

## **MS20 VEHICLE BRIDGE (BRIDGE ON VEHICLE CHASSIS)**

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### **Abstract**

*Article represent modern bridge on vehicle chassis MS-20 Daglezja – bridge span transported on special mobile transportation vehicle, where chassis, despite transportation, has opportunity to lay as well as to remove the span from site obstacle in very short time. Bridge allows rapid overcoming natural and artificial site obstacles of width up to 20m for Polish army and NATO vehicles, subject to impose a load less than 70MLC for track laying vehicle, and 110MLC for wheeled vehicles.*

*Vehicle has a lot of characteristic features. The MS20 vehicle bridge of cryptonym “Daglezja” with easiness can run in heavy terrain thanks to practical application of 12x12 wheel drive. Important is that vehicle can go public ways without of pilotage, mainly thanks to possibility to change span width for transport, and to fact that overall dimensions are not exceeding traffic regulations. In consequence of above MS-20 Daglezja is allowed to ride on public ways, creating possibility to fast reaction if need be. Bridge can be used in many situations, not only in combat, but for example in situation of cataclysm and sudden necessity to deliver food and clothes, or other goods for separated from world population.*

**Keywords:** MS-20, Daglezja, vehicle bridge, bridge on vehicle chassis, tank bridge

### **1. Introduction**

The MS20 vehicle bridge of cryptonym “Daglezja” is a result of research and development work started in 2003 upon the order of the Ministry of National Defence. The works were to be completed at the end of 2005. Finally, the product in its current design has been constructed in 2007 and in December that year, qualification examinations have been started which were finished at the end of 2008.

Ośrodek Badawczo-Rozwojowy Urządzeń Mechanicznych “OBRUM” Gliwice (now Sp. z o.o.) was the contractor of the works.

During the works, the product passed the stage of a model, then a prototype and then, during the examinations, it was necessary to change conception thus design the second, completely different prototype II.

Data presented in this paper relate to the latter version of the product, i.e. prototype II.

### **2. The MS 20 bridge configuration**

The MS20 bridge set consists of:

- bridge transportation vehicle (MPT), which, in turn, consists of a truck-tractor and special semitrailer with a layer
- bridge span (PM).

Basic technical features of the bridge:

- carrying capacity of the span 70/110 MLC,
- span length 23.2 m,
- span length with approach ramps 25.6 m,
- maximum width of an obstacle 20 m,
- bridge width 4 m,
- weight of the set  $48 \cdot 10^3$  kg,
- length of the set 16.5 m.

In theory, only one operator is sufficient to unfold the bridge. Optimum number of operating personnel – 3 men.



*Fig. 1. MS20 bridge set*



*Fig. 2. MS20 bridge set in the beginning stage of unfolding*

### 3. Truck-tractor

JELCZ C662D43 is the truck-tractor with assembled hydraulic pump connected to the power output and hydraulic oil tank has been installed behind the truck-tractor on the frame.

The truck-tractor frame is equipped with catches for coupling the truck-tractor with semitrailer during handling the span. Height of the fifth wheel coupling (1600 mm) as well as diameter of the pin (2") is typical and enable using the truck-tractor for transportation of other semitrailers, not only the special bridge semitrailer.



*Fig. 3. Jelcz C662D43 truck-tractor*



*Fig. 4. Jelcz C662D43 truck-tractor – rear view*

#### **4. Span**

The span is of wheel track type, scissors-like folded in relation to the transverse axis in the middle of its length. When positioned on an obstacle, the span is filled along its whole length. In transportation position, the span is retracted to 3 m width. The extension and retraction mechanisms are placed on the semitrailer frame. Lifting and lowering the fillings is also operated from the semitrailer.

Operation width (4 m) and transportation width (3 m) are locked with special mechanisms during preparation for unfolding or transportation.

Approach ramps are installed manually after placing the span on an obstacle.

Weight of the span with the equipment but without approach ramps is 15 000 kg.



*Fig. 5. Folded span*



*Fig. 6. Span in the final stage of unfolding*



*Fig. 7. Part of the span with approach ramps*



*Fig. 8. Span during unfolding*

The system is able to operate (taking off and positioning) the span being in the following positions:

- completely unfolded of full width,
- unfolded of transportation width (3 m),
- folded of operation width (4 m),
- folded in transportation position (3 m).



*Fig. 9. Span at night*

## 5. Layer

The span layer is an integral subunit of the special semitrailer. Its task is to take the span off the semitrailer and position it on an obstacle. Functions of the layer are as follows:

- inserting hooks into span,
- raising the span and its rotation (maximum angle of rotation is app. 200°),
- positioning the span over an obstacle,
- disengaging from the span,

Moreover, the layer stabilizes the whole set during unfolding and folding operations.

During taking off (raising) the span, it enables guiding the span onto the fixing hooks.

The layer rotation is possible by means of three pairs of actuators:

- pair No 1 between the semitrailer frame and the intermediate crank,
- pair No 2 between the intermediate crank and the lower arm of the layer,
- pair No 3 between the lower and upper arm of the layer (upper frame cooperates with the span).

Both arms of the layer are connected on a common pin with supporting footing, whose task is to stabilize the whole set and relieve the semitrailer frame.

Before the supporting footing rests on the ground, the layer performs rotation by the angle app. 90°. This operation is performed by the pairs of actuators No 1 and 2.

Positioning on an obstacle is executed by pair No 3.

Operation of the layer during taking off the span is performed by the pairs of actuators No 3 and 2.



*Fig. 10. Layer in unfolded position*



*Fig. 11. View of the layer in folded position*

## 6. Special semitrailer

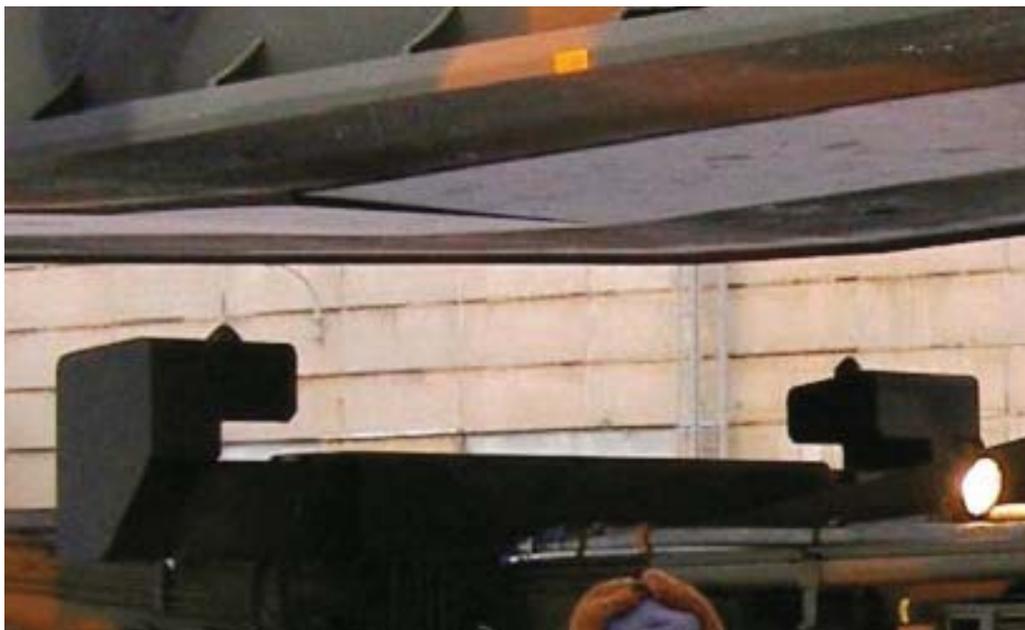
The semitrailer of the set fulfils many basic (except transportation) functions.

- Because weight of the truck-tractor is used to keep the set in balance during operating the spans, frame of the semitrailer has to transfer bending moment of high value. The truck-tractor uses special fixed coupling (Fig. 12) at the connection with the semitrailer.
- Change of the span width from 3 m to 4 m takes place by means of the mechanism installed on the semitrailer frame (Fig. 13).- Before resting the supporting footing, the semitrailer (and the whole set) is stabilized using additional supporting actuators shown in the Fig. 10 and 11.

- The semitrailer is automatically levelled before starting the unfolding operation.
- Bridges of the semitrailer are equipped with own hydraulic drive used under severe terrain conditions. The drive is activated from the driver cockpit. This activates 12x12 drive of the set.
- Due to design aspects, new, atypical suspension system had to be used, based on suspension arms, coil springs and shock absorbers (Fig. 14).



*Fig. 12. Coupling mechanism*



*Fig. 13. Mechanism for changing the span width*

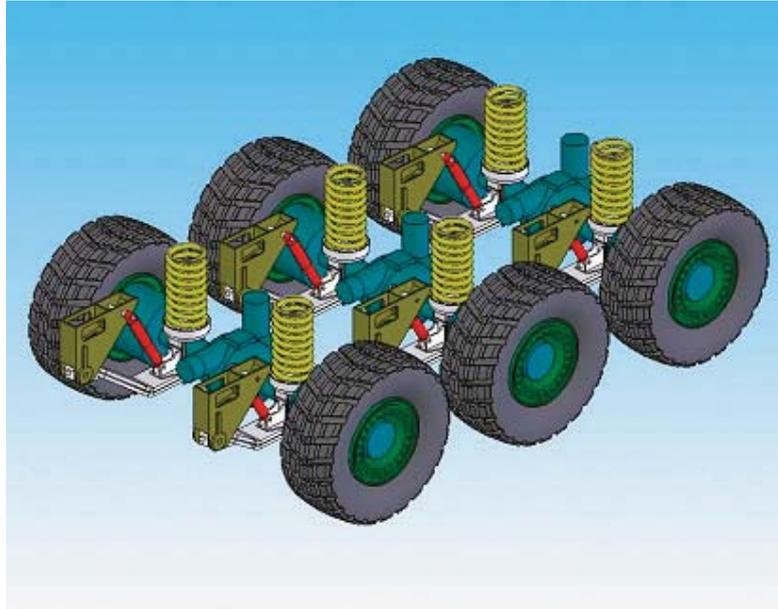


Fig. 14. Diagram of the semitrailer suspension

## 7. Control

The control system enables operating the set in automatic and manual mode, controls levelling the system as well as other elements that influence safety, such as hooks coupling, pressure, position of executive elements. Operations are performed by one operator standing next to the set. The operator is equipped with portable panel connected with the semitrailer with a cable. Using the panel, the operator can perform and supervise all activities from levelling to unfolding the bridge, disengaging the hooks and folding the layer.



Fig. 15. Portable panel

The control system is based on CAN bus.

Synchronization of the semitrailer hydraulic drives with the truck-tractor drive (12x12 drive) is another challenge.

The worked out algorithm controlling hydraulic motors driving the semitrailer axles considers speed of the truck-tractor as well as supervises possible slides of the semitrailer wheels.

## 8. MS20 test under different terrain conditions

The bridge set successfully passed wide range of tests according to the Qualification Tests Program. One of the most important elements of these examinations was terrain tests.



*Fig. 16. Test of positioning the span on a pontoon*



*Fig. 17. Tank passing dry pit*



*Fig. 18. Unfolding the bridge at inclination 20%*

## 9. Final remarks

The product presented in this paper is undisputable achievement of OBRUM Gliwice Sp. z o.o., which performed all design and assembly works by company's employees. It is worth to mention the numerical modelling of the basic bridge units which is of deciding meaning for the construction strength, carried out by the Faculty of Mechanics in the Wrocław University of Technology.

The product is ready for lot production in the design presented above, and at the same time works over its version on track-laying carrier are being carried out providing compatibility of spans, layer elements, control and other mechanisms.

## References

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