

**TECHNISCHE  
UNIVERSITÄT  
DRESDEN**



# Experimental investigation of solid masonry walls reinforced in different directions

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- 2) The characteristics of the experiments carried out
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# 1 The aim of the test series

Aim: developing the deformation capacity of masonry shear walls with reinforcement

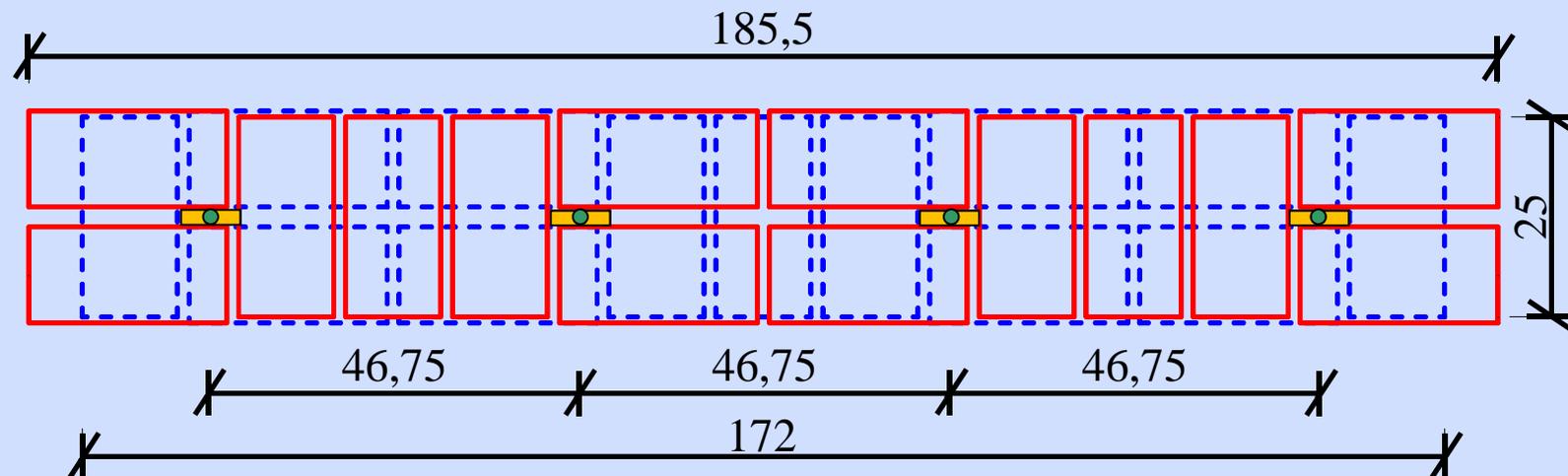
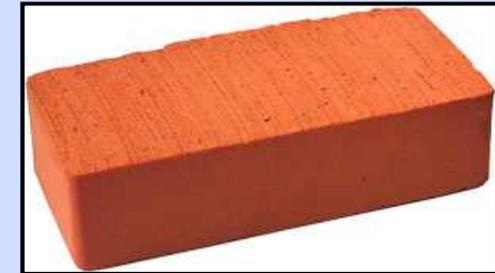
## Requirements for the walls:

- Solid → To avoid the local failure of the units
  - Clay bricks → Widespread material in Hungary
  - The same mortar in all joints
  - Without formwork
- } → Easy implementing

## 2 The characteristics of the experiments

### The new developed brick bonding

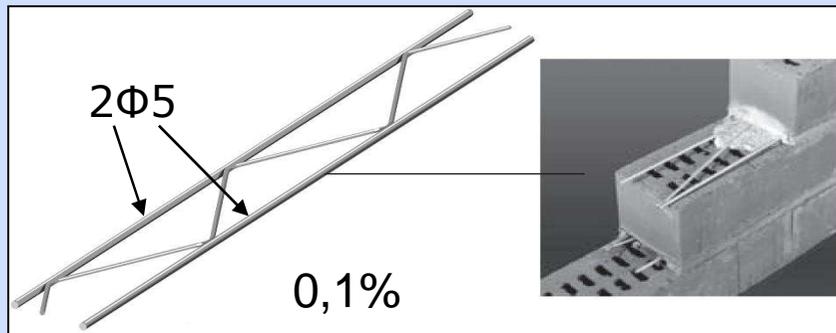
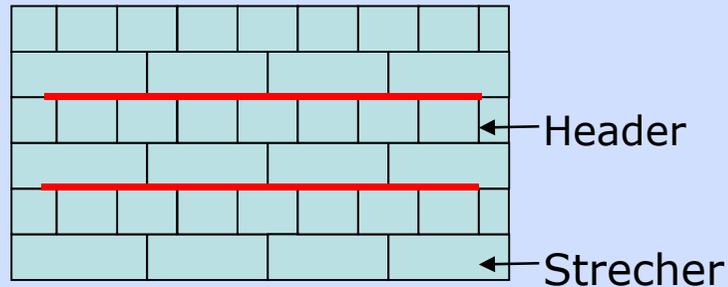
Dimensions of the unit: 250x120x65



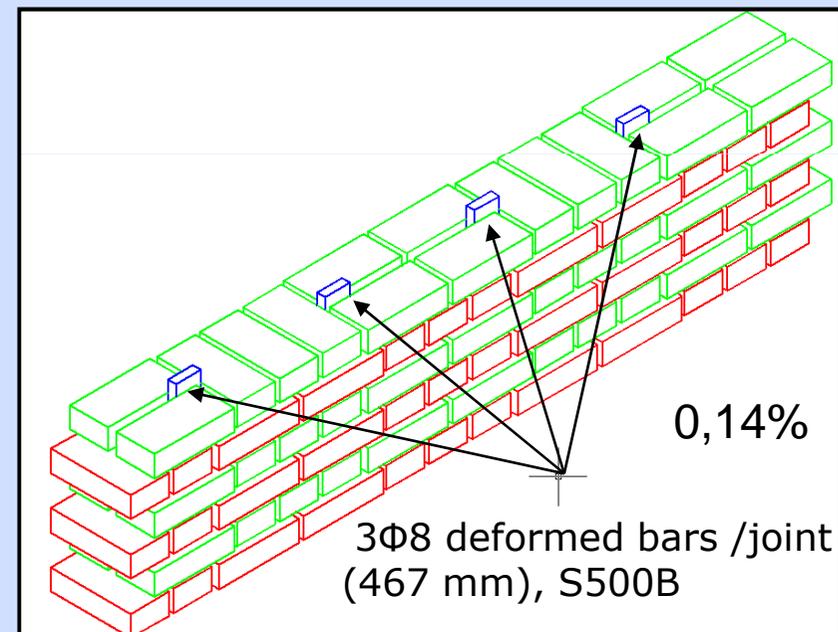
## 2 The characteristics of the experiments

### The test specimens

**For plain and horizontally reinforced masonry walls**



**For vertically and for horizontally and vertically reinforced masonry**



## 2 The characteristics of the experiments

Plain



3 walls

Vert. reinforced



2 walls

Horiz. reinforced



2 walls

Vert. and horiz.



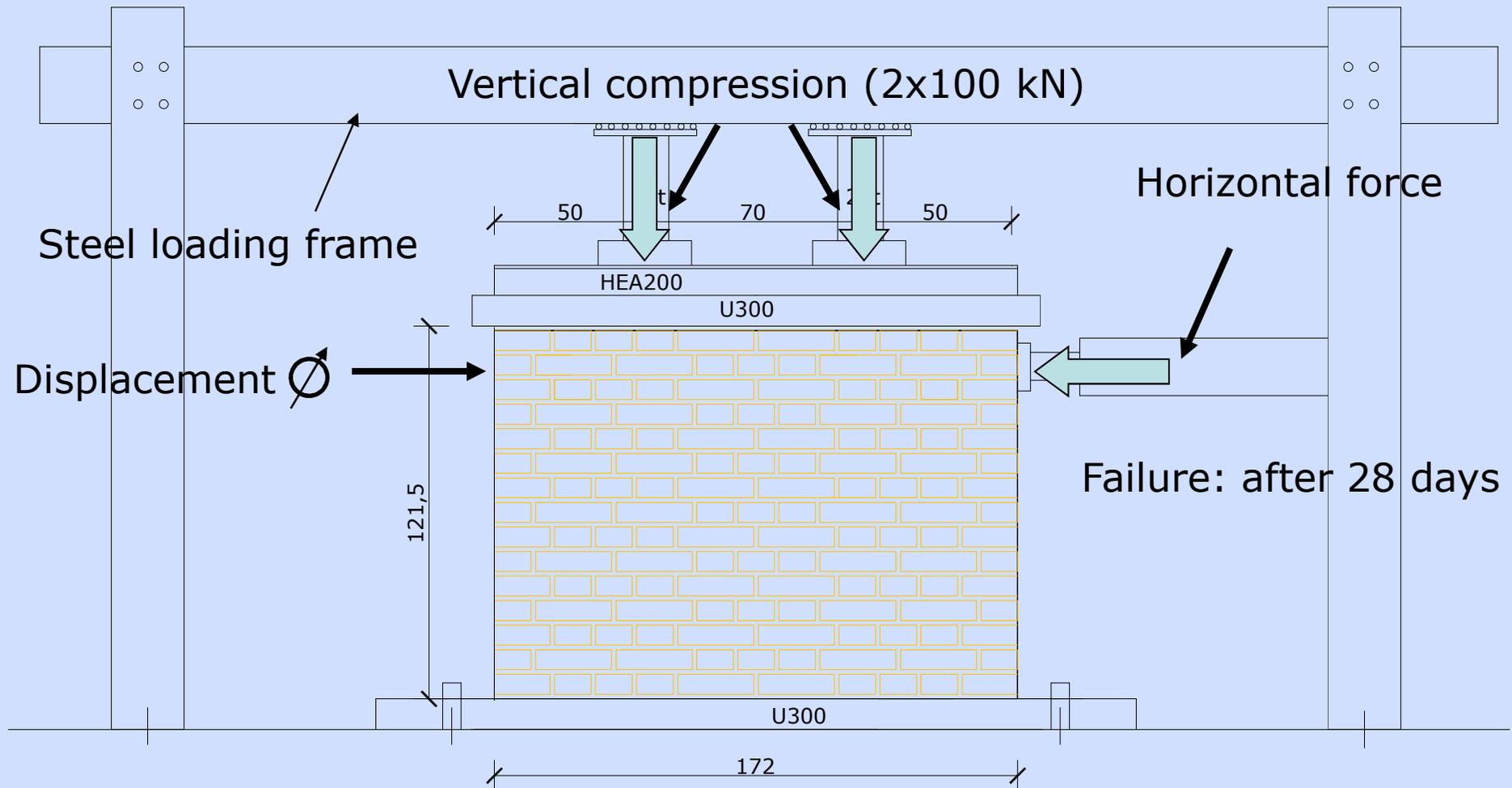
2 walls

**AIM:** for both reinforcement directions whether reinforcement can

- enhance the load bearing capacity,
- improve the deformation capacity,
- modify the width and pattern of the cracks, the type of the failure.

## 2 The characteristics of the experiments

### The layout of the test setup



## 2 The characteristics of the experiments

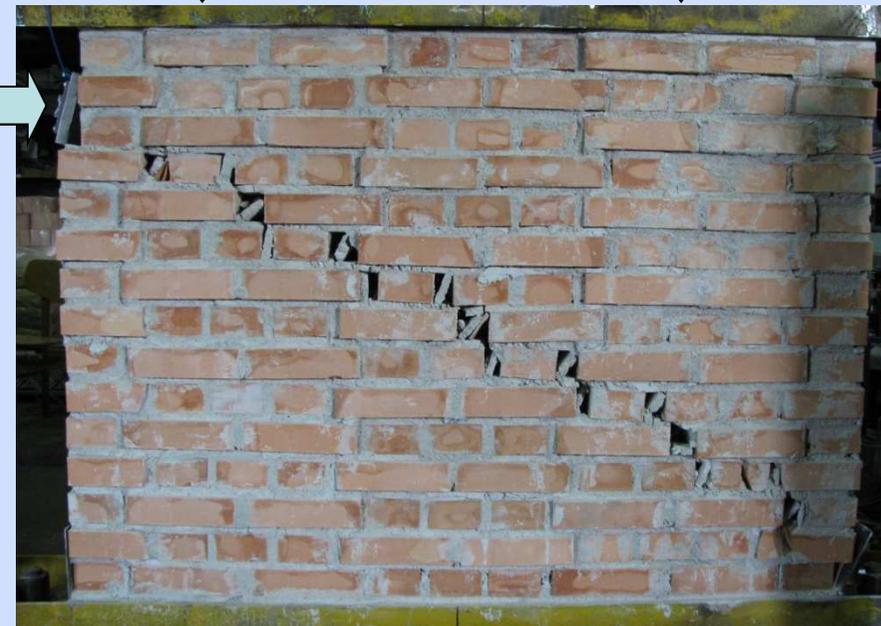
- ❑ Geometry of the walls: the same ( $H/L=0,7$ )
- ❑ Vertical compressive force: constant, 200 kN
- ❑ Type of the brick: the same (mean compressive strength:  $10 \text{ N/mm}^2$ )
- ❑ Amount, shape, type and placement of the reinforcement were the same in one direction
- ❑ Two types of mortar:
  - ❑ the compressive strength of the mortar is less ( $3 \text{ N/mm}^2$ ) than that of the brick ( $10 \text{ N/mm}^2$ )
  - ❑ and it is the same  
(M30-weaker and M100-stronger mortar)

### 3 Presentation of the results

#### Crack pattern of walls with weak mortar



Plain masonry wall



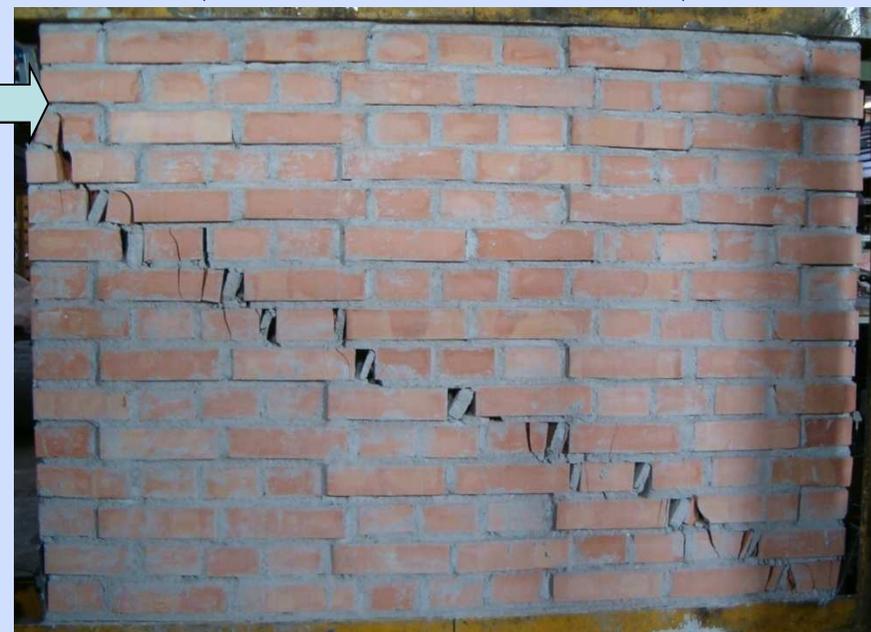
Vertically reinforced masonry wall

### 3 Presentation of the results

#### Crack pattern of walls with strong mortar



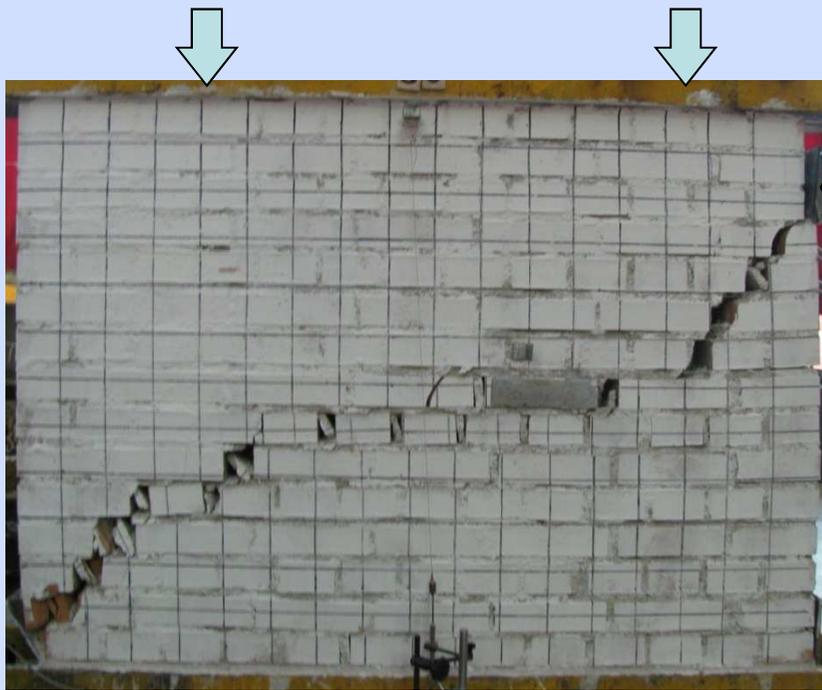
Plain masonry wall



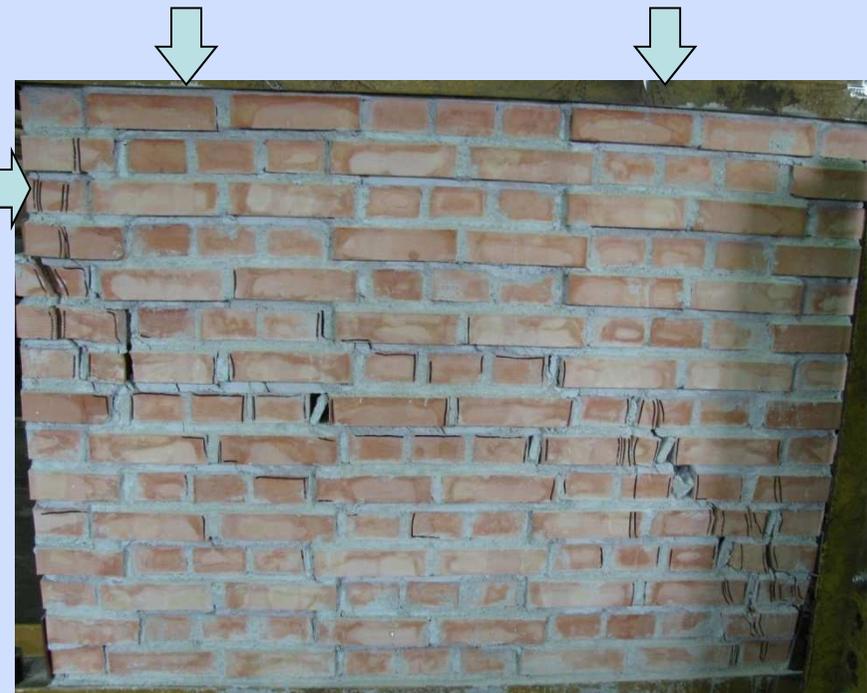
Vertically reinforced masonry wall

### 3 Presentation of the results

#### Crack pattern of walls with weak mortar



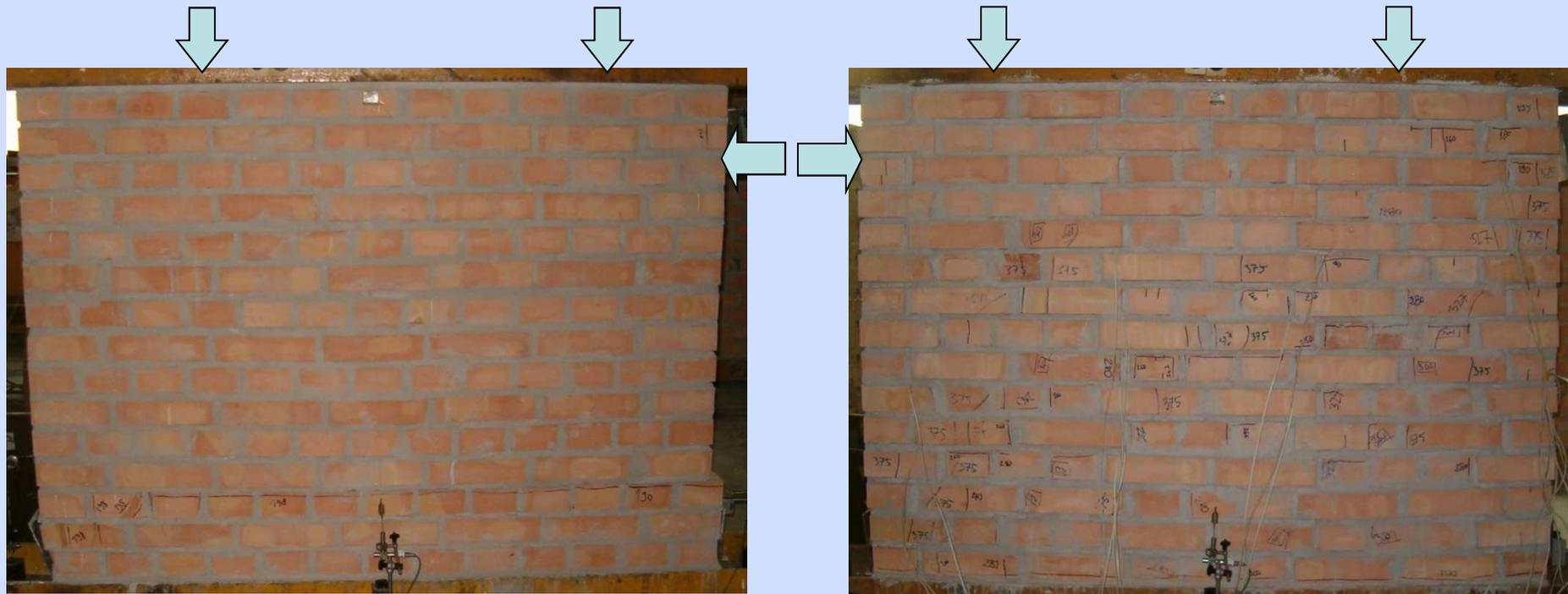
Horizontally reinforced masonry wall



Horizontally and vertically reinforced masonry wall

### 3 Presentation of the results

#### Crack pattern of walls with strong mortar

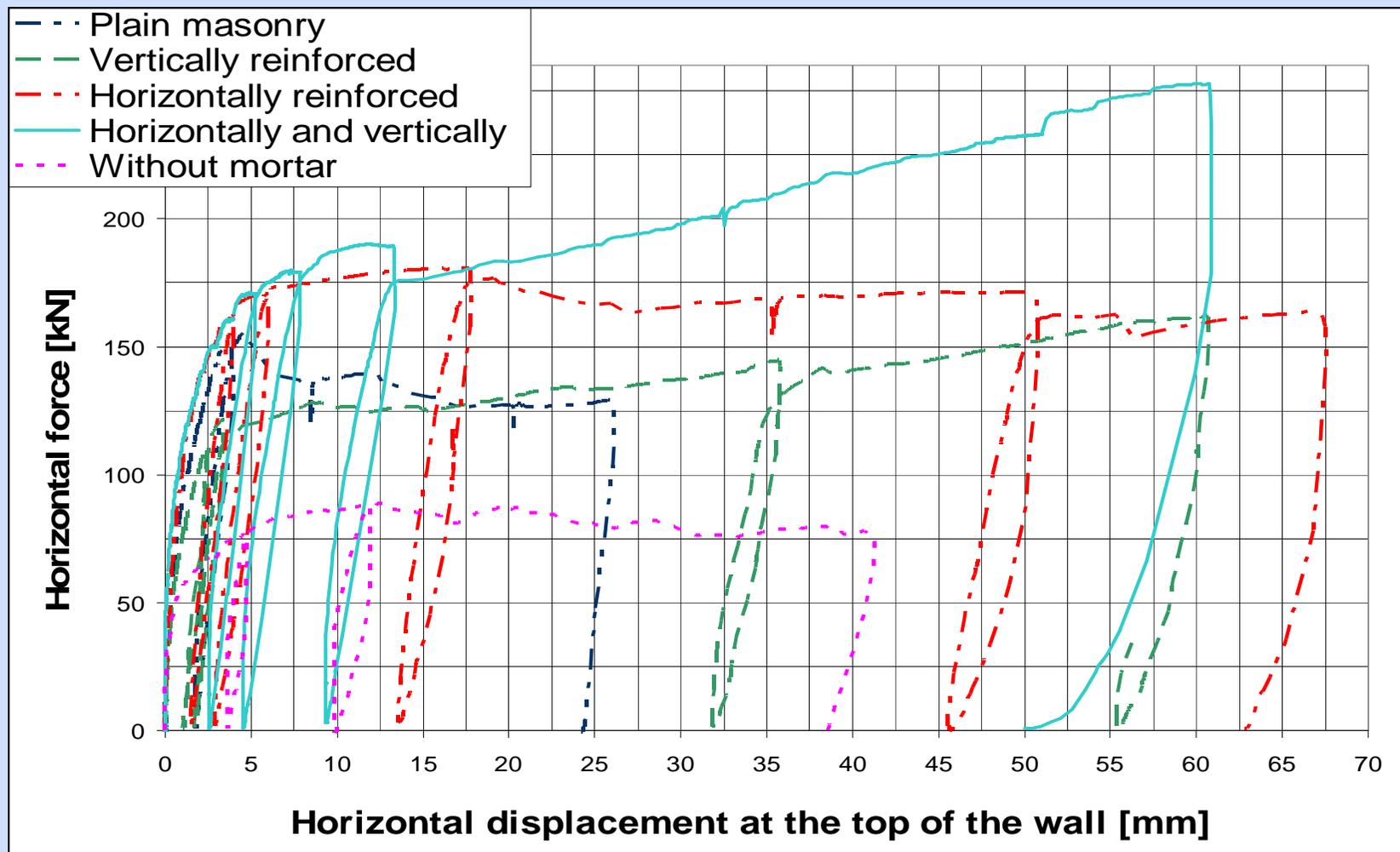


Horizontally reinforced masonry wall

Horizontally and vertically reinforced masonry wall

# 3 Presentation of the results

## Horizontal force vs. horizontal displacement for weak mortar walls



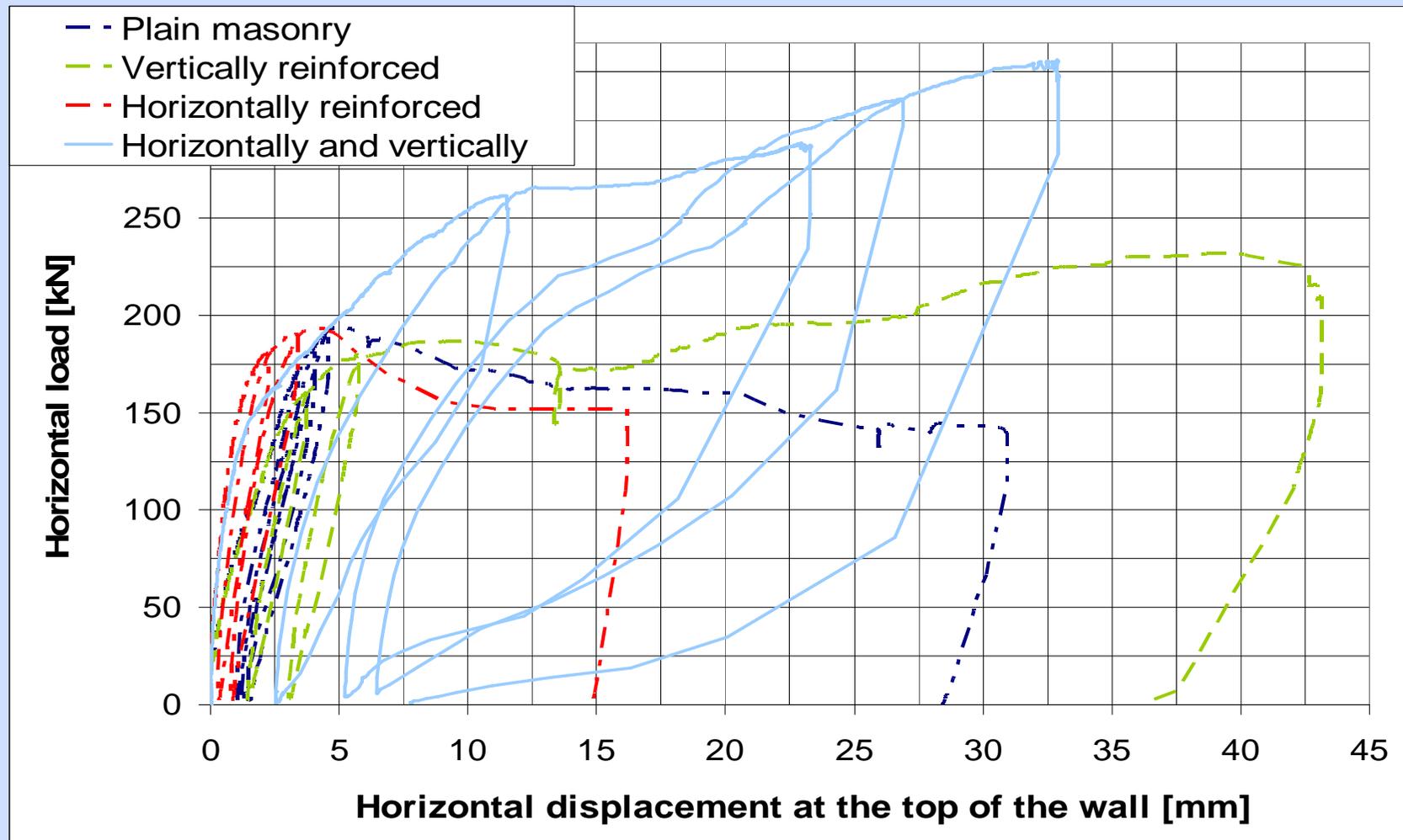
### 3 Presentation of the results

#### Summary for weak mortar walls

Type of the wall	Appearing first crack		Maximal load		Maximal displacement (residual force)	Forces belonging to 25 mm displacement
Plain masonry without mortar			89 kN	12.6 mm	41 mm (76 kN)	80 kN
Plain masonry	145 kN	3.2 mm	154 kN	4.6 mm	26 mm (129 kN)	128 kN
Vertically reinforced	121 kN	3.4 mm	161 kN	60.7 mm	60 mm (161 kN)	133 kN
Horizontally reinforced	173 kN	6.6 mm	180 kN	16.9 mm	67 mm (163 kN)	166 kN
Vertically and horizontally reinforced	176 kN	6.5 mm	252 kN	60.8 mm	60 mm (252 kN)	189 kN

# 3 Presentation of the results

## Horizontal force vs. horizontal displacement for strong mortar walls



### 3 Presentation of the results

#### Summary for strong mortar walls

Type of the wall	Appearing first crack		Maximal load		Maximal displacement (residual force)
Plain masonry with weak mortar	145 kN	3.2 mm	154 kN	4.6 mm	26 mm (129 kN)
Plain masonry with strong mortar	180 kN	3.7 mm	193 kN	4.8 mm	31 mm (143 kN)
Vertically reinforced	176 kN	5.3 mm	231 kN	39 mm	42 mm (231 kN)
Horizontally reinforced	192 kN	4.4 mm	193 kN	4.4 mm	38 mm (171 kN)
Vertically and horizontally reinforced	200 kN	5.0 mm	331 kN (378 kN)	32 mm	32 (38) mm 331 kN (378 kN)

## 4 Conclusions

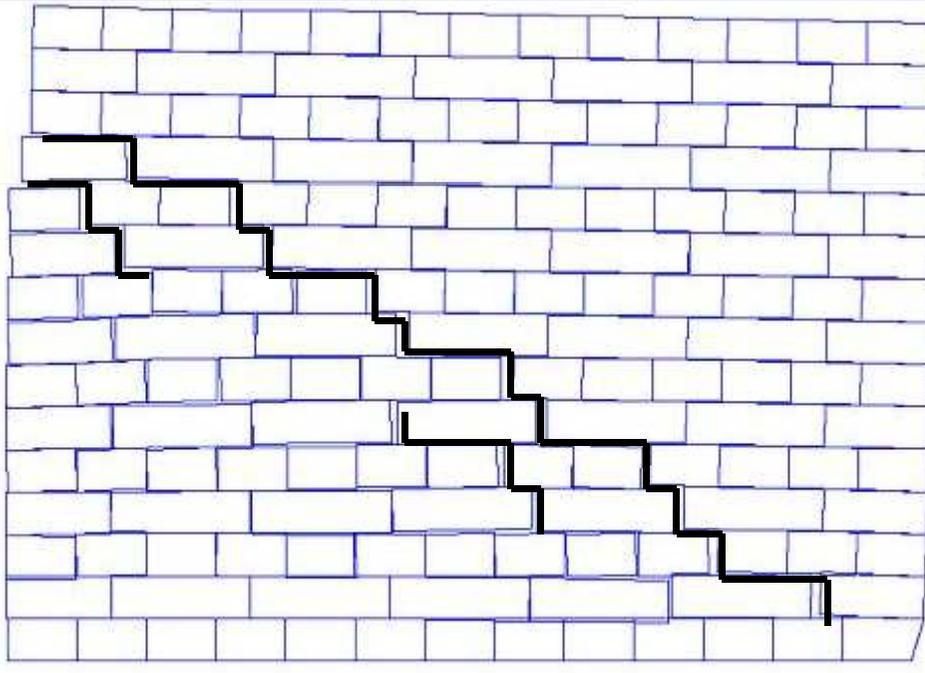
- The favourable influence of the mixed reinforcement is clearly shown. The crack pattern modification effect and the shear capacity enhancement of reinforcement are unambiguously proved.
- Altogether, the new bond wall with reinforcement in both directions has much more ductility, deformation and shear capacity than others. It is capable to decrease crack width and cracks are not that concentrated to a diagonal strut.
- With this construction method of walls the deformation capacity can be enhanced particularly and a high increase in shear capacity can be achieved.

# 5 Further plans - Developing of the discrete element model

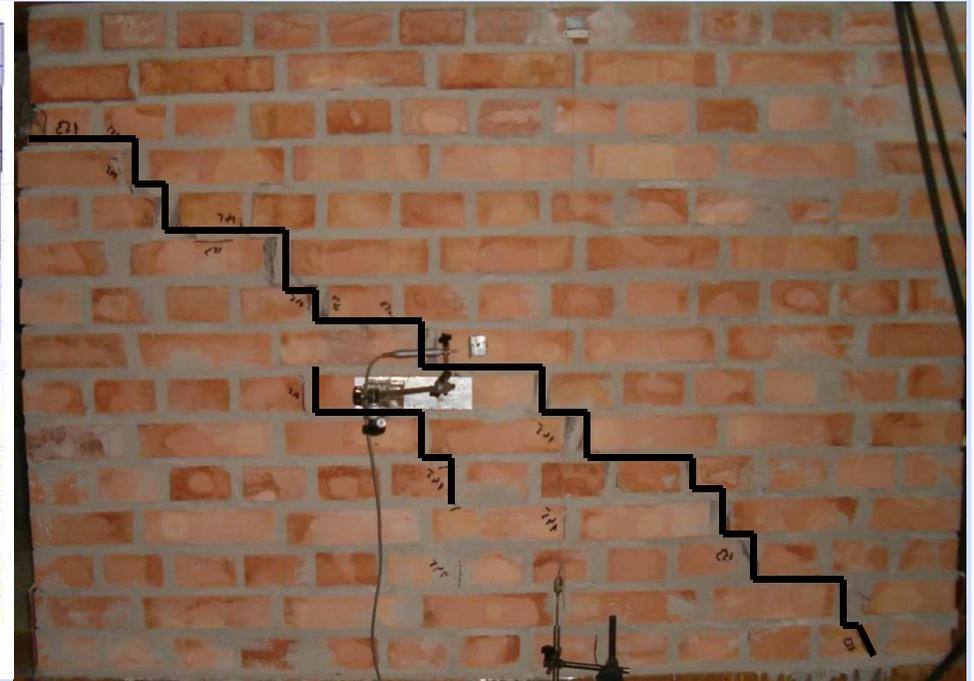
## Results for plain masonry with weak mortar

Displacement at the top: 32 mm  
in case of 120 kN horizontal load

Displacement at the top: 26 mm  
in case of 130 kN horizontal load



Deformed shape from model

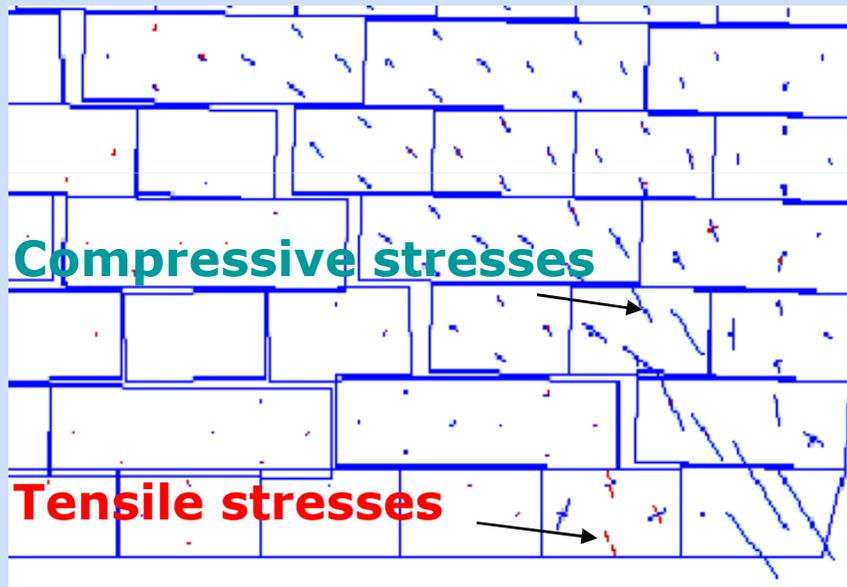


Real failure

# 5 Further plans - Developing of the discrete element model

Results for plain masonry with weak mortar

Displacement at the top: 32 mm  
in case of 120 kN horizontal load



Principal stresses from model

Displacement at the top: 2,6 cm  
in case of 130 kN horizontal load



Real failure



# Thank you for your kind attention!

