

# Long-term behaviour of reinforced concrete panel walls

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## Long - Term Behaviour of Reinforced Concrete Panel Walls

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### Summary

Most of multifamily buildings constructed in large panel technology in Poland have outer façade precast layer fixed by special steel links. These buildings are actually thermally inefficient. There are also noticed certain failure of the façade plates. Additional thermal insulation requires evaluation of strength and technical conditions of the external plate and links coupling with the bearing precast wall.

Paper presents some results of investigation and analysis of outer precast panel in large panel building constructed in OWT system in Białystok.

### 1. Introduction

Within last four decades in Poland were constructed tenfold thousands of multistories RC large paneled buildings. Most of the buildings have RC composite three layered external wall where outer façade plate is suspended with steel links to the structural bearing plate.

New requirements in respect of energy saving solution proved that these buildings are thermally inefficient, besides some problems related to safety of the external façade plates arose recently [1], [3].

Evaluation of strength and technical condition of the outer façade plates and steel links coupling with the bearing part of the wall became indispensable in view of currently realized additional thermal insulation. Paper presents results of investigations and assessment of technical state of the outer RC façade plate in multifamily buildings constructed in large panel system OWT in Białystok.

### 2. Results of testing

768 wall large panels were investigated directly in the buildings where twelve suspension steel links  $\phi 12\text{mm}$  coupling outer façade plate with bearing part of the wall were uncovered and tested.

Twelve insignificantly damaged wall panels prefabricated within period when buildings were constructed still remained on the stockyard were investigated in the precast yard.

The following incorrectness, defects and failures of the built-in RC façade plates in investigated buildings were detected and discovered:

- at about 40% of investigated panels had visible cracks width of ~1.5mm and external failure of concrete,
- damaged corners of the panels and uncovered already corroded reinforcement,
- significant loss of granulated grit externally covering the façade plate,
- varying thickness of the outer plate differing in 2.5 - 5.0 cm,
- heterogeneous not uniform and porous structure of concrete,
- low quality of concrete class evaluated in the range of 7.5 - 12.5MPa,
- delamination of concrete in the façade plate,
- insufficient thickness of cover layer for reinforcing wire at the thermal insulation side. In limiting cases no cover at all,
- initial phase of corrosion in uncovered reinforcement of façade plate,
- reinforcement and link bar  $\phi 8\text{mm}$  anchoring coupling link  $\phi 12\text{mm}$  are directly placed on thermal insulation without any cover of concrete,
- partial melting or completely melt out polystyrene insulation around the coupling links  $\phi 12\text{mm}$  (~25% of investigated links),
- concrete plugs around the coupling links on all thickness of the thermal insulation layer.

Some evident defects of anchoring and coupling links were discovered:

- 40% of investigated links have no protecting cover of concrete from outside,
- the thickness of corrosion in coupling links were 0.5 mm,
- deviation of coupling links  $\phi 12$  from vertical position were at about  $30^\circ$ ,
- coupling links were placed and arranged inconsistently to the design arrangement,
- bars  $\phi 8\text{mm}$  linking and anchoring suspension hangers  $\phi 12\text{mm}$  were often placed directly on the thermal insulation, hence there's no required bond of surrounding concrete.

Resembling the above defects were detected in large panels in the precast yard. Remarkable in many investigated panels lack of cover for reinforcement at the thermal insulation side or inadequate its thickness were noticed in many outer façade plates.

### 3. Conclusion

- construction and materials defects of RC façade plate create different working condition than those foreseen on the stage of design,
- detected degree of corrosion in the coupling links does not reduce their bearing capacity,
- poor quality of concrete in the façade plate, its delamination and low strength creates inadequate anchorage of coupling links,
- insufficient concrete cover of reinforcement in façade plate, cracked and damaged concrete can lead in result to withdrawal of reinforcing wire mesh and failure of the plate,
- the façade plate left in existing state may lead to continuously progressive corrosion of reinforcement and concrete and destruction of all wall panel in result,
- additional thermal insulation improves thermal and moisture conditions in the panel but it cannot be anchored in the façade plate,
- large panelled wall should be investigated and analysed in respect of future anchorage and its technical state before construction of new façade layer with additional thermal insulation.