CVS
Cantilever Formwork Carriage

// Flexibility and safety for small areas

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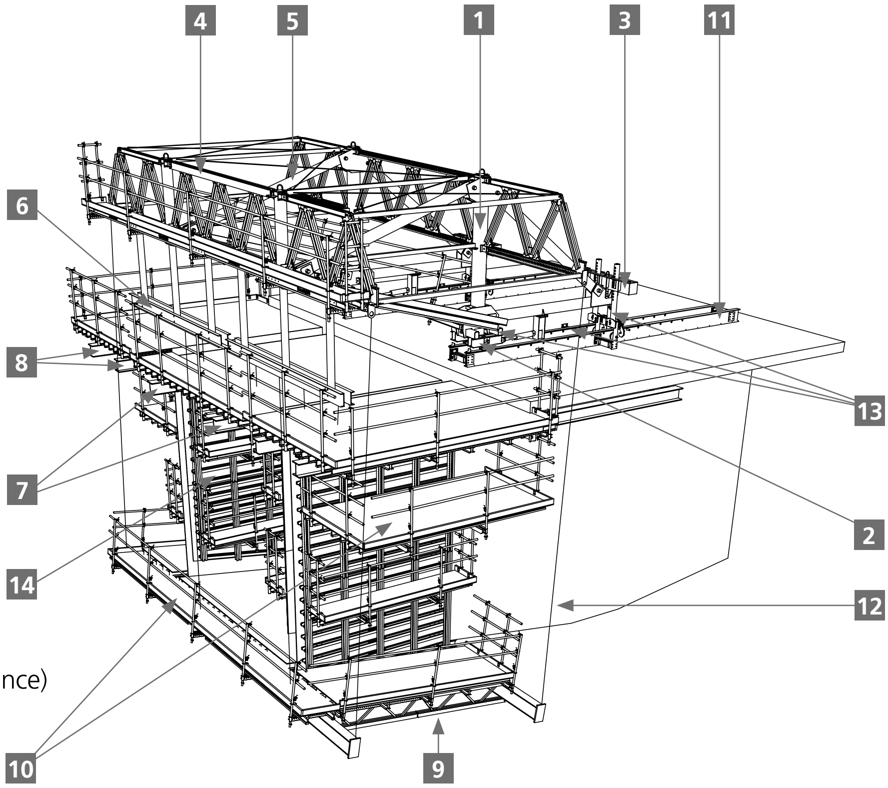
// Features

- **Mobile steel structure** for the construction of **pier segments** using the **balanced cantilever method.**
- **Comprehensive solution** that integrates carriage and formwork using standard elements from the MK System.
- Advisable for **pier heights exceeding 50 m.**
- Ideal for the construction of **wide-span bridge decks and arches, or where terrain conditions make it difficult to support a shoring structure.**
- Technology appropriate for **spans between piers of up to 200 m:** riverbeds, interchanges, railroad crossings, etc.

System Components

1. Main load truss
2. Front rolling and support system
3. Rear rolling and support system
4. Transverse bracing
5. Horizontal bracing
6. Suspension brackets
7. Upper slab support structure
8. Flange support structure
9. Lower slab support structure
10. Platforms
11. Guiding rails for advance
12. Form ties
13. Hydr. syst. (loading, containment, advance)
14. Formwork



Forming carriages with different load capacities

Maximum pier segment (t)	Pier segment length				
Carriage type	5 m	4,5 m	4 m	3,5 m	3 m
CVS 165/4,5		165 t	182 t	202 t	227 t
CVS 200/4,5		200 t	220 t	247 t	279 t
CVS 165/5	165 t	180 t	200 t	220 t	248 t
CVS 200/5 (Rentable)	200 t	218 t	240 t	267 t	300 t

// Benefits

Comprehensive Solution

- Carriage and formwork can be optimised for any situation.
- Modular system is adaptable to different section types.
- Allows varying distances between piers to be spanned.
- Allows varying deck depths to be formed.

High efficiency

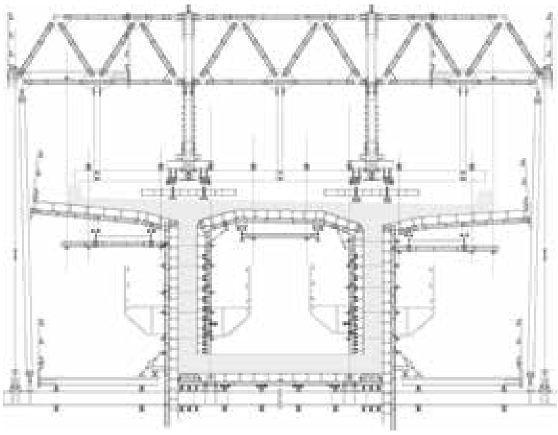
- Standard components with a reduced number of parts.
- Fast and safe hydraulic advance Repetitive movements.

Global Safety

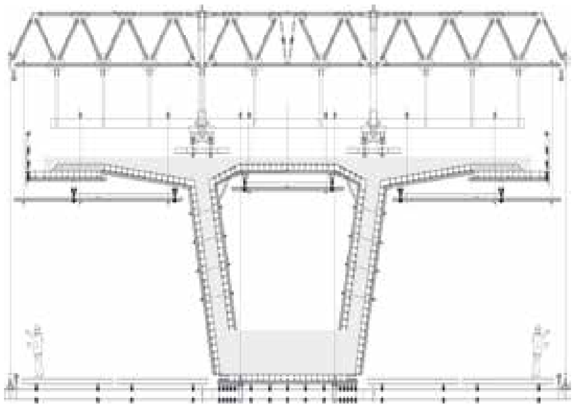
- Pre-assembly performed on the ground.
- All operations are concentrated in a small area on the bridge deck.
- Work platforms with safe access at various levels.

// Solutions

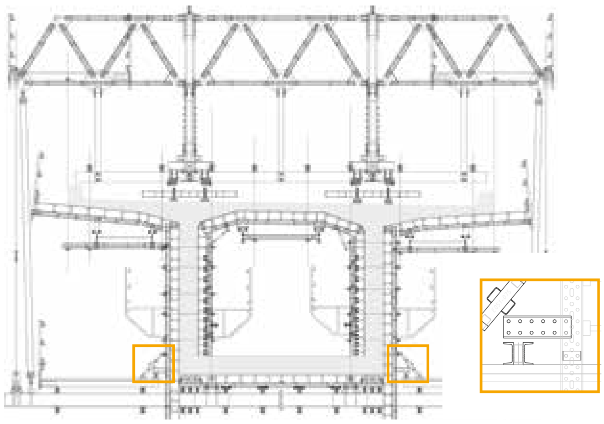
▸ Straight side wall section



▸ Inclined side wall section

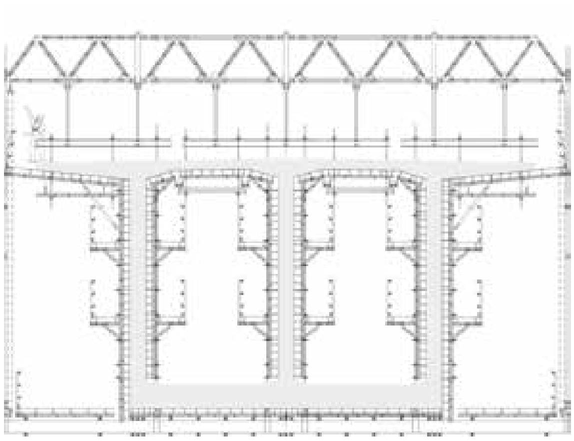


▸ Backward motion

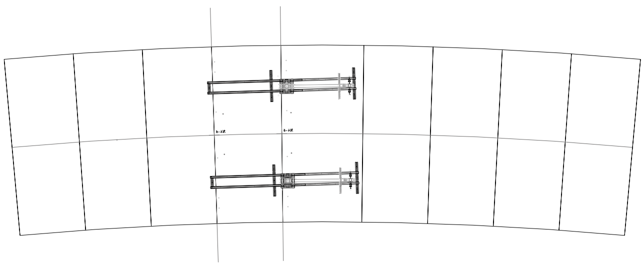


Support points for backward motion

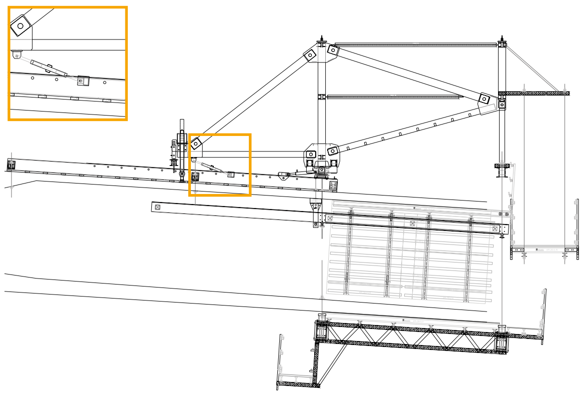
▸ Section of more than two side walls



▸ Curved bridges

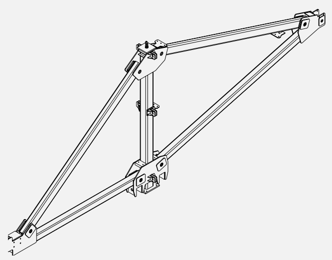


▸ Holding system

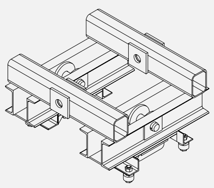


Basic components

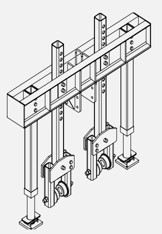
MAIN TRUSS		
Central post CVS165 C5	3200053	979
Central post CVS200 C5	3200290	1034
Rear lower ledger CVS165 C4	3200072	479
Rear lower ledger CVS200 C4	3200300	524
Rear diagonal CVS165 C2	3200094	334
Rear diagonal CVS200 C2	3200295	387
Lower diagonal CVS165 45 C3	3200084	562
Lower diagonal CVS165 50 C3	3200284	591
Lower diagonal CVS200 45 C3	3200305	568
Lower diagonal CVS200 50 C3	3200335	597
Upper diagonal CVS165 45 C1	3200097	347
Upper diagonal CVS165 50 C1	3200277	373
Upper diagonal CVS200 45 C1	3200310	400
Upper diagonal CVS200 50 C1	3200340	431



ROLLING-FRONT SUPPORT		
Front rolling set	3200028	283
40 tn Roller	1990657	30,8

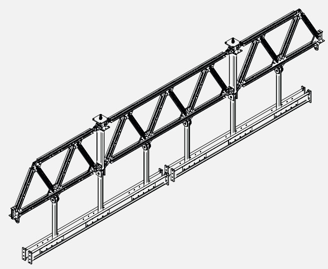


ROLLING-REAR SUPPORT		
Prestressing screw jack 85 tn	3200010	87
Tube 120x120x8/1765	3200020	44,3
Rear rolling set	3200021	46,1
Tube 100x100x8/540	3200027	11,3
Clamps UPN profile	3200039	69
Rear pincer	3200047	14,2
Rear clamp	3200048	20,3
Rear roller IPN380	3200104	11,1
Rear prestressing profile for curve	3200610	521

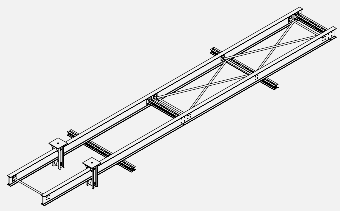


TRANSVERSAL BRACING		
Transversal bracing post	3200106	283
Node 60 hinge MK	1990362	37
Node 180 hinge MK	1990481	55
Node 180 MK	1990485	30,6
Node 180 D40 MK	1990480	31,8
Node 120 MK	1990420	24
Node 90 MK	1990390	18,8
Node 60 F MK	1990360	16
Node 60 M MK	1990361	21,3
Node axial M D40 MK	1990300	15
Waler MK-120 (from 1.125 to 5.625 m)		

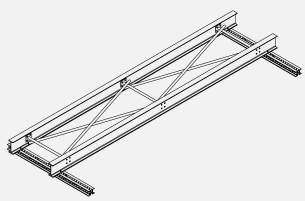
HANGING SUPPORT		
Hanging support post 1,75	3200563	95
Hanging syst. profile UPN-320/1250	3200695	111
Hanging syst. profile UPN-320/2250	3200630	173
Hanging syst. profile UPN-320/4500	3200648	313
Hanging syst. profile UPN-320/6750	3200649	453
Hanging syst. profile UPN-320/11250	3200625	734



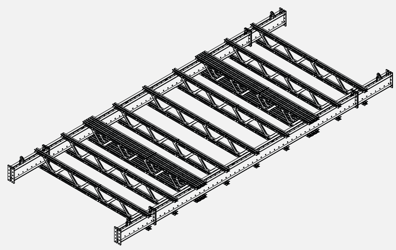
TOP SLAB STRUCTURE		
IPN-320/11400 (segment 4.5 m)	3200568	693
IPN-320/11900 (segment 5 m)	3200470	724
Formwork hanging roller	3200175	74
Internal formwork wheel	3200220	10,5
Waler MK-120 (from 1.375 to 4.125 m)		



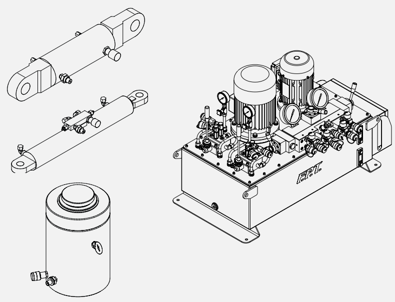
WING SLAB STRUCTURE		
IPN-300/6000 (segment 4.5 m)	3200569	351
IPN-300/6500 (segment 5 m)	3200450	351
Waler MK-120 (from 1.875 to 4.125 m)		



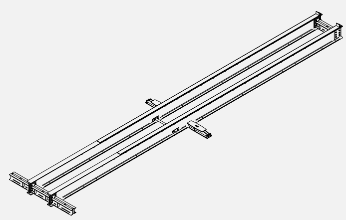
BOTTOM SLAB STRUCTURE		
Truss diagonal 625-DUPN500	3200586	7,3
Truss diagonal 687-DUPN500	3200650	8,8
Vertical tube 625-DUPN500	3200587	5,3
Profile UPN 500/2000	3200685	220
Profile UPN 500/2500	3200640	263
Profile UPN 500/3000	3200673	306
Profile UPN 500/6000	3200676	564
Profile UPN 500/9000	3200679	821
Profile UPN 500/11500	3200680	1036



HYDRAULICS AND ACCESORIES		
Power unit CVS FPT5	1992120	300
Hyd.Cyl.CRI-200/160-GS-TA	1992105	160
Hyd.Cyl.CRI-10/500-UL	1992115	45
Hyd.Cyl.CRI-25/200-UL	1992110	70



ADVANCING RAILS		
Advancing rail 4,5 m segment	3200123	968
Advancing rail 5 m segment	3200406	1030
Rail union element	3200128	45,5
Rail outer anchor	3200364	39,2
Intermediate Anchorage AR	3200730	42,4
Advancing rail spacer	3200670	4,8



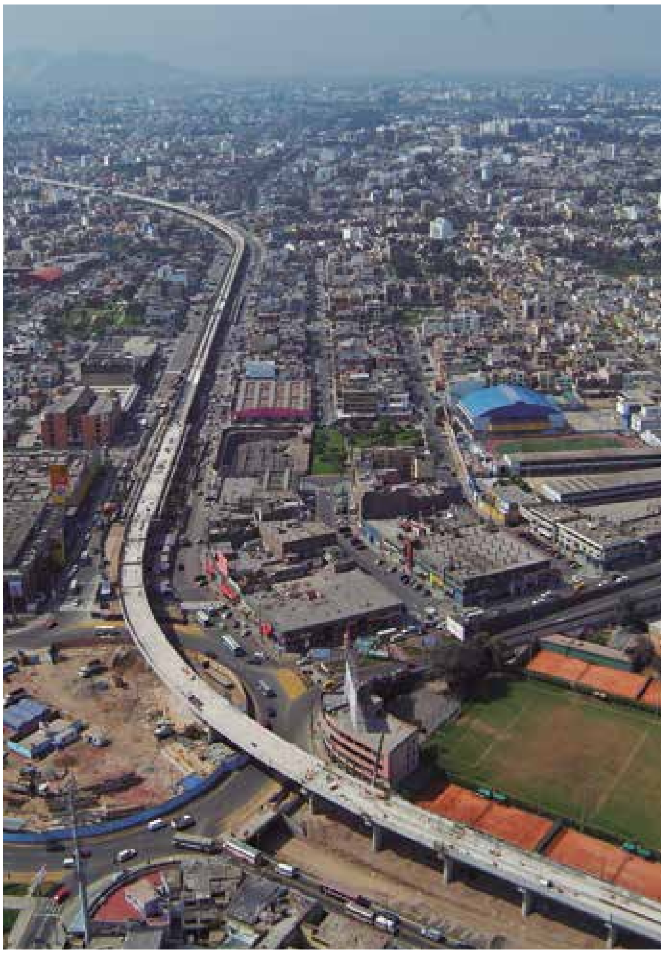
ULMA

// CVS Projects

// Electric train, Lima, Peru

***Contractor**: Odebrecht Perú Ingeniería y Construcción S.A.C. / Graña y Montero S.A.*

This emblematic project of the City of Lima involved the construction of a 12.5 km long elevated viaduct and 8 train stations to solve traffic problems and the chaos of public transport suffered by more than 300,000 passengers daily.



The CVS system has avoided road closures and works in the river for the construction of two bridges in the large Lima Metro project.

The largest structures of the project have been the two 38 m high bridges spanning the Rimac River built in situ with the balanced cantilever method and the Via de Evitamiento bypass.

Huascar Bridge: The 274 m long bridge consists of 3 spans of 75 m, 124 m and 75 m with an 8.60 meters wide deck for 2 railway tracks in both directions.

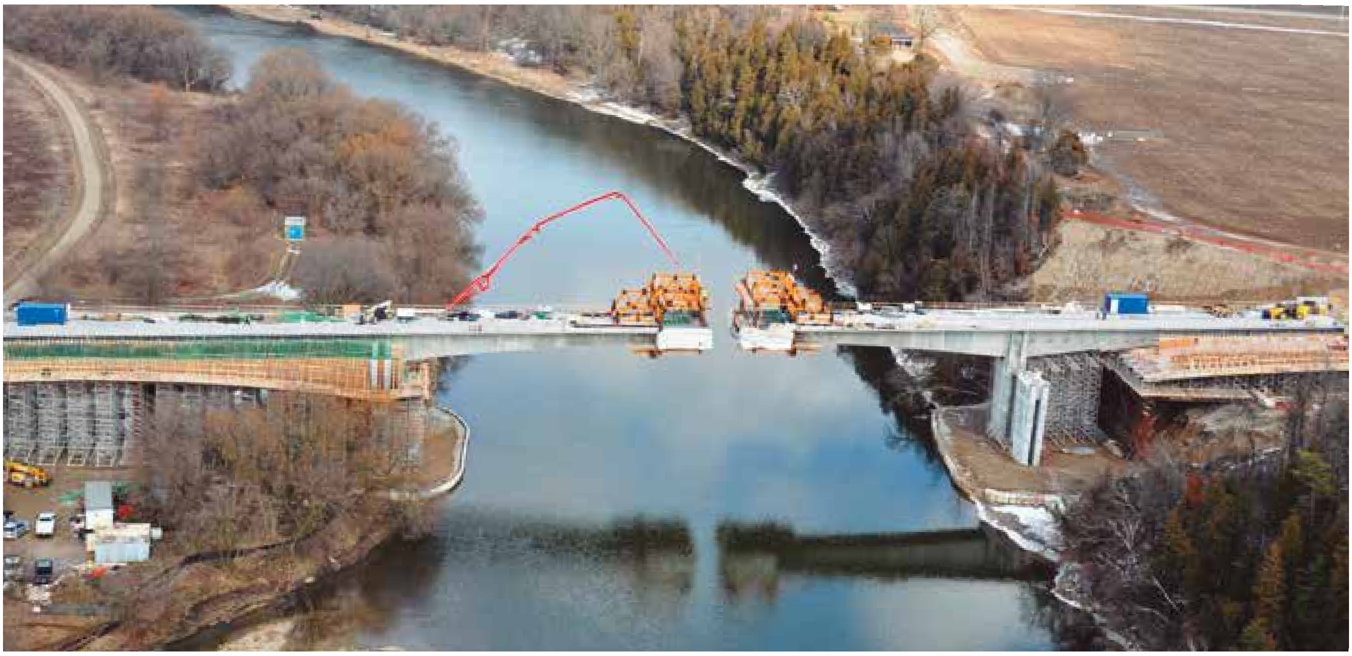
Each CVS form carriage has started work from one side of the pier segment and simultaneously has moved forward in segments of 4 m in opposite direction until closing off the bridge in the middle with a final segment of 2 m. 10 linear metres per week make this system a highly efficient construction method. In each forward movement, the continuously varying sections of 7 m at the pier ends and 3.07 m in the centre have been solved thanks to the flexibility and easy adaptation of the system.

Rimac Bridge: The 240 m long Rimac River Bridge consists of three spans of 65 m, 110 m and 65 m and an 8.64 m wide deck with a variable cross section of 2.75 m at the outer piers and 6 m in the centre. The first 65 m long stretch starts off in a horizontal curve with a radius of 400 m.

// Bridge over the Grand River, Ontario, Canada

***Contractor:** Grascan Construction Ltd*

The bridge over the Grand River links for the first time since 1963 two economically important areas, Kitchener and Cambridge. It moreover enhances the connection with one of the major motorways of the country, the 401.



With a length of 247 m, it consists of 4 spans. The largest one, 95 m, bridges the Grand River.

The construction method of on-site incremental segments for the longest span turns the bridge into the first one built in Ontario with this technique since the 80s. ULMA has put the most advanced system and experienced specialists in the application of the system at the disposal of the customer to construct a bridge suiting a mountainous geography with a technique rather popular in Europe.

In this case, two form carriages CVS have been used. They have been placed at opposite ends, each one starting off from one pier of the span and moving forward simultaneously towards each other until the centre of the span. A total of 19 segments of 4.75 m length each have been built. The flexibility and easy adaptation of the system has provided a powerful solution for the continuously varying bridge deck sections in each advance of the form carriage.

Based on the modular concept of the MK system, this form carrier adapts well to the different cross sections. The inside and outside formwork are independent from each other which allow of shorter work cycles. The use of MK standard components reduces the weight and costs of the equipment compared to other custom made form carriages.

// River Madeira Bridge, Porto Velho, Brazil

***Contractor**: M. Martins Consortium / EMSA*

The bridge spans the River Madeira to connect the cities of Porto Velho and Manaos.

The bridge spans 975 m and has required 40,000 m^3 of concrete for its completion. At its height, almost 500 workers have been employed on the project.

Using cantilever forming carriages, 84 bridge segments have been built, each measuring between 3-4.5 m in length and 2.8-6.75 m in height.

// Serra do Cafezal Motorway Expansion, Brazil

Contractor: *Ferrovial - Toniolo, Busnello*

The most important section of the Régis Bittencourt - BR-116 (Sao Paulo - Curitiba) motorway improvement, one of the main transportation arteries in the country with 402 km.

ULMA has been the ideal partner to supply the formwork and shoring for the various structures between kilometres 363 and 367. This is possibly one of the most critical sections of the entire motorway, due to its tight curves and irregular topography.

Due to the difficulty in constructing traditional shoring towers, the builders have opted for the balanced cantilever method. ULMA's innovative CVS Carriage has an excellent weight to carrying capacity ratio. Moreover, it's hydraulic levelling and advance system considerably reduces labour costs and construction time.

Eight CVS Carriages have been employed simultaneously throughout the worksite.

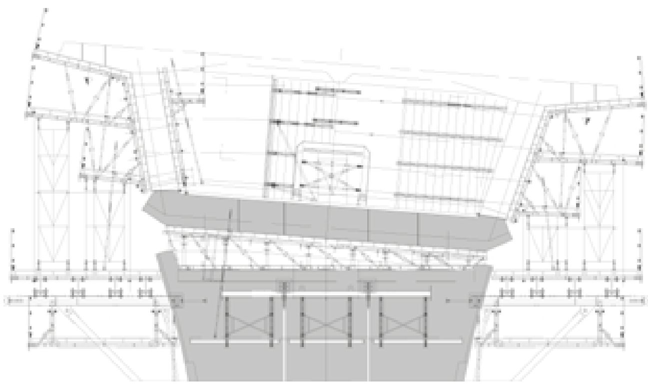
// Trapagaran viaduct, South Metropolitan Variant, Bilbao, Spain

In this large project, a careful design has been combined with the highest structural, aesthetic, and difficult terrain requirements of the area.

With a length of 1.000 m, the viaduct has been based on a single 38.80 m wide platform. The deck cross section has been with pre-stressed concrete box with a constant 5.90 m height. At a height of 40 m above the ground, the span has reaches 125 m.

The complexity of this project has laid on the large cross sections to be supported by the structure and in the width variability of the deck.

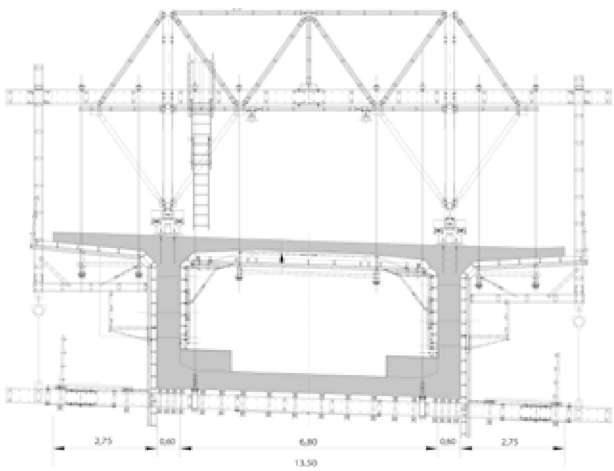
Cantilever system CVS carriages have been assembled at both ends of the starter pier cap. These carriages are designed to support large deck dimensions sections. The successive deck portions have been cast starting from the initial starter pier cap, forming in this way the deck between the viaduct's piers. ULMA's integral solution has enabled the execution of stretches at a weekly pace, achieving the expected project profitability.



// Koberny Bridge, D3 Tábor – Veselí nad Lužnic Highway, Czech Republic

***Contractor:** Metrostav a.s.*

This bridge is one of the characteristic construction projects of the D3 Tábor – Veselí nad Lužnic highway. It connects the Scandinavian countries with Greece through Germany, the Czech Republic, Austria and Italy.



The upper structure of this bridge, with a length of 560 m, consists of two parallel lanes at a maximum height of 18 m. In order to shorten the project duration, complete sets of material have been provided to perform the work simultaneously on two different piers. All in all, 4 cantilever CVS carriages have been used, 2 for each pier, each of them 12 m long.

Each system, located on consecutive piers, has made 5 m stretches until both carriages have met at the centre of the span. In accordance with the project requirements, the span closing has been completed in 9 + 9 stages, along with the last keystone segment.

The use of standard material and the possibility of renting the products for a period of 17 to 24 months have provided maximum financial advantages. The solutions proposed by the engineers, before and during the construction work, have made the execution of the project easier within the planned 24 months project duration. The customer has been fully satisfied with the logistics management and the complete engineering study of all of project phases. Thanks to their constant presence and site control, high work paces have been obtained.

// Arch bridge over the Mangart River, Slovenia

***Contractor:** Primorje*

The bridge over the Mangart river makes part of the road connecting Italy and Slovenia through the Predil Pass. The work has been performed 50 m above the river in an environment with a rather complicated terrain—the Alps.

The construction of the arch with a variable thickness (1.5 to 0.8 m), 5 m width and 90 m length has been carried out. The most cost-effective solution for this case has been offered taking into consideration its location and dimensions: MK Structures have been applied to create a cantilever system trolley that has been used from the beginning to the end of construction.

The first stages of the project have been completed without moving the cantilever trolley, which has supported on the foundation and tied to the pier. The following stages have been performed by moving the trolley to the consecutive pouring steps by means of a hydraulic system. This mechanism has minimised the time and the number of operations needed for placing it in the required position—less than 4 hours.

The fast progress of the work has been possible since 5 m of arch structure have been built in less than a week.

The 12 m trolley length and the 6 m working platform have enabled to use 12 m reinforcement steel bars.

// Paraiba River Bridge, Rezende-RJ, Brazil

Contractor: *Tardelli Ltda*

At kilometer 297 of the Presidente Dutra motorway, on the border between the towns of Resende and Porto Real, in the state of Río de Janeiro, a new bridge was built to cross the river Paraíba do Sul.

The bridge, almost 150 m long, was built as part of GAP (Growth Acceleration Program), whose purpose is to improve and expand bridges and waterways. The balanced cantilever method was chosen because shoring towers could not be placed in the riverbed.

Moving outwards from the pier, the bridge was constructed using CVS Forming Carriages to successively place segments of varying lengths. The ULMA system, apart from being lightweight, is equipped with a hydraulic advance, which provides considerable savings in time and labour.

The builders were able to finish the project in 17 segments over the course of 2 months, rather than the 4 months estimated in the original design plan. This demonstrates ULMA’s capacity to provide comprehensive formwork and shoring solutions.

// Aserradero Bridge, Colombia

Contractor: *Pavcol S.A.S.*

The Aserradero Bridge is part of the called "Motorways for Prosperity", an extensive infrastructure designed to reduce transit times for almost 260,000 people.

In order to complete one of the most difficult sections (a viaduct measuring 34 m in height and 250 m in length) CVS carriages have been proposed as a solution, given that local orography prevented falsework from being reliably supported on the ground.

The double-carriageway viaduct is 34 m tall with a symmetrical cross-section 10.3 m wide, thickness va rying between 2 m and 6 m, straight sidewalls, and a slight curve at one end. Each deck is supported by two piers with a maximum span of 125 m between them.

ULMA has supplied four 10.3 m wide carriages designed to support a maximum load of 200 t each. The efficiency and speed of this system has been crucial in the reduction of the estimated completion time.

The CVS carriages have begun at opposite ends of the span – at pier segment 0 – on both carriageways, and have advanced simultaneously toward each other. They have moved in 5 m segments with week-long pouring cycles until meeting in the middle and completing the 2 m keystone segment.

All carriages have offered working platforms and access systems for all work areas, maintaining strict conformity to the highest safety standards.

// Itapaiuna Bridge, Brazil

***Contractor:** Odebrecht S.A.*

The Itapaiuna Bridge is a three-lane overpass stretching 340 m in length, which will alleviate traffic conditions in newly built residential areas.

Facing the impossibility of building conventional shoring systems on the ground, with a distance of 113 m between riverbanks to span, CVS solution has been choosen. A flexible, high-performance system with a high load-bearing capacity and capable of adapting to varied deck widths.

Speed and efficiency have been key factors for the construction firm. Accordingly, four CVS carriages have been employed simultaneously to build bridge segments weighing approximately 190 tonnes each. With a cross-section ranging from 12.46 m to 15.05 m, and thickness varying between 4.80 m and 2.70 m, the bridge decks have been built in 5 m segments, thus reducing construction time by 30%. Each carriage has started at a different pier along the span, completing a total of 35 segments starting at 8 m in height and reaching up to 32 m over the centre of the river. The flexibility of the system has allowed it to adapt with ease to deck section variations at each advance.

Each of the CVS carriages has been equipped with a hydraulic levelling and advance system, which – along with the independent configuration of the interior and exterior formwork systems – has allowed pouring cycles to be completed in 5 days.

In accordance with ULMA safety standards, each structure has been equipped with working platforms and accesses for all working areas, in addition to perimeter protection systems.

// Bridge over the river Drweca, Expressway S7, Poland

***Contractor**: Budimex SA*

The MS-30.1 bridge is on the C2 stretch (Rychnowo - Olsztynek) of highway S7. With its two carriageways, the structure has allowed the Drweca valley to be crossed.

The bridge has three spans constructed with post-tensioned concrete. Given the 100 m length of the spans situated over the riverbed, balanced cantilevers have been the best option.

The deck has a simple box cross section with vertical side walls and a variable edge that oscillates between 5.80 m over the riverbed column and 2.35 m on the central point of the span. Due to a considerable deck width (17.6, and 19.3 m, which correspond to the right and left carriageways, respectively), reinforced concrete beams have been used as reinforcement, being placed in the springing of each segment. The riverbed span has a total of 20 sections of 4.025 and 5.030 m in length.

Being the site in full operation, up to 8 CVS carriages have been working at the same time.

// Bridge over the river Óder, Expressway S3, Poland

Contractor: *Strabag Sp. z o.o.*

The bridge runs parallel to another pre-existing bridge that crosses the Óder river and gives the S3 motorway an uninterrupted route to the Cigacie area.

It is a post-tensioned concrete structure with a simple box section and oblique side walls. Its spans are configured as follows:

72.5 + 120 + 73 + 4 x 42 + 41.5 m.

The balanced cantilever method has been chosen for the construction of the span over the riverbed and the adjacent spans. The pier segment is 11 m in length, connected to incremental segments with a constant length of 4.45 m. A total of 4 CVS carriages have been used over two columns, with a pouring cycle of 7 days. The construction of the rest of the bridge has been carried out by means of incremental launching.

From the beginning of your projects

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