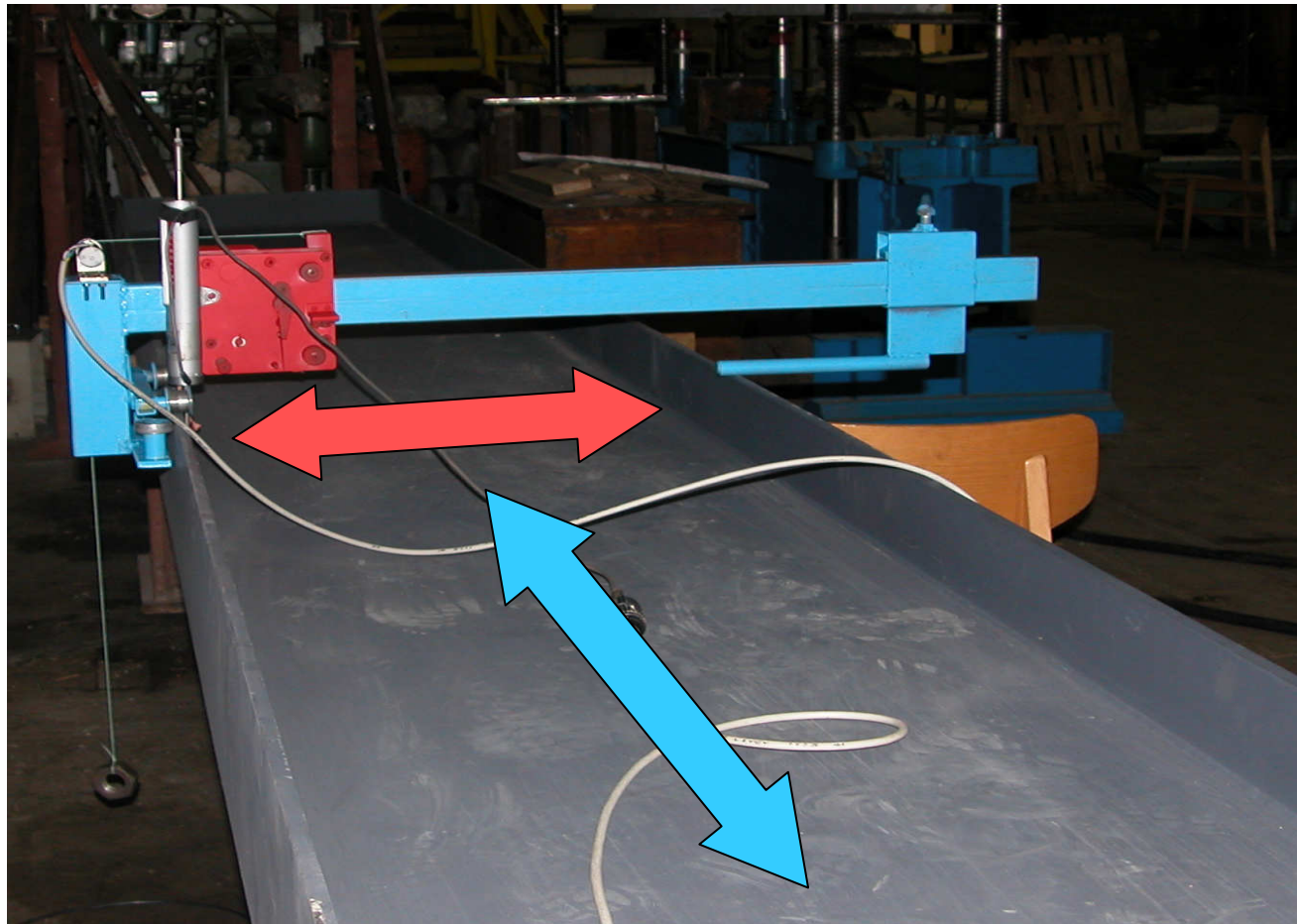
# Measurement results





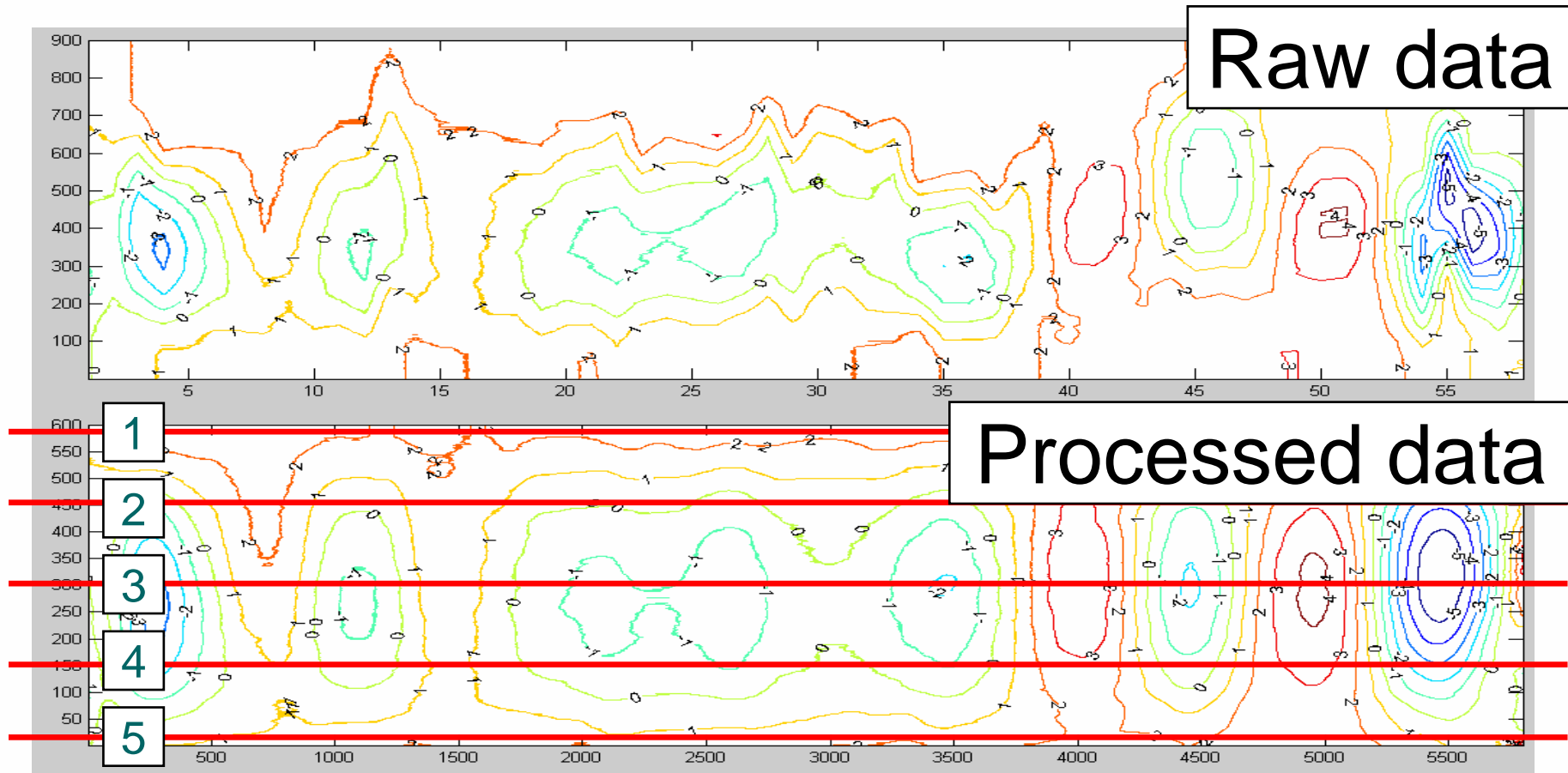


# Imperfection measurements

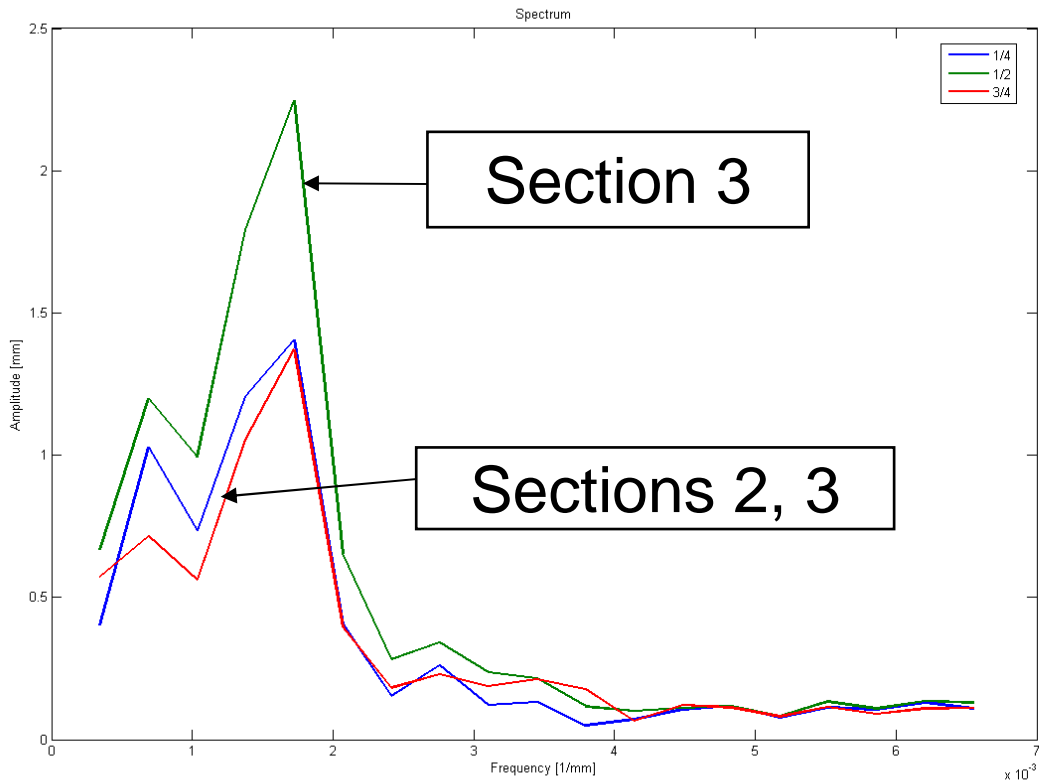




# Measurement results



# Characterising imperfections



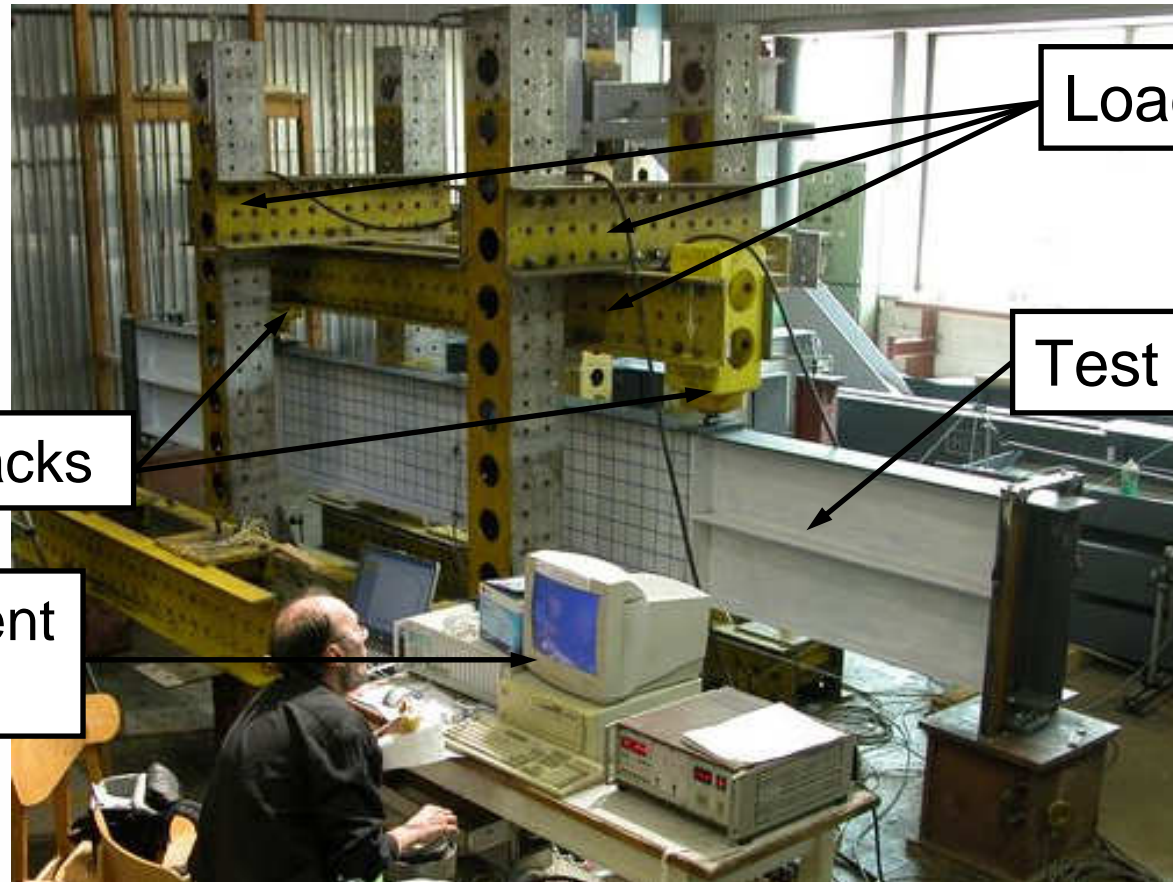
Defining wavelengths,  
amplitudes of the waves

OR

Using Fourier  
Transformation



# Test arrangement



Loading frame

Test specimen

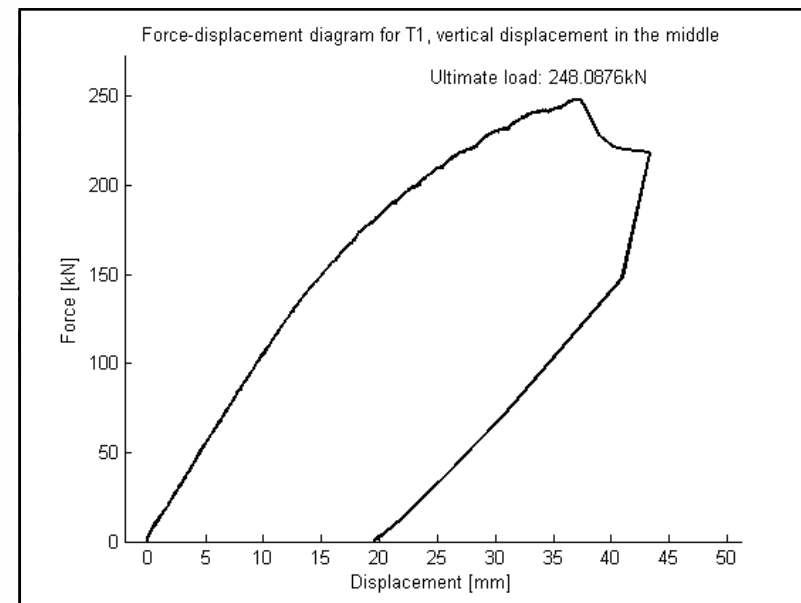
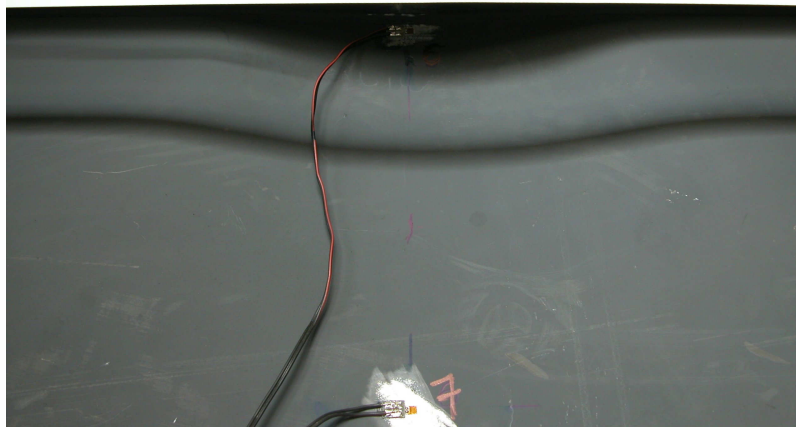
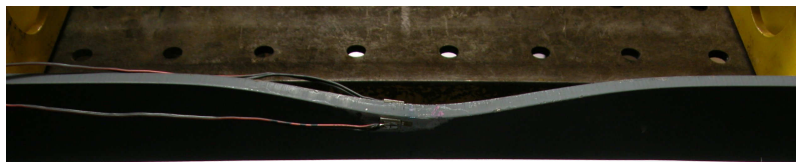
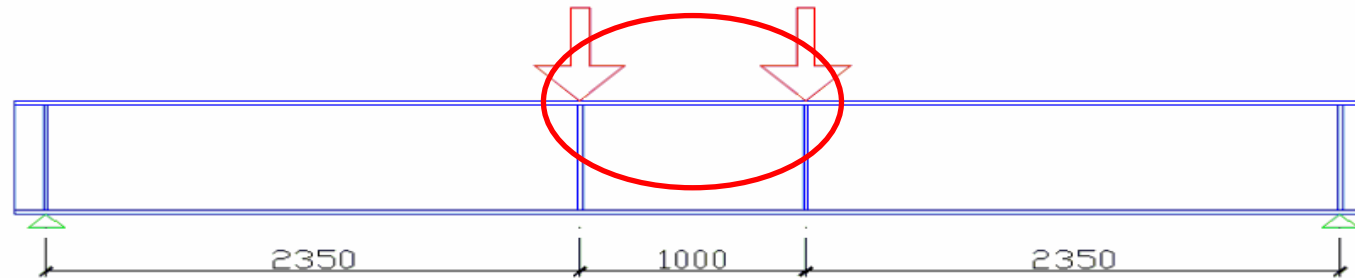
Hydraulic jacks

Measurement devices





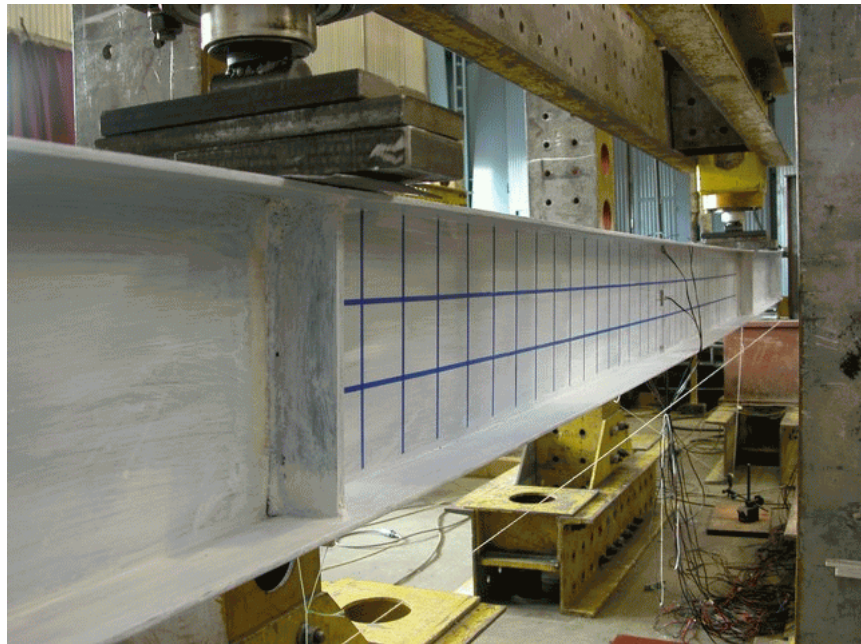
# Phenomenon – local buckling





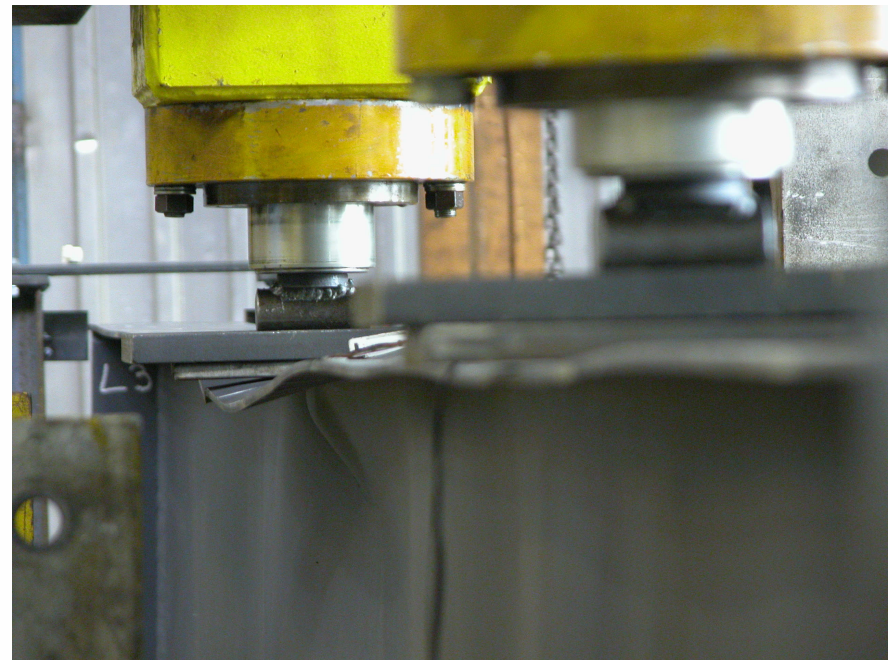
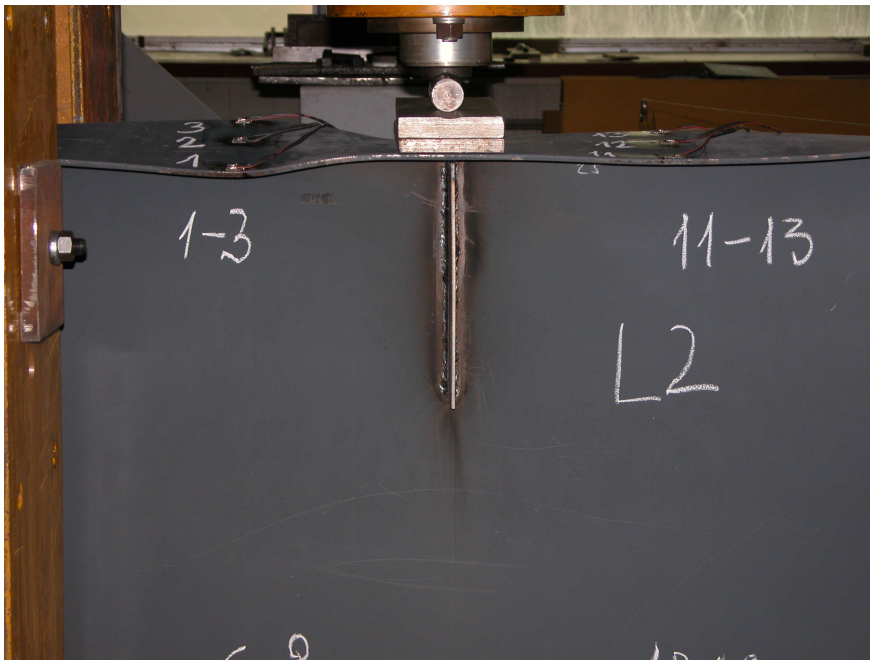


# Global phenomena





# Local phenomena

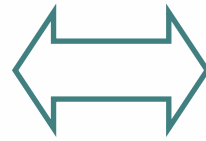






# Evaluation of test results

Test  
resistance



Standard-based  
resistance

Plate buckling: ~1.18 – 1.20

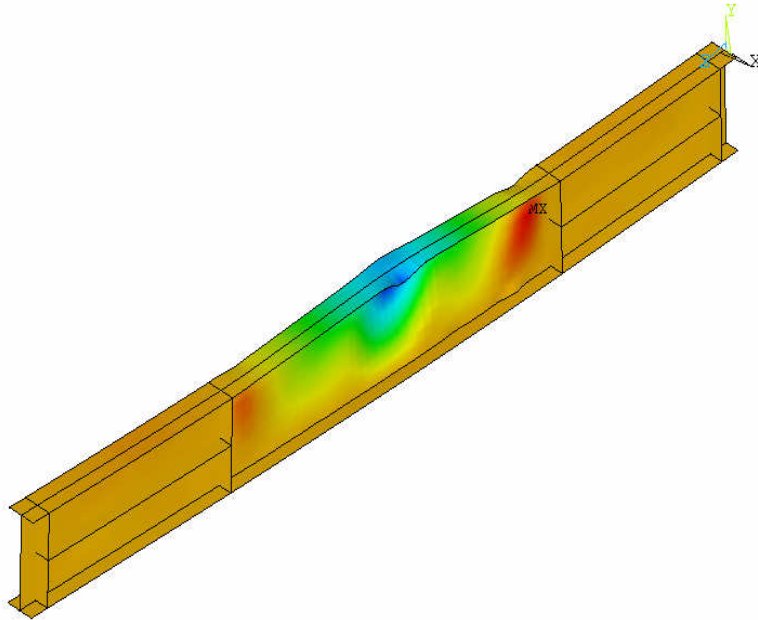
LT buckling: ~1.40 – 1.80

Shear buckling: ~2.20

Web crippling: ~1.10 – 2.00



# Numerical model



Imperfect geometry based on



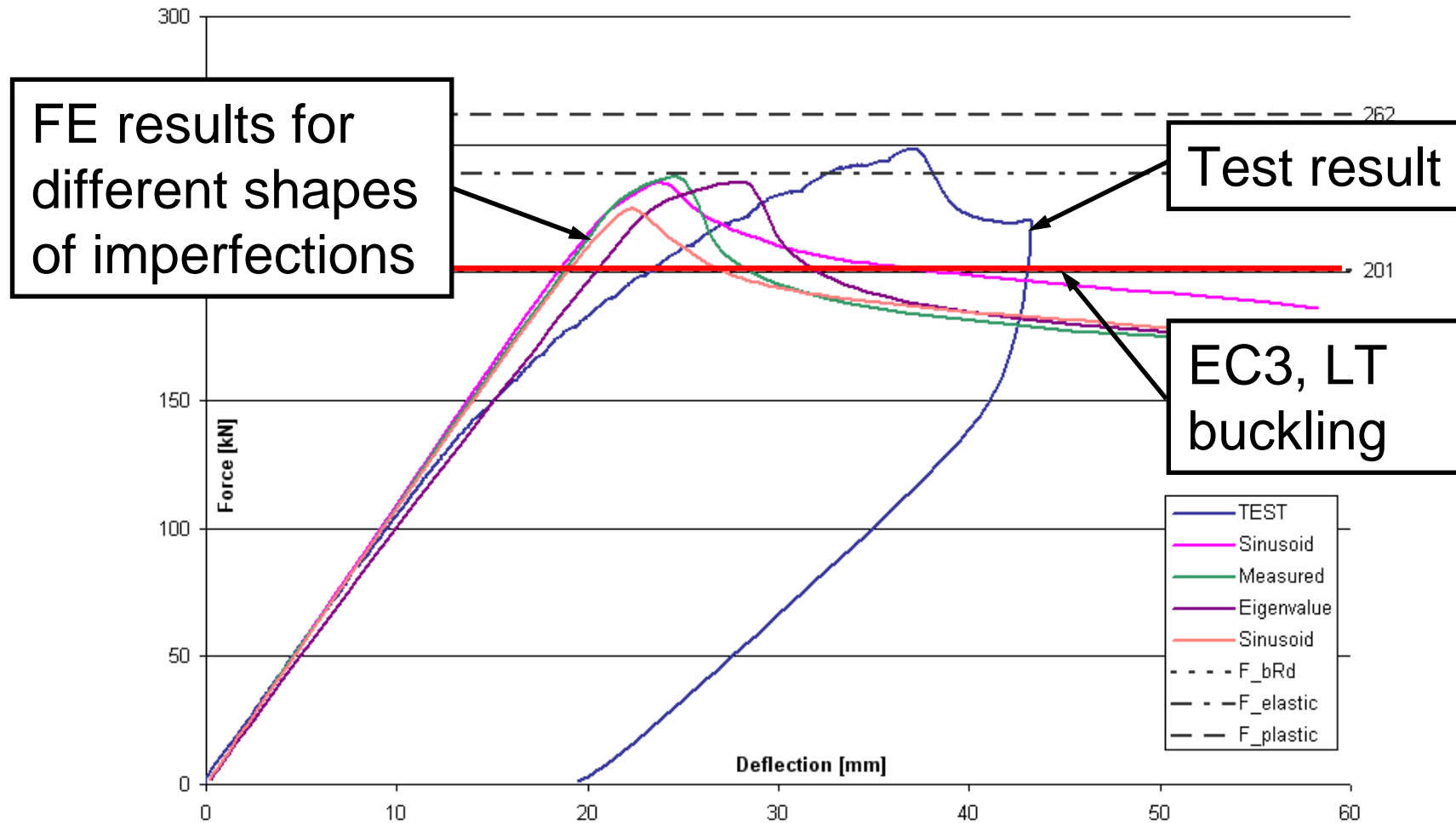
Geometrical measurements

Eigenvalue analysis

EC3 Part 1.5, Annex C



# Numerical model







# Conclusions

- Geometrical imperfections and residual stresses of specimen fabricated with single-sided fillet weld were measured.
- Local and global failure modes have been investigated on the specimens.
- No direct effect of the single-sided fillet weld on the load-bearing capacity of the specimen was observed.
- Satisfactory safety of the specimen – with significant differences for different failure modes – was obtained.
- A FE model was introduced; effect of different imperfection shapes were investigated by nonlinear simulation.



Thank you for  
Your attention!