

# **TRIMARAN – CONGRESS AND COMMERCIAL CENTRE**

## **Concrete structure suspended on steel superstructure**



**Presented by Vladimir Janata**

**Vladimír JANATA, Dalibor GREGOR Jan VČELÁK**

**Rostislav MAZÁČ**



**Jindřich HÁTLE**



**METROSTAV**

**TEL AVIV – 22<sup>nd</sup> MAY 2017 Trimaran in Prague, CZE**

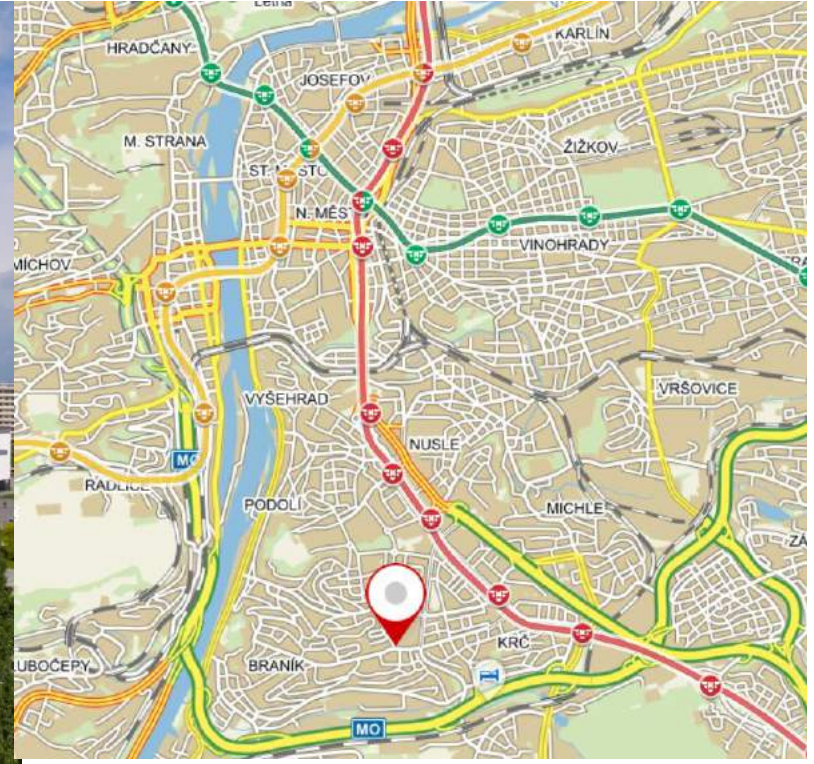


## **Contents of presentation**

- 1) Introduction**
- 2) Basic layout and static scheme of the structure**
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- 5) Fabrication of the steel parts**
- 6) Erection of the steel superstructure**
- 7) Prestressing and monitoring of forces**



# Trimaran, congress and commercial centre



Architect: Ernst Hofmann

Detail design: Václav Aulický, Antonín Sova, Spojprojekt Praha

Concrete design: Rostislav Mazáč **RECOC**

Steel structure design: Vladimír JANATA, Jan Včelák, **EXCON**

Main contractor: **S+B Plan und Bau Prag**

Steel structure fabrication and erection: **Metrostav**

Macalloy tendons delivery, erection: **Tension systems**

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## Basic layout of the structure

Steel superstructure - 9 trusses, 257 prestressed tendons

Suspended 3 storey building

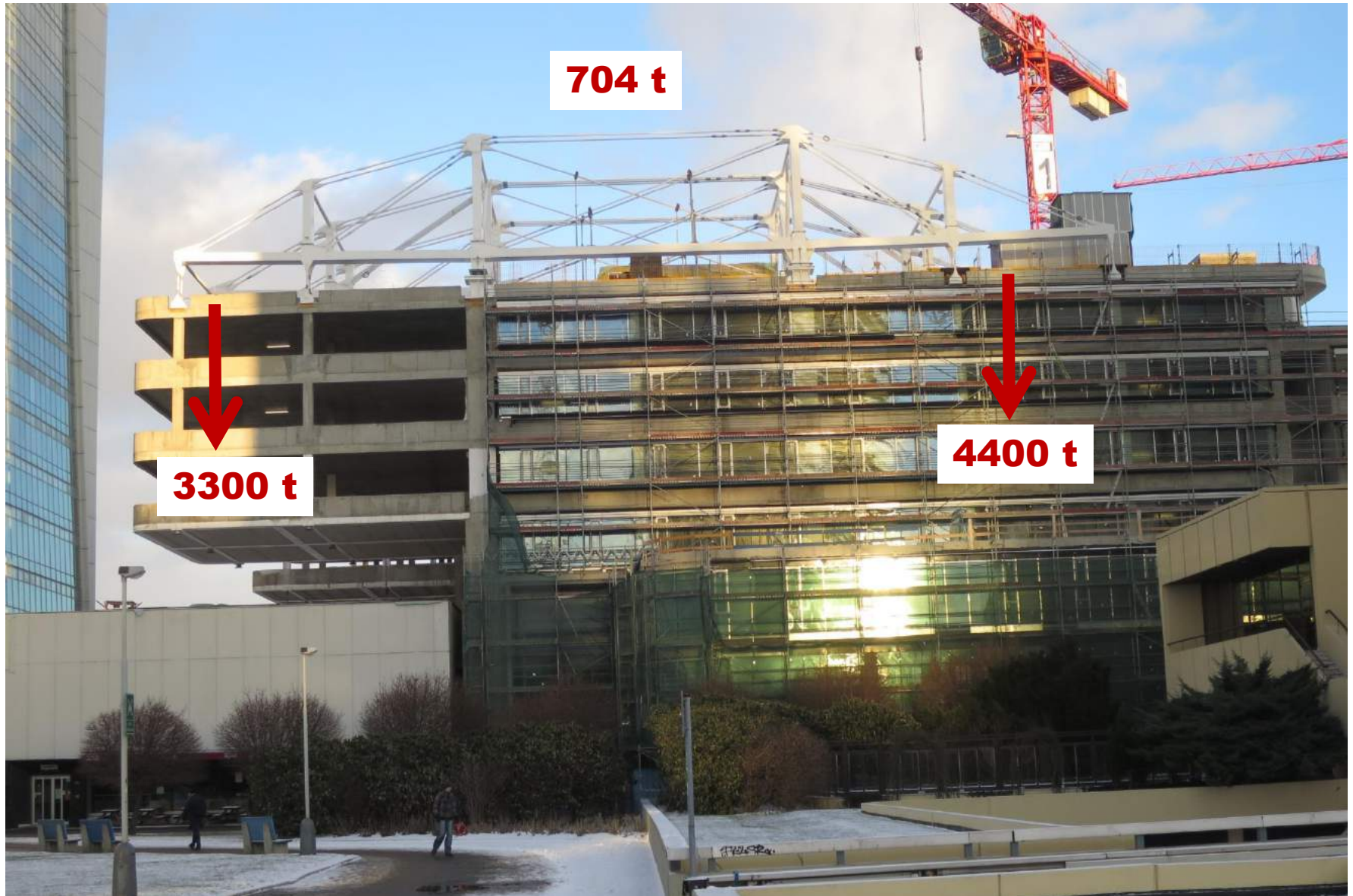
Suspended four storey building

Supports

New concrete structure

Existing building

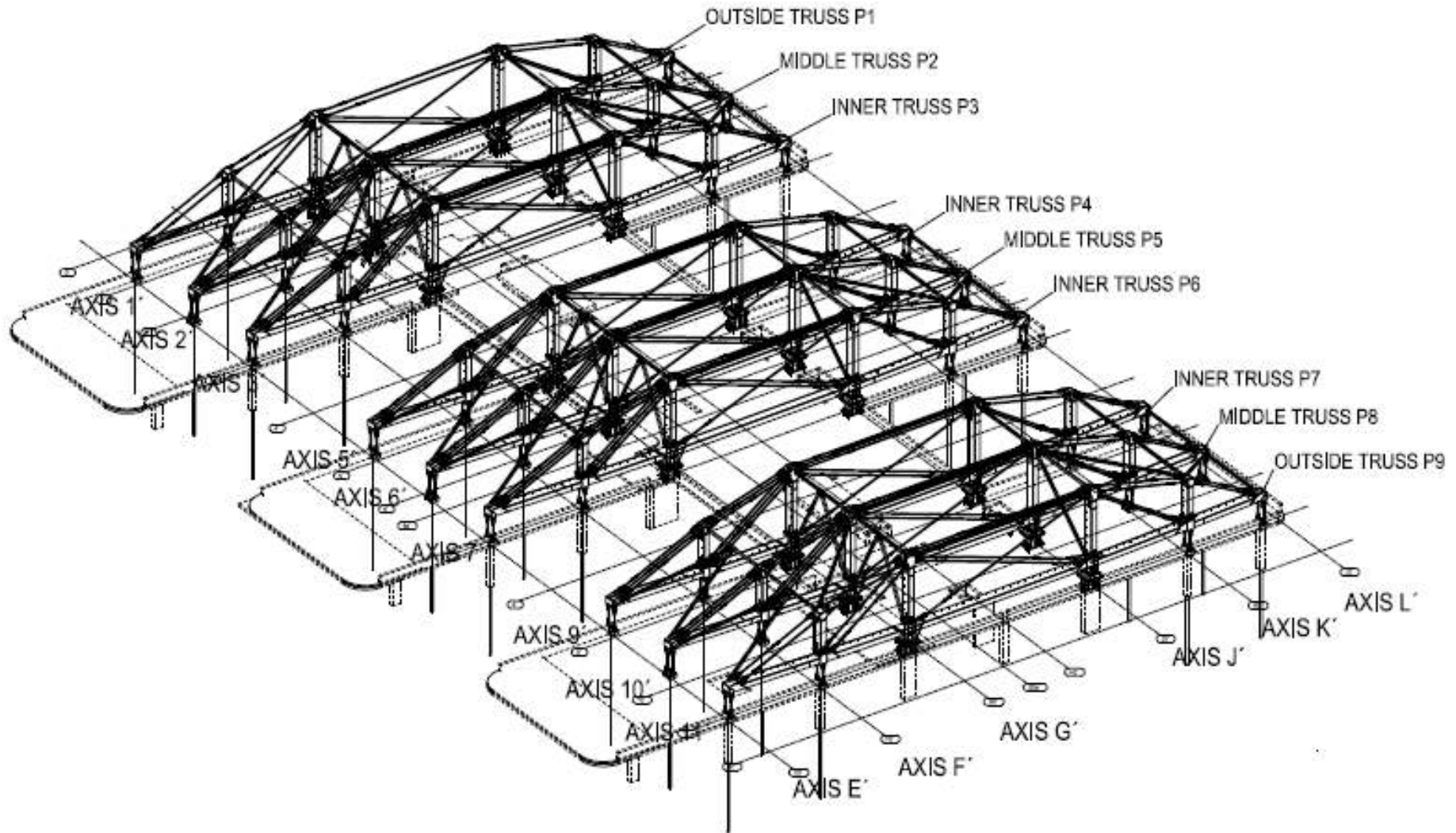
## Building after concreting the suspended parts



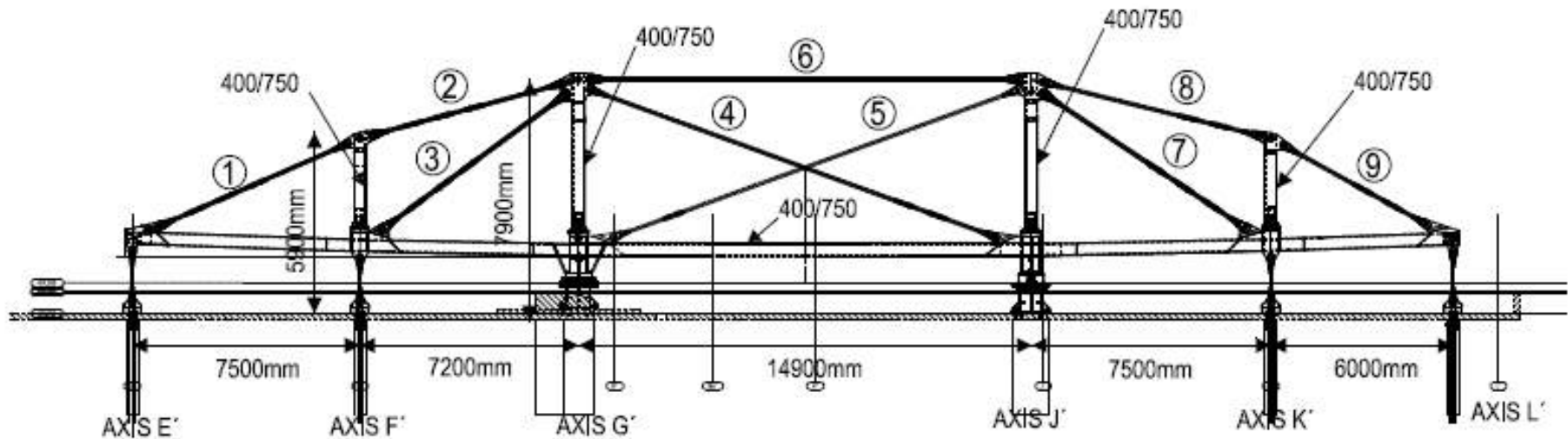
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**Superstructure consists of 9 trusses in three sections acting as a simple beam with adjacent cantilevers**



## View to truss



**185 prestressed tendons Macalloy 520 - M76 M90 M100 (trusses)**  
**72 tendons Macalloy 520 - M85 (suspensions)**  
**Total 257 tendons = 122 tons**

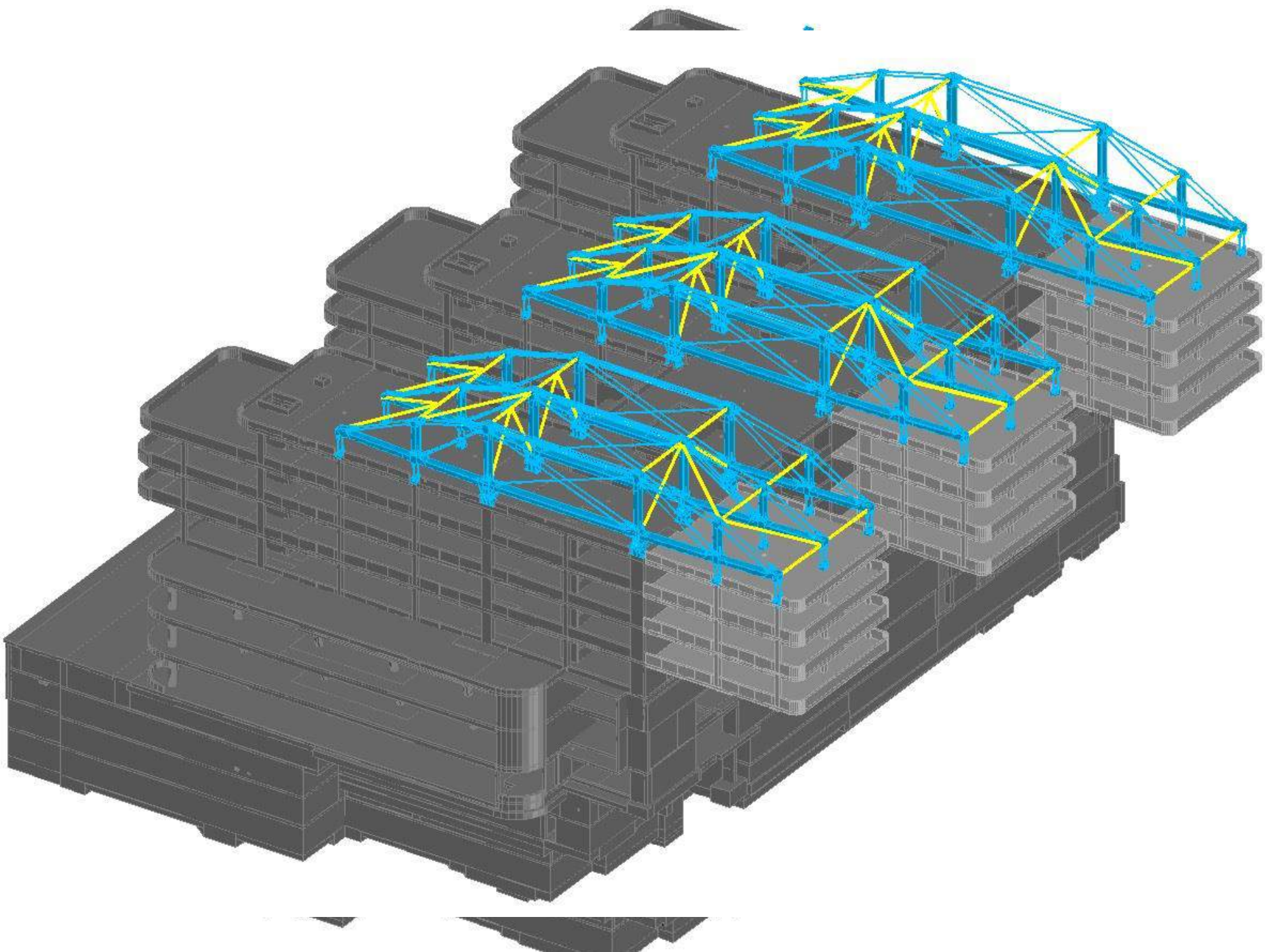






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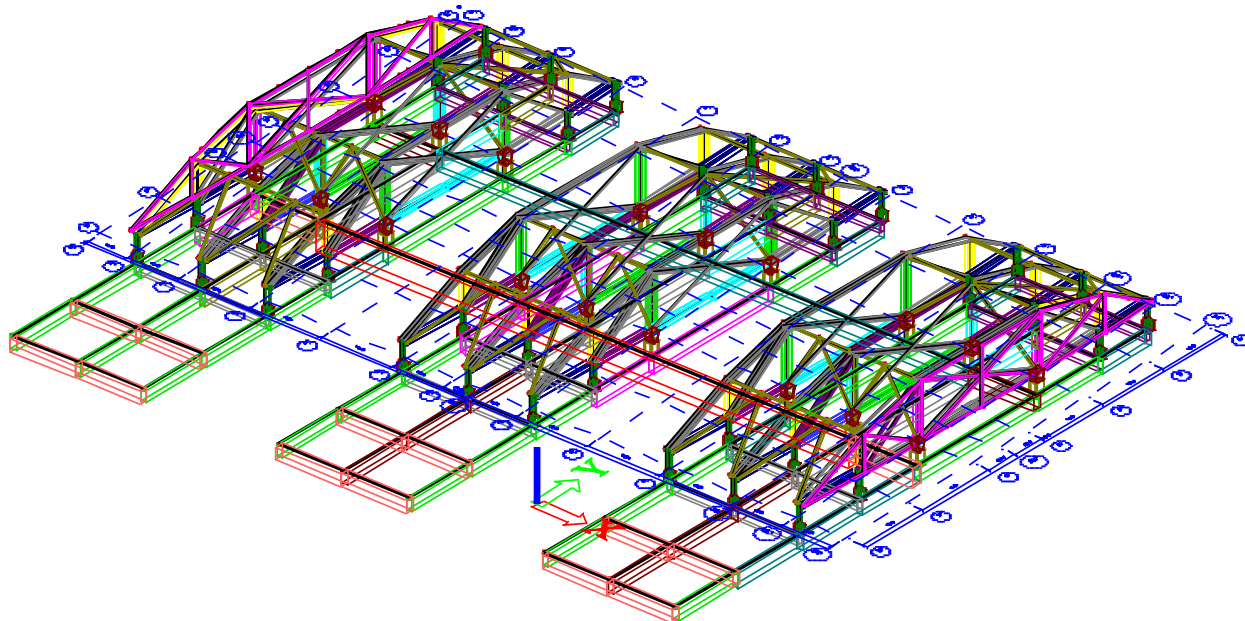


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### THREE TYPES OF MODELS

- **Common model for global analysis of steel and concrete parts. RECOC special software connected with AutoCad.**
- **Model for steel structure analysis. Concrete parts are replaced by simplified frame on elastic supports with similar features as full model. 33 linear building phases are taken in the account (Scia Engineer)**
- **Special EXCEL models based on influence matrix for tuning the prestressing procedures**





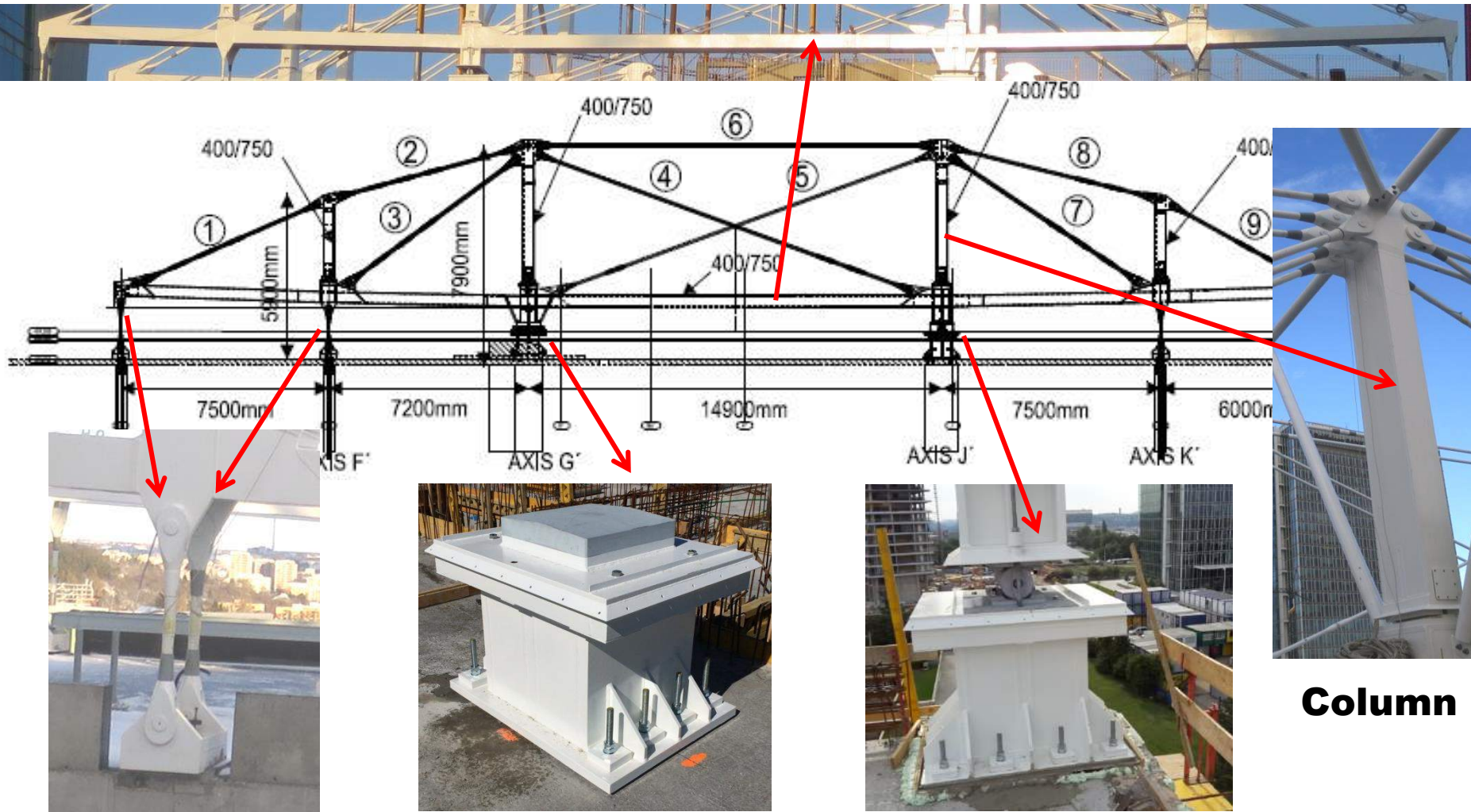


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# Steel structure – 582 tons

## Chord of the truss – convex shape



**Suspension M85**

**Pinned support box**

**Sliding support box**

**Column**





## Columns of the trusses



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## Joint of the bottom chord



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## Bottom chord



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## Detail of the rolling bearing of the truss



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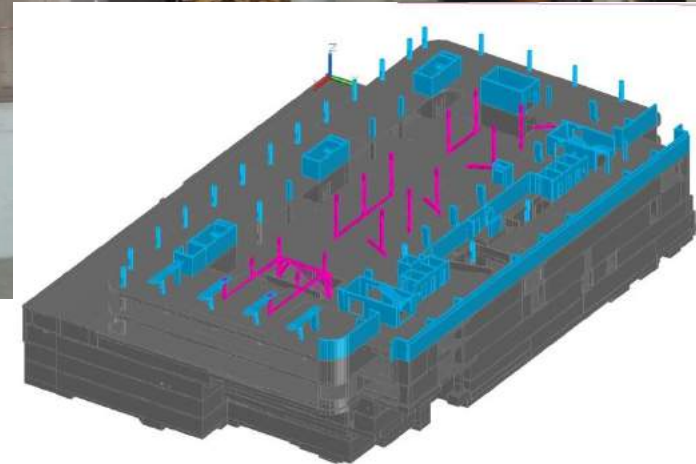


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## Temporary supports of the suspended structure (2<sup>nd</sup> floor)



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## Hydraulic controlled bottom of the temporary column



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**Hangers M85**  
**Strain gauges**

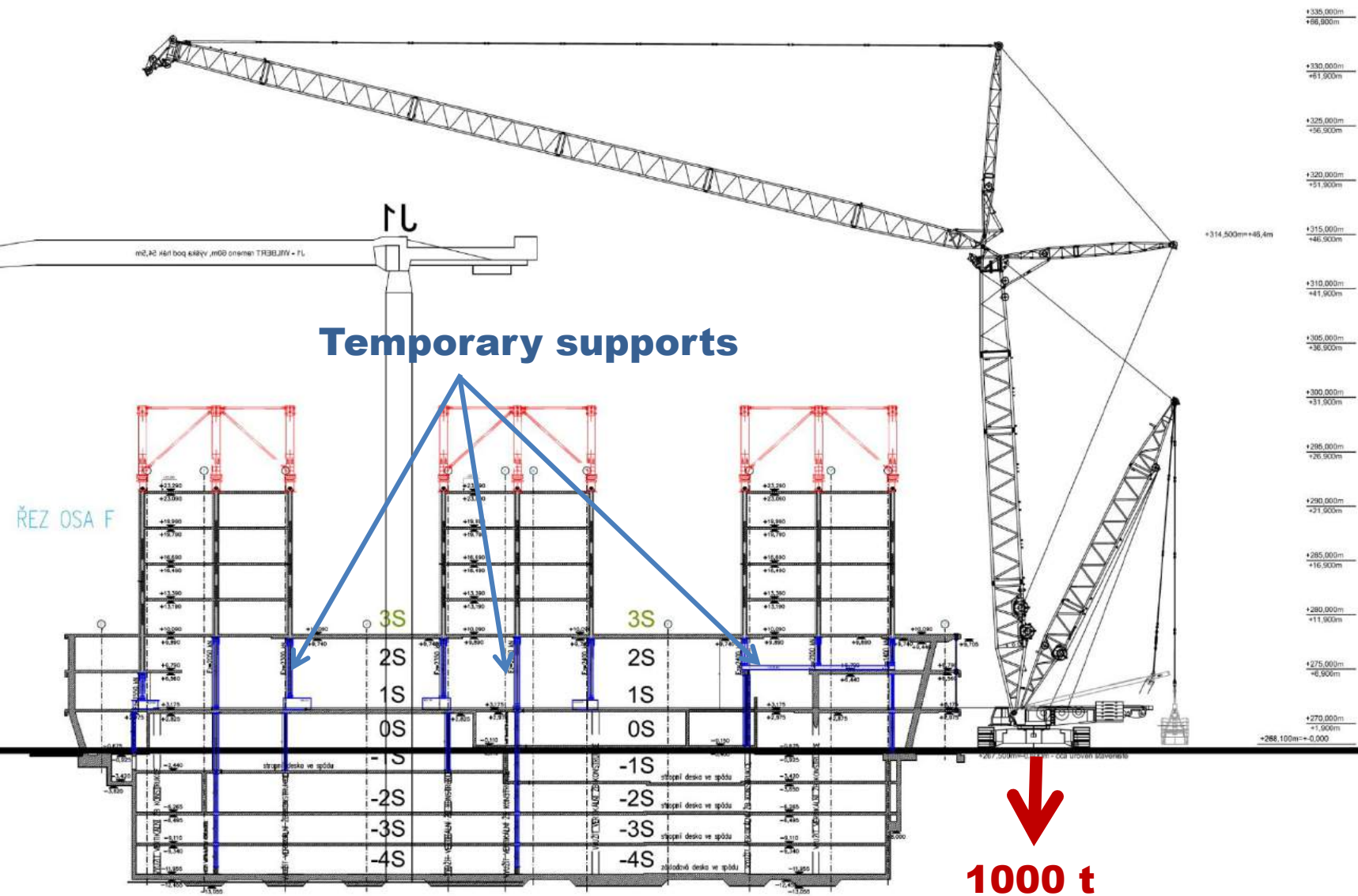
**Prestressing cable**

**Connecting box for suspension**

**Reinforcing of the concrete column  
around the inner steel tube**

**Formwork of the floor**

## Mobile crawler crane LR1750

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## Mobile crawler crane



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## Erection of the bottom chord



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## **Bottom chord in reverse position**



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## Erection of the column



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## Erection of the tendons no 5,7,8,9 and hangers M85



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## **Rotating of the partially assembled truss to the final position**



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## Positioning of the partially assembled truss



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## Truss in the final position



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## Erection of the top tendon M100 (no.6)



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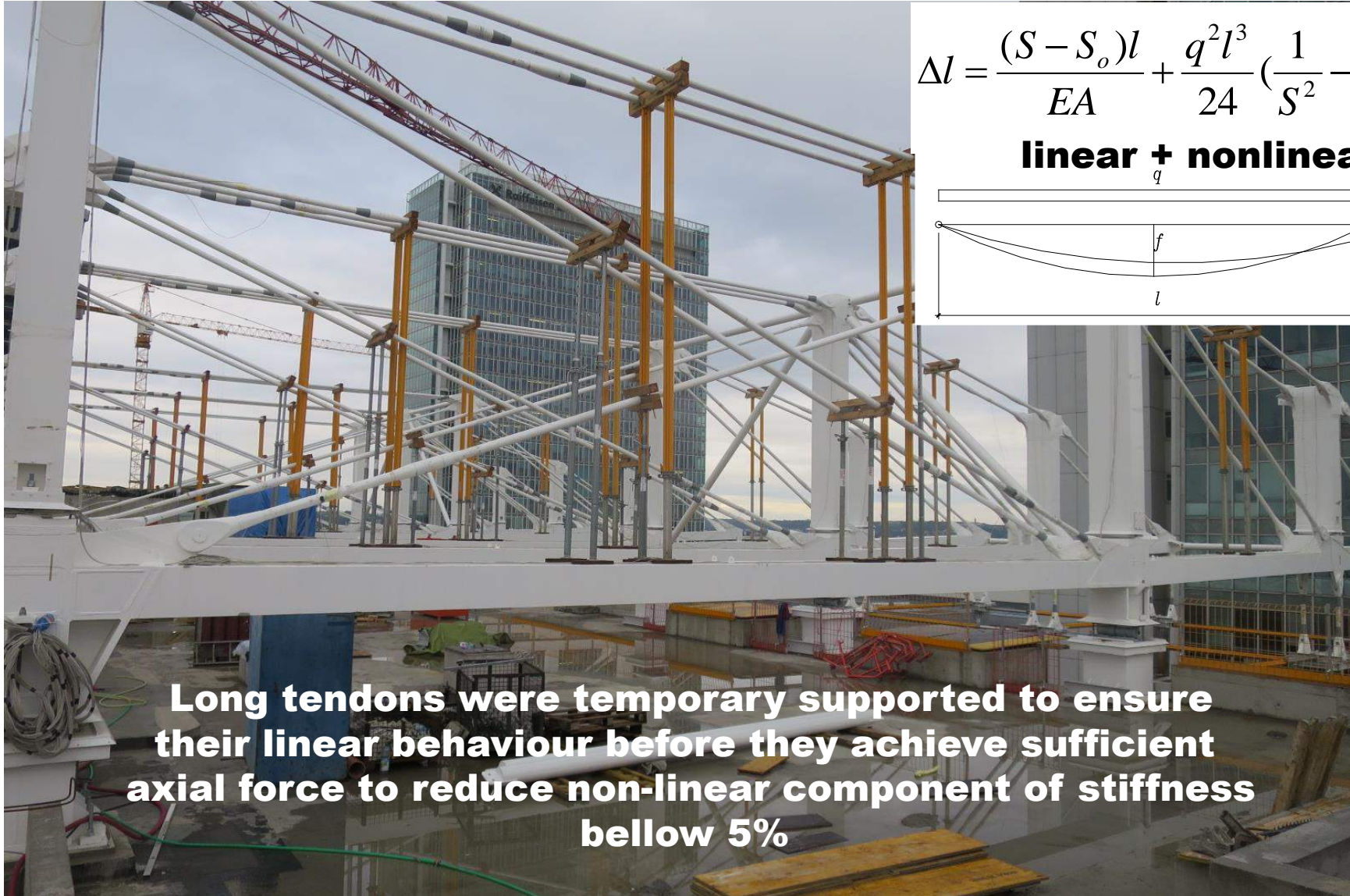
## **Erection of the top tendon M100 (no.6) and temporary supports**



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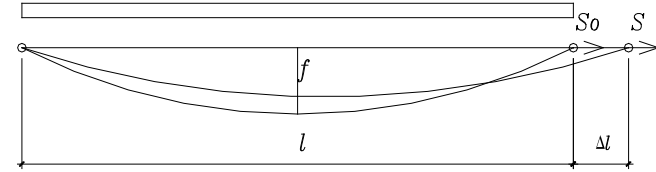
## Temporary supported tendons



$$\Delta l = \frac{(S - S_0)l}{EA} + \frac{q^2 l^3}{24} \left( \frac{1}{S^2} - \frac{1}{S_0^2} \right)$$

**linear + nonlinear**

$q$





**Assembly of the suspension tubes**



**Suspended steel structure**





## Suspended steel structure



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## Suspended steel structure



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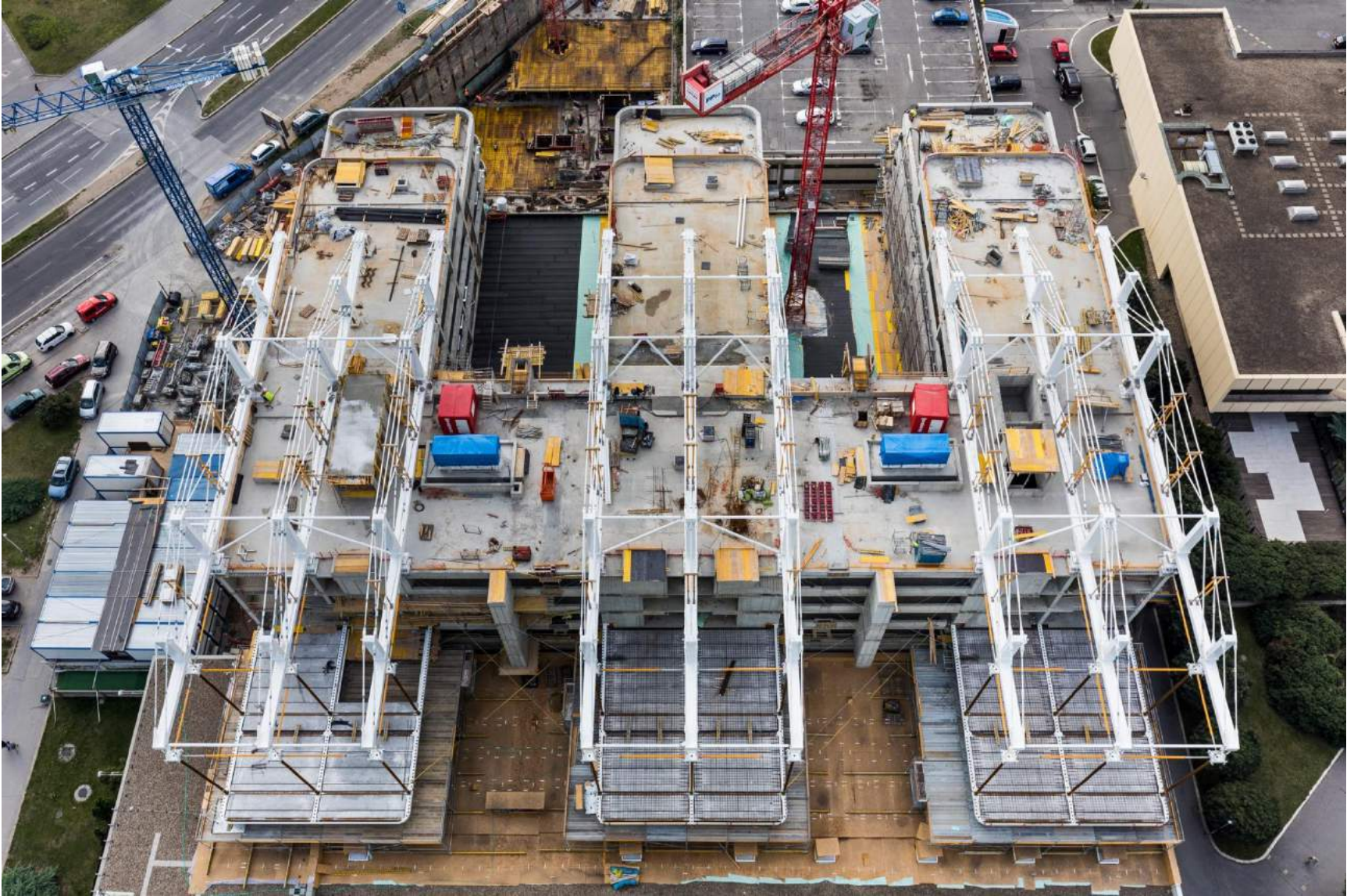
## **Joint of the tube and suspended structure before welding**



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## **Completed superstructure consisting 9 trusses**

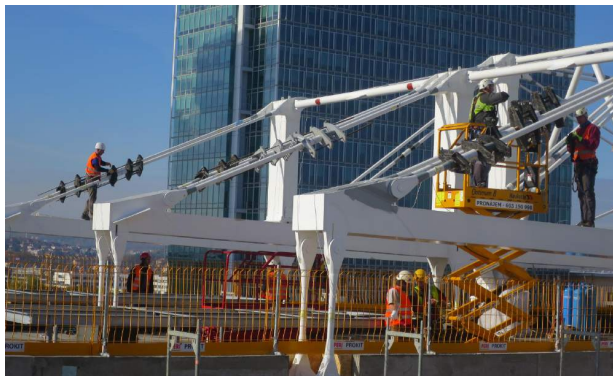


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## Prestress and monitoring of forces

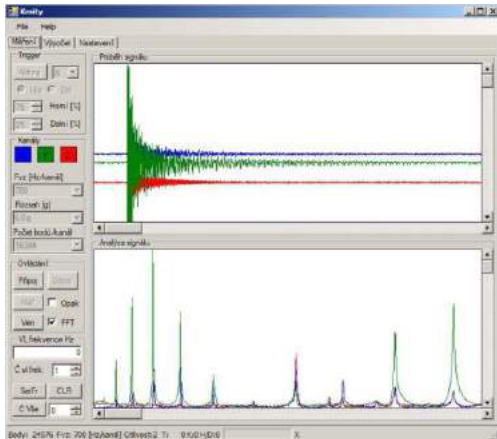
**Prestressing was carried out in three phases**

**Forces were measured by strain gauges  
switch board with 80 channels**

**Prestressing procedure was  
optimized using influence matrix**



**Frequency measurement was carried out  
finally**



**Type: Peekel Autolog 2100  
Number of channels : 80**

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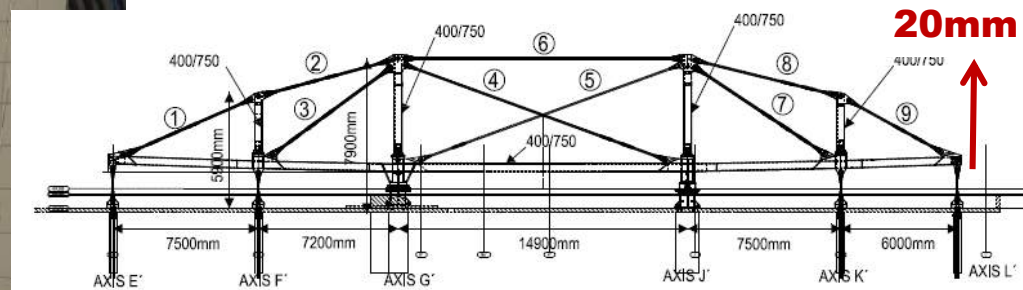
## Prestressing procedure

	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
VA5-1	373,1	323,1	-256	194,3	-92,1	125,9	17,65	14,46	13,47	-11,3	-9,74	-0,4	4,14	-6,07	-22,8	-14,1	-5,74	-5,35
VA5-2	354,3	306,9	-248	184,6	-87,5	119,6	16,77	13,73	12,48	-10,7	-9,25	-0,38	3,93	-5,77	-21,7	-13,4	-5,45	-5,08
VA5-3	-236	-204	560,2	245,3	-92	126	17,31	14,8	13,79	0,32	0,28	-22,2	-1,15	-4,72	-27,3	-14,8	-7,11	-6,62
VA5-4	150,2	130,1	205,8	861,5	148,7	-211	-31,9	-25,1	-23,4	4,24	3,67	0,35	-25,1	18,59	28,76	22,12	9,36	8,72
VA5-5	-143	-124	-155	295,9	1019	-690	68,92	47,86	44,59	-11,1	-9,65	-11,4	40,46	-34	-67,6	-48,9	-19,6	-18,2
VA5-6	69,1	59,85	75,08	-149	-244	339,2	48,79	39,85	37,13	-12,3	-10,6	-17,4	18,89	-20,8	-59,1	-37,7	-16,4	-15,2
VA5-7	19,2	16,63	20,27	-45,8	49,25	97,16	185,4	-53,2	-49,6	-13,6	-11,7	-17,4	25,88	-26,9	-67,6	-69,2	-1,63	-1,52
VA5-8	20,82	18,03	23,11	-47	44,39	104,6	-59,4	121,9	113,6	-10	-8,7	-14	20,71	-19,9	-52,6	-12,3	-30,3	-28,3
VA5-9	20,94	18,13	23,33	-46,9	44,38	105	-62,8	124,6	116,1	-10	-8,67	-14	20,41	-19,8	-52,2	-15,1	-28,1	-26,2
VA6-1	-11,3	-9,74	0,35	4,72	-7,19	-22,3	-12,6	-7,07	-6,58	396,7	343,6	-277	178,5	-83,5	152	29,09	25,13	23,41
VA6-2	-10,7	-9,25	0,33	4,49	-6,83	-2,12	-6,71	-6,25	376,8	326,4	-263	169,6	-79,3	144,4	27,63	23,87	22,24	-11,3
VA6-3	-0,37	-0,32	-22,2	-0,28	-6,76	-29,2	-14,9	-9,07	-8,45	-255	-221	630,6	259,8	-94,9	173,3	33,26	28,72	26,76
VA6-4	2,88	2,49	0,8	-27	20,45	26,65	18,89	11,35	10,57	138,3	119,8	218,6	908,7	137,1	-254	-47,9	-43,6	-40,6
VA6-5	-9,41	-8,15	-7,94	38,76	-34	-58,8	-38,9	-21,7	-20,2	-129	-112	-160	274,1	1081	-656	100,3	74,85	69,73
VA6-6	-12,5	-10,9	-16,3	20,09	-24	-59,1	-34,4	-20,3	-18,9	83,42	72,25	103,3	-180	-232	42,8	81,14	71,41	66,53
VA6-7	-12,2	-10,6	-13,9	24,9	-27,3	-59,5	-54,9	-7,55	-7,04	25,17	21,8	31,26	-53,5	55,98	127,9	235,1	-67,9	-63,2
VA6-8	-3,76	-7,61	-11,7	18,51	-19,3	-45,6	-3,18	-32,5	-30,3	37,88	32,81	47,03	-84,8	73,26	196,2	-119	229,1	213,5
VA6-9	-6,2	-13,3	21,09	-21,9	-51,8	-3,15	-37,3	-34,7	42,03	36,4	52,17	-94,1	80,93	217,6	-131	253,8	236,5	-9,26
139	459	31	-1,28	3,73	-2,98	-4,23	-2,71	-1,88	-1,75	-11,3	-9,74	-0,4	4,14	-6,07	-22,8	-14,1	-5,74	-5,35
700	0,34	0,29	-1,22	3,55	-2,83	-4,01	-2,57	-1,78	-1,66	-10,7	-9,26	-0,38	3,93	-5,76	-21,7	-13,4	-5,45	-5,08
831	131	0,2	-2,65	0,43	-1,54	-5,78	-2,55	-2,17	-2,03	0,32	0,28	-22,2	-1,15	-4,72	-27,3	-14,8	-7,11	-6,62
VA7-4	2,8	2,43	0,18	-4,08	3,95	8,36	4,64	3,3	3,07	3,08	2,67	0,83	-28,2	20,17	27,97	22,48	9,41	8,76
VA7-5	-4,62	-4	-2,59	7,79	-8,02	-17,7	-9,66	-6,92	-6,45	-11,1	-9,65	-11,4	40,47	-34	-67,6	-48,9	-19,6	-18,2
VA7-6	-2,32	-2,01	-3,44	6,08	-6,27	-13,5	-7,28	-5,41	-5,04	-12,3	-10,6	-17,4	18,89	-20,8	-59,1	-37,7	-16,4	-15,3
VA7-7	-4,16	-3,6	-4,26	9,35	-9,59	-20,4	-13,2	-6,66	-6,21	-19,1	-16,5	-24,5	37,14	-38,3	-95,2	-95,6	-4,01	-3,74
VA7-8	-2,99	-2,59	-3,75	6,87	-7,1	-15,7	-6,88	-7,73	-6,83	-11,3	-9,76	-15,7	23,28	-22,3	-58,9	-41,1	-33,8	-31,3
VA7-9	2,67	2,15	-4,56	8,39	-8,67	-19,1	-8,47	-8,87	-8,26	-13,6	-11,8	-18,9	28,31	-27	-71,3	-14,1	-42,9	-40
2560	373,1	323,1	-256	194,3	-92,1	125,9	17,65	14,46	13,47	-11,3	-9,74	-0,4	4,14	-6,07	-22,8	-14,1	-5,74	-5,35

**1<sup>st</sup> phase of prestressing by chain wrench up to 100 kN  
was carried out during installation of hangers in order to:**

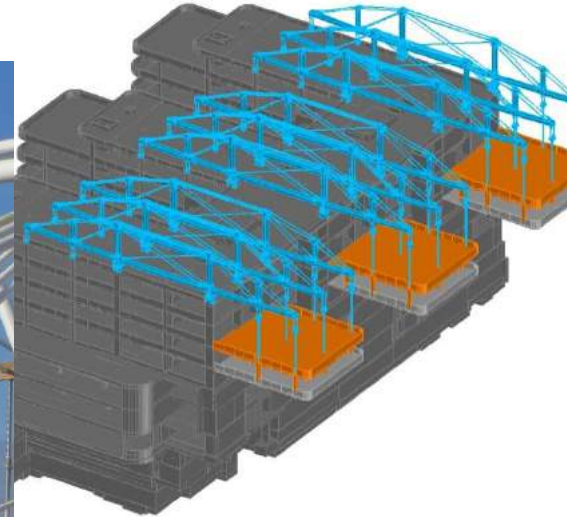
**Ensure the linear behaviour  
of tendons**

**20 mm vertically pre-deform  
the end of the truss**





**2<sup>nd</sup> phase of prestressing by the device up to 350 kN  
was carried out after 2<sup>nd</sup> floor of suspended structure  
was finished in order to:  
Activate all tendons and to equalize the forces in trios  
and couples of tendons**



## **2<sup>nd</sup> phase of prestressing up to 300 kN**



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**3<sup>rd</sup> phase of prestressing up to 1800 kN  
was carried out in order to:**

**Uplift the structure from the temporary supports**

**Favorable redistribute internal forces in concrete**

**20 mm**

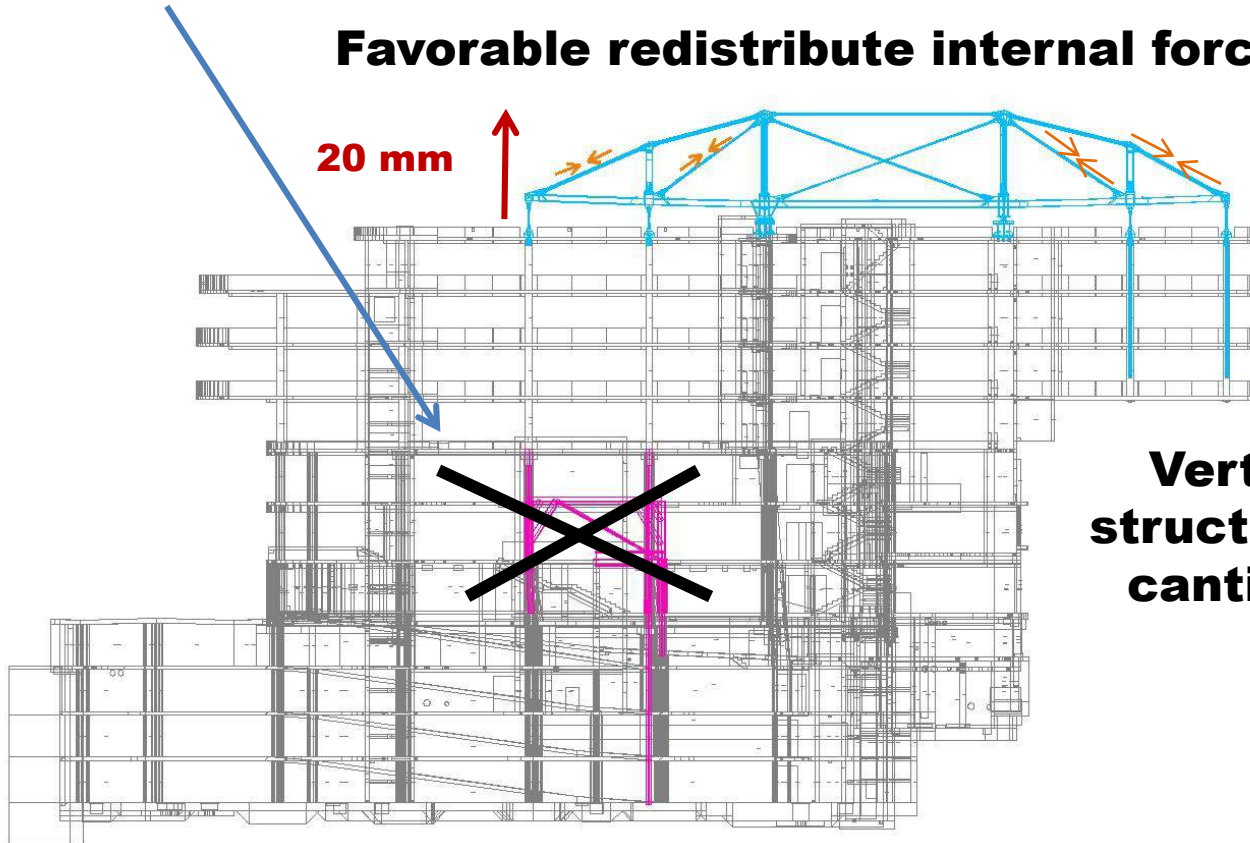


**Leveling the  
differences**

**60mm**



**Vertically rise the  
structure deformed by  
cantilever concrete  
casting**



### **3<sup>rd</sup> phase of prestressing up to 1800 kN**



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## **Multifunctional space in the 2<sup>nd</sup> floor after removing temporary supports**



**Anchoring of the prestressing cable**

## Current state of Trimaran



**End of 2017**



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A photograph of two men standing on a construction site. The man on the left is wearing a white hard hat, a grey t-shirt, and a yellow high-visibility vest. The man on the right is wearing a red hard hat, a yellow high-visibility vest, and dark trousers. They are both smiling at the camera. In the background, there is a large, modern building with a glass facade and a complex network of scaffolding and construction equipment. A yellow crane is visible on the left side of the frame. The sky is clear and blue.

**Thank you for invitation EDI**

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