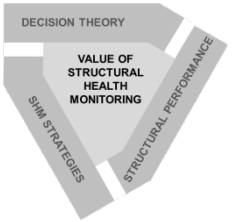
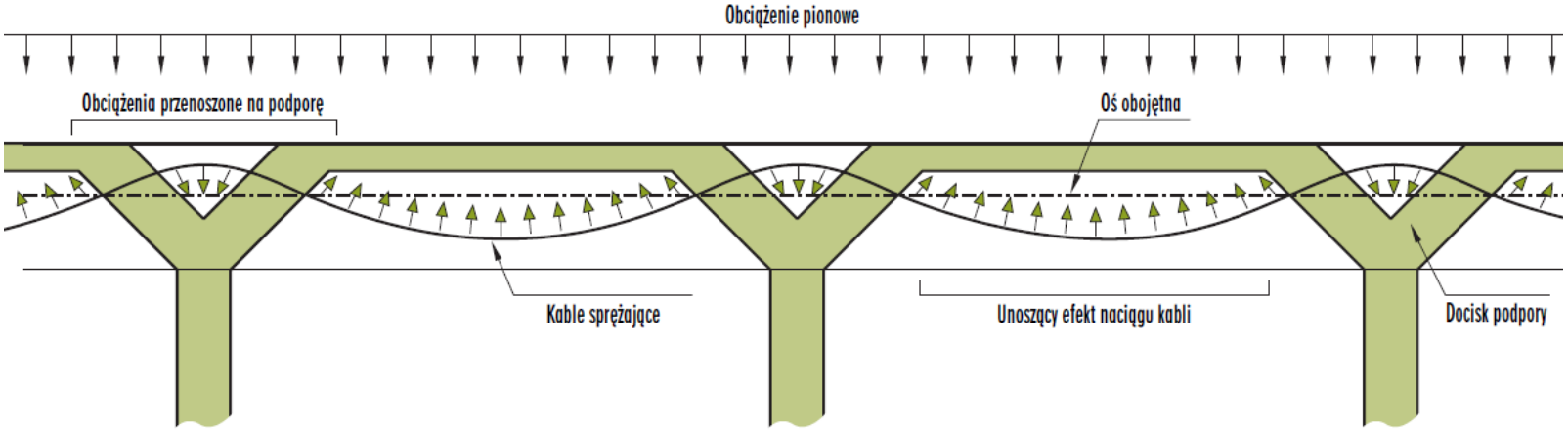
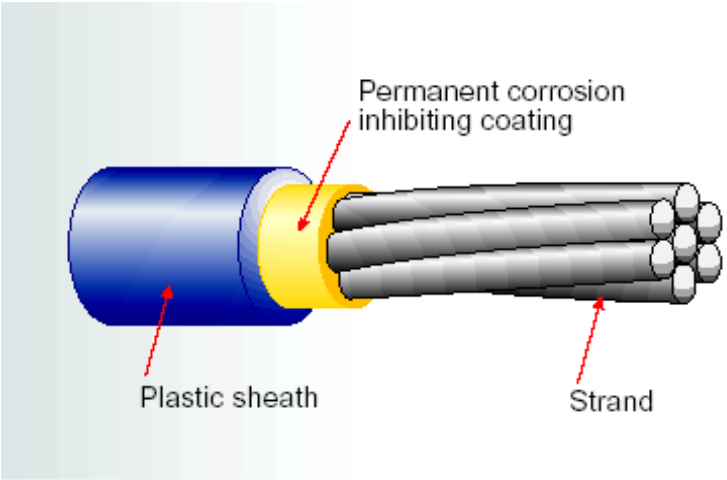


Monitoring of prestressed concrete slab with unbonded tendons during erection and in service

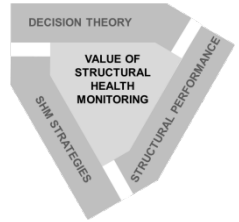
Rafal Szydlowski, Maiusz Maslak, Michal Pazdanoski
Cracow University of Technology

Prestressing action on structure

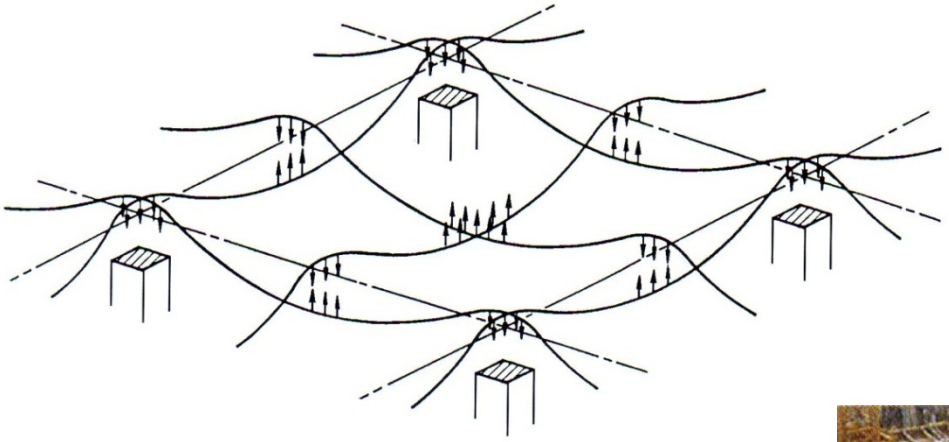


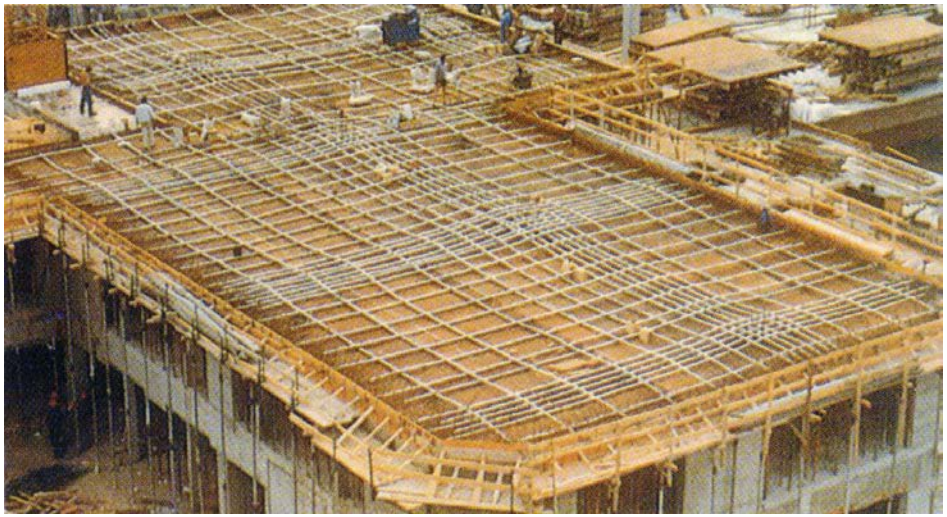


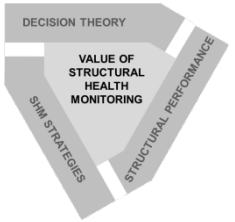
Unbonded tendon



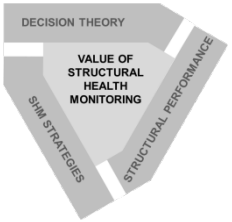
Tendon layout and action in two-way slab





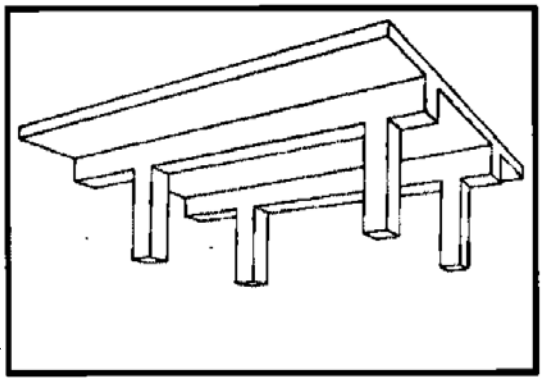


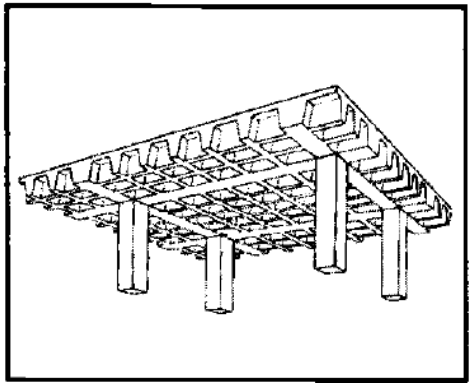
- The slabs prestressed with unbonded tendons have been realised all over the world for several decades,
- a lot of guidelines and recommendations have been issued for this time,
- one of the most important parameter is the slab slenderness (span/depth).

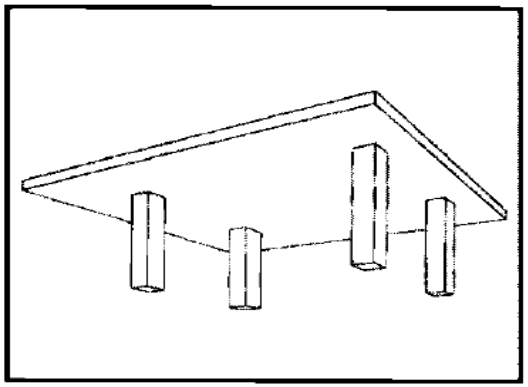


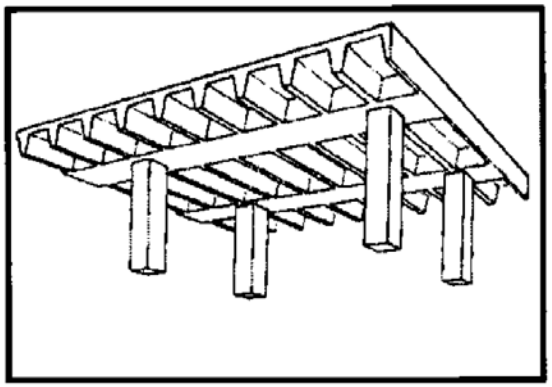
Span/depth ratio according to Khan i Williams

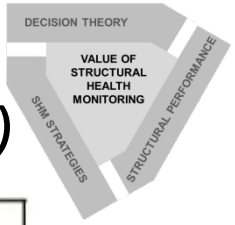
Slab type	Span/depth
One-way solid slab	30÷45
Ribbed slab	25÷35
Solid flat slab	35÷45
Waffle slab	20÷30





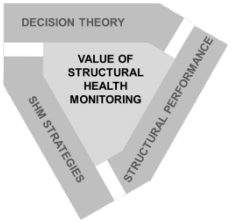






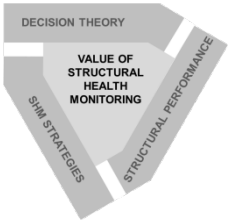
Maximum reccomended span according *fib (Bulletin No 31)*

Type of slab			Imposed load, kPa	Depth mm	Maximum recommended span, m (0 2 4 6 8 10 12 14)
Solid slab	One-way	Simply supported	1,75	200	
				300	
			4,0	200	
				300	
		Continuous, interior span	1,75	200	
				300	
			4,0	200	
				300	
	Two-way	Simply supported, span ratio ≈ 1:1	1,75	200	
				300	
			4,0	200	
				300	
		Continuous, interior span, span ratio ≈ 1:1	1,75	175	
				250	
			4,0	175	
				250	
Waffle slab		Span ratio 1:1	1,75	200	
				300	
			4,0	200	
				300	
		Span ratio 1:1,5 (recommended *longer* span)	1,75	200	
				300	
			4,0	200	
				300	



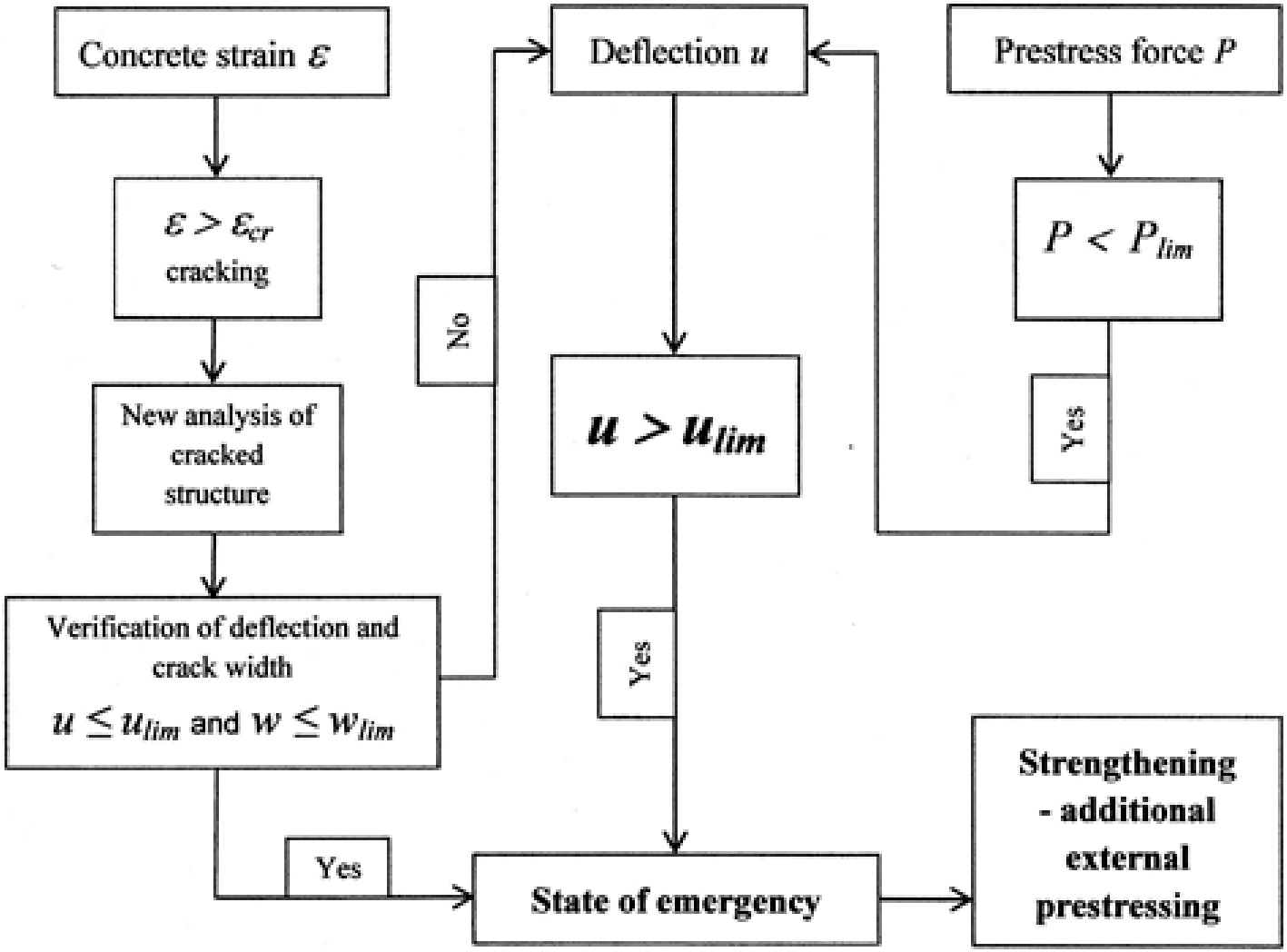
Some conclusions:

- Maximum recommended span/depth ratio is 45 (for solid one-way and two-way flat slabs),
- maximum recommended span is 12,3 m for one-way and 13,8 m for two way-slab,
- most of the built slabs all over the world doesn’t exceed 12,0 m span length,
- slabs of larger span are constructed very rarely and with additional construction and material solutions,
- for above reasons, it is hard to find an example of realisation of solid prestressed slab counstructed with common used concrete of the span higher than 12 m.



- calculation and estimation conducted in Cracow University of Technology indicated that it is possible to construct more effective structures and several attempts have been made for last years,
- because of recommended values have been strongly exceeded, despite provide all the required conditions in computer calculation, monitoring system was installed and operation procedure in spite of emergency was prepared,
- Because recommended values have been strongly exceeded, despite of providinig all the required conditions in computer calculation, monitoring system was installed and operation procedure for case of emergency state was prepared,
- additionally, obtained possitve results can be useful in further designing and improving the structures.

Algorithm for action when the critical values are reached



Base of measurement

$$\varepsilon = f^2 \frac{4L_w \rho}{E \cdot g}$$

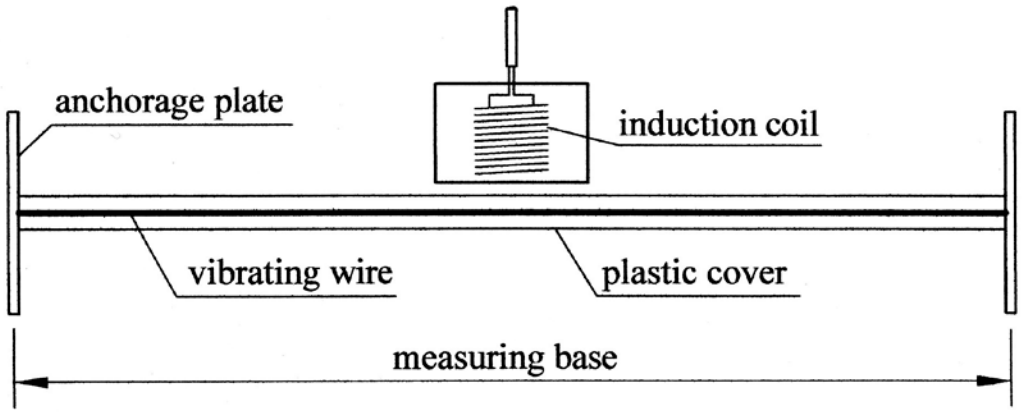
f – wire vibrating frequency,

L_w - basis length,

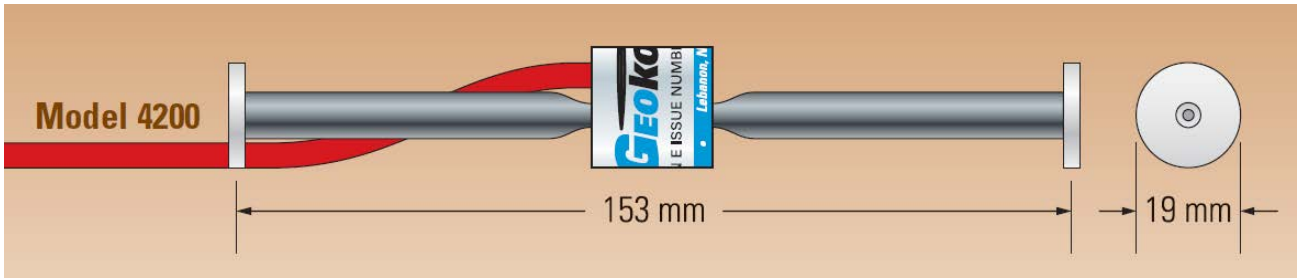
ρ – wire material density,

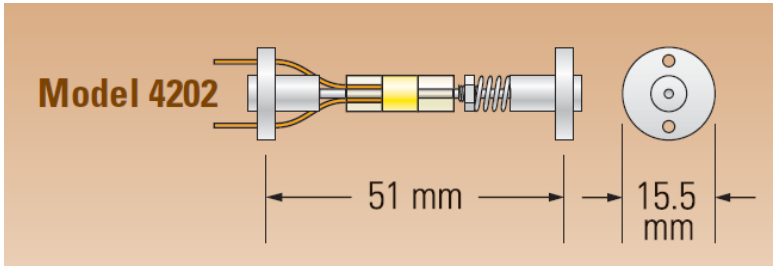
E – Young's modulus,

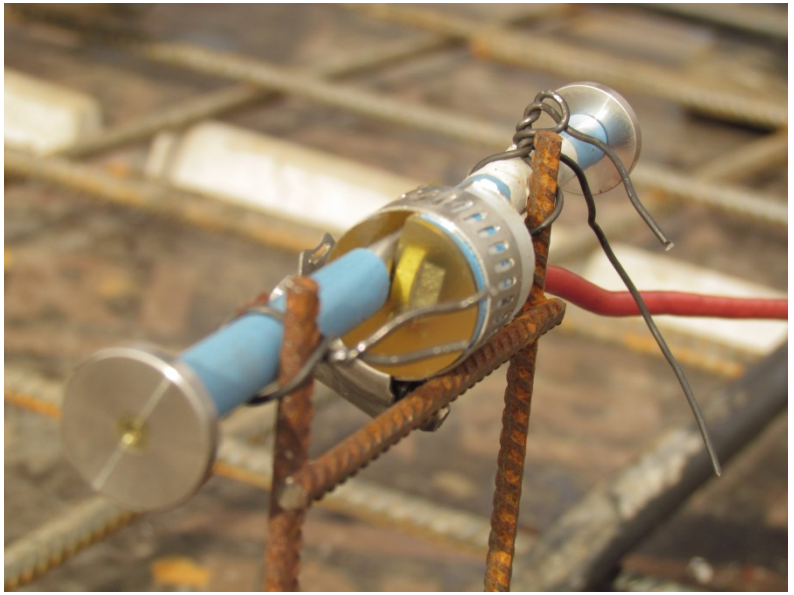
g – acceleration due to gravity.



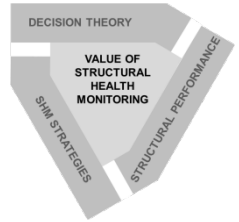
Concrete strain transducers



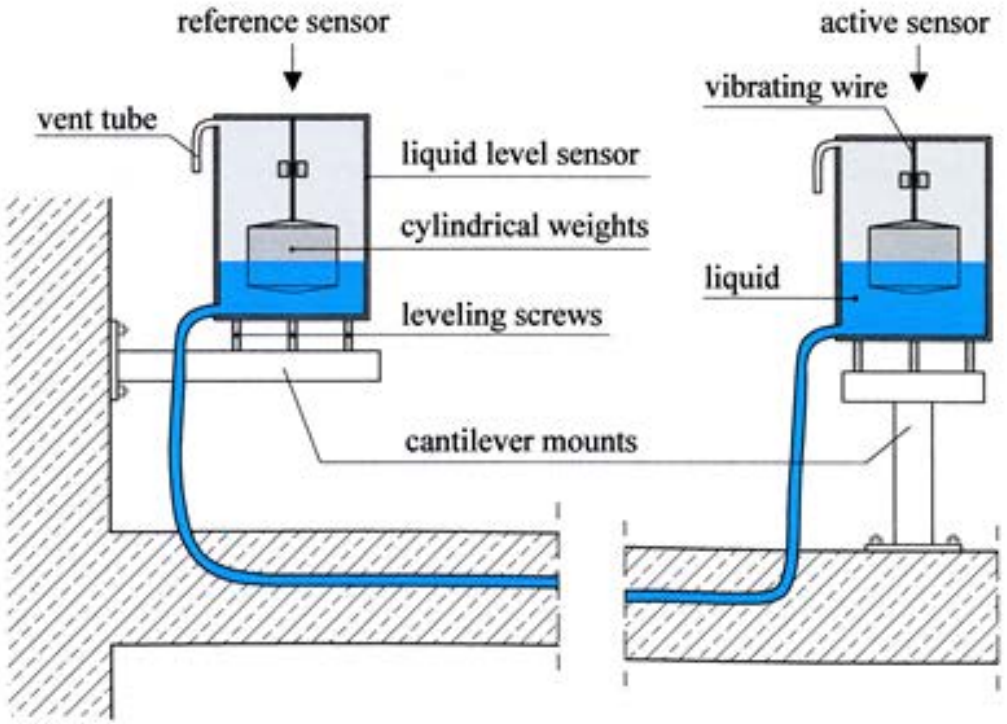




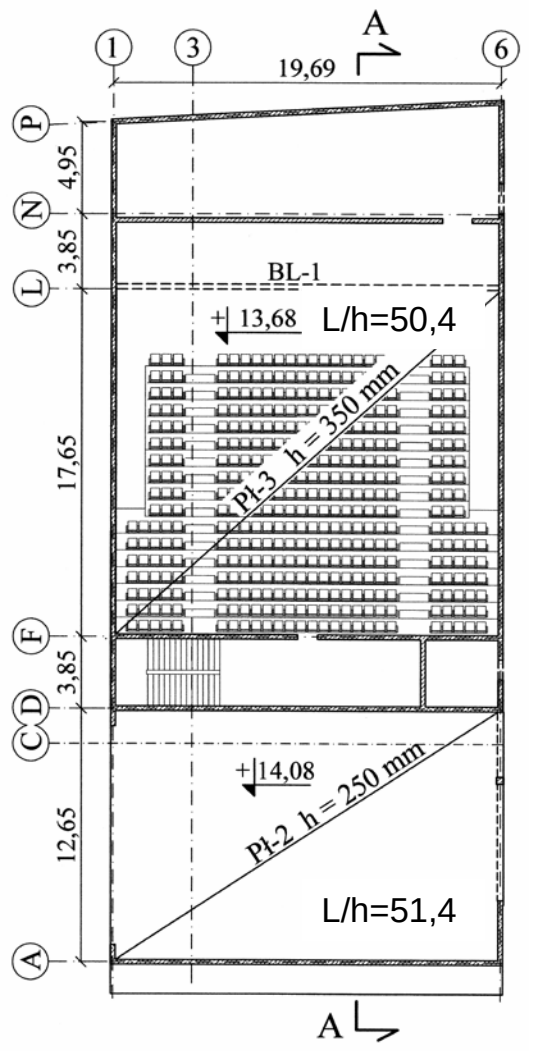
Prestress force controlling

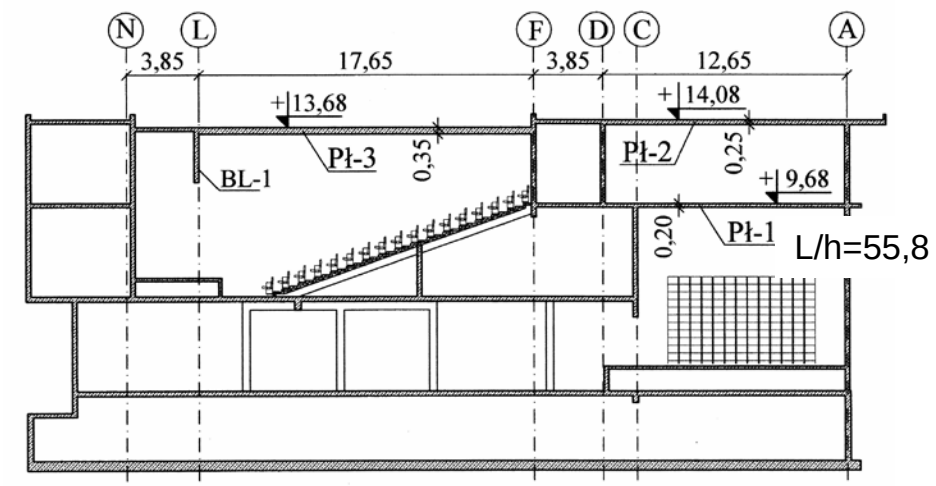


Hydraulic system to control the deflection

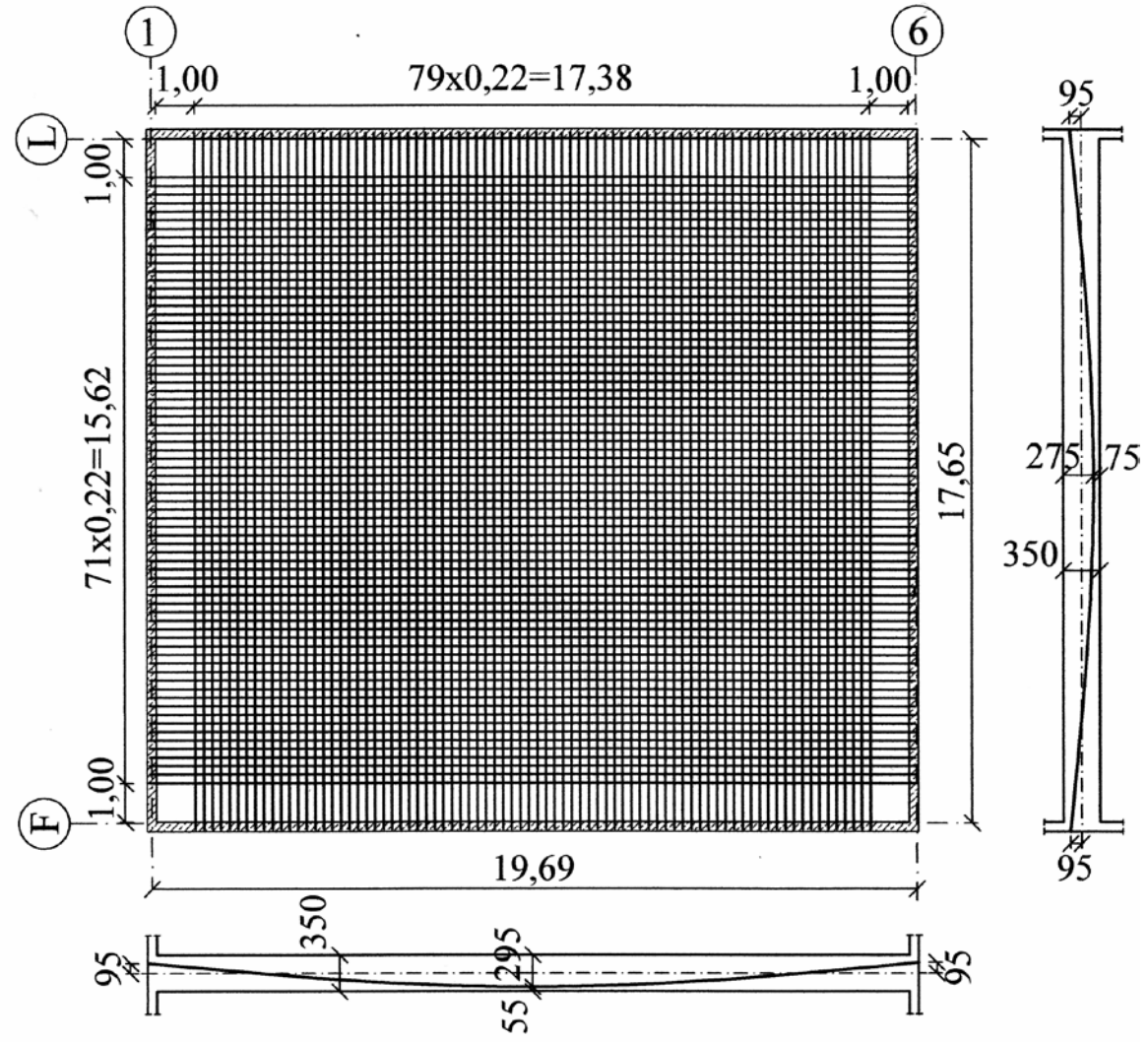


Art gallery building in Kozienice

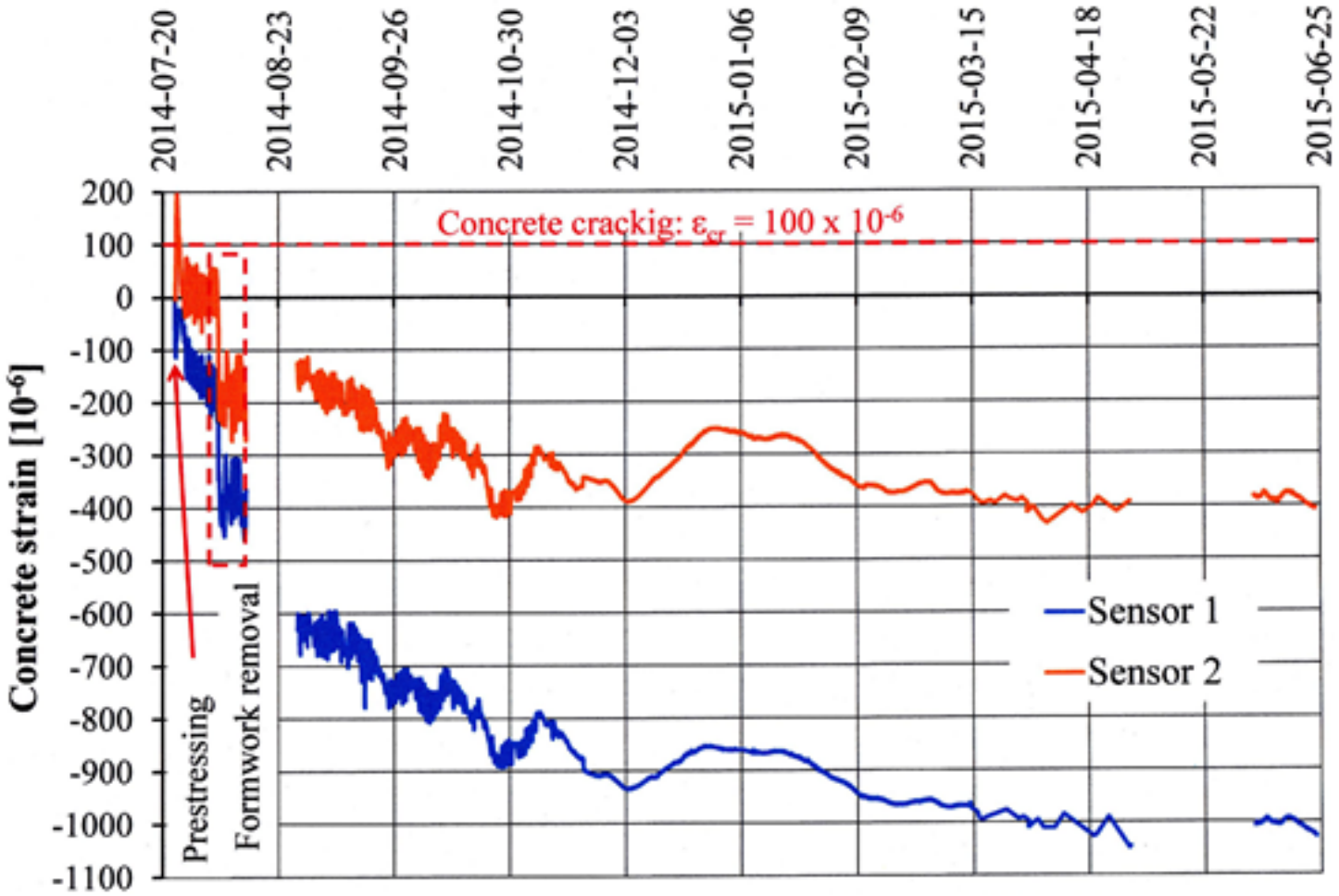


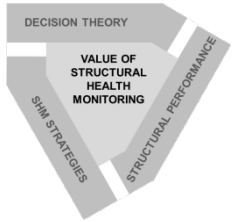


Prestressed slab over the cinema hall

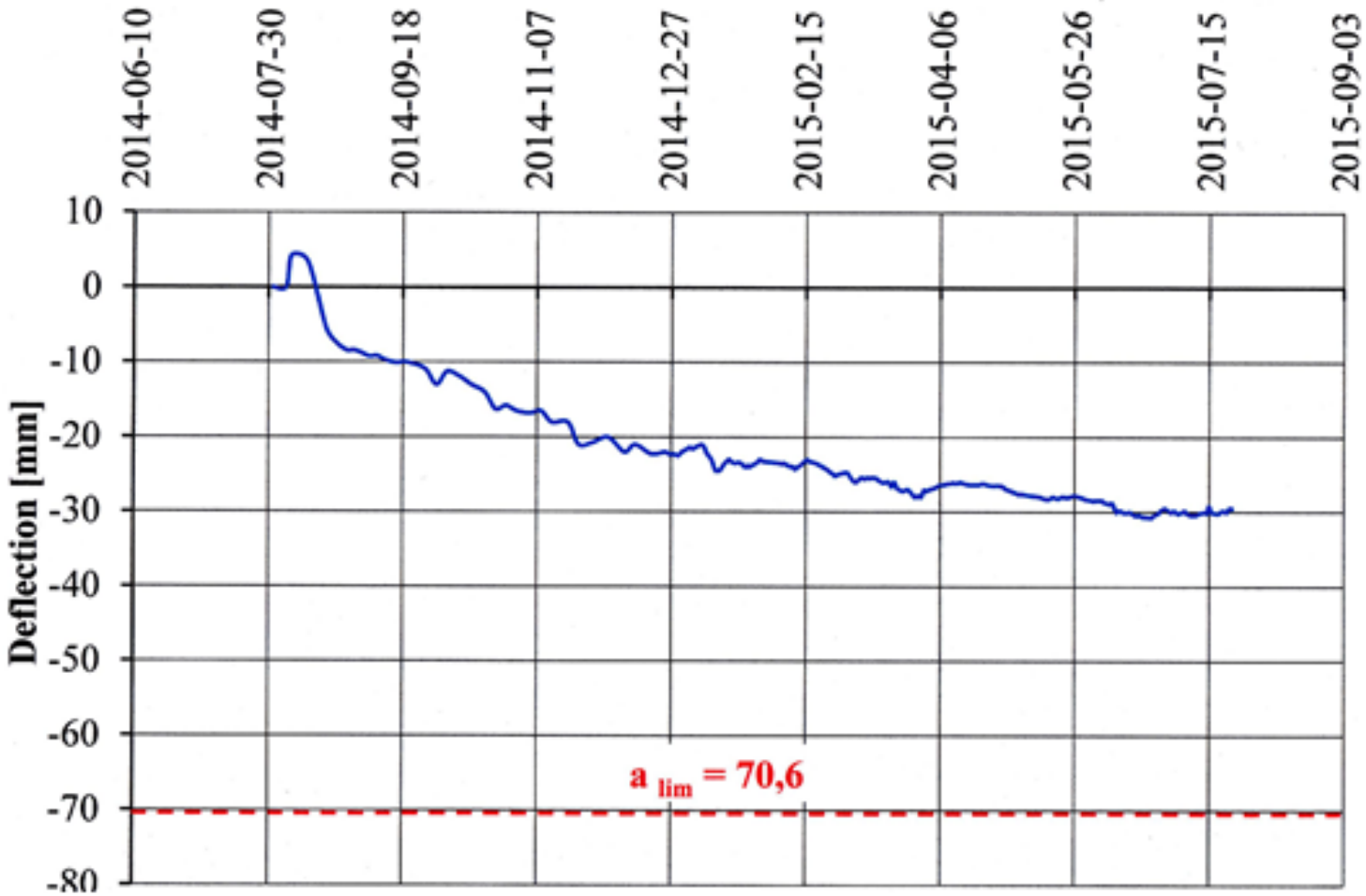


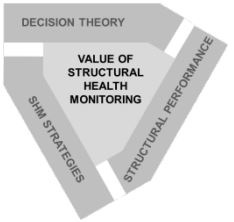
Concrete strain development





Slab deflection





Conclusions

- Application of monitoring during the erection and the initial phase of service of slabs prestressed with unbonded tendons allows to verify of computational methods and design assumptions applied.
- Positive behaviour of executed slabs, supported by the measured values, constitutes a contribution towards the construction of similar prestressed slabs in the future projects and their improvement.