END OF THE BRIDGE FOR TEMPORARY BRIDGE CONSTRUCTION MS SET - PROPOSAL

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ABSTRACT
The paper deals with the proposal draft end of the bridge for temporary bridge of MS set construction. This conceptual draft is based on the similar system that is use for modernized bridge MMS set, but it is modified for MS set. Paper presents the reasons why this system is designed by this way and there is also made suggestion for static assessment.

Key words:
Engineer, Temporary bridges, CAD, CAE – Scia Engineer, Construction Assessment

ABSTRAKT
Článok pojednáva o návrhu ukončenia mosta pre provizórny most MS konštrukcie. Tento návrh je založený na podobnom systéme, ako je ten používaný pre modernizované mosty typu MMS, ale je prispôsobený pre MS. Článok prezentuje dôvody prečo systém navrhnutý týmto spôsobom a obsahuje tiež návrh statiského posúdenia.

Kľúčové slová:
Staviteľstvo, dočasné mosty, CAD, CAE – Scia Engineer, posúdenie konštrukcie

1 INTRODUCTION

The Czech Republic territory was hit by floods in 2009 a 2010. The region of northeastern Moravia was affected by flood in 2009 and there were damaged bridges mainly in Liberec region and Ústí nad Labem region next year. More than 50 requirements for replacing by temporary bridge were received from local governments. The engineer experts from University of Defence designed 33 temporary bridge from MS set and one from TMS set in total during flood in 2009 and 2010 (see

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Tab. 1) [1], [2]. Table No. 1 shows the location of the MS type bridge with its span. As you can see the average span of the bridge was less than 18 meters. The MS set is stored in state strategic supplies store houses as 21 meter compact set according to former requirements.

From above mentioned we can conclude that if we hypothetically used all material from state strategic supplies (in 2009 the number of MS set was 1092 meters [3]) we could not use all middle bays of the MS set. Approximately 33 middle bays of the MS set would be left without any use in store houses and five bridges could be built in addition from these bays. The problem is that the bridge assembled only from middle bays has no suitable end part to overcome space between road and bridge deck. Standard MS bridging set is equipped with two end bays used at both end of the bridge. This end bays is equipped with ramps that allows get on the bridge from the road (see Fig. 1).

Table 1 Location of the MS bridges with its span

Rok 2009		**Rok 2010**	
Bernartice - hasičárna	18m	Rousínov 1	12m
Bernartice – u Leimanů	21m	Rousínov 2	18m
Bernartice – Za tratí	18m	Kytlice	15m
Červená voda	21m	Hřensko	24m
Dolní Habartice	21m	Chrastava	21+21m
Kunín	15m	Lužec	15m
Nový Jičín - brod	21m	Děčín	18m
Nový Jičín - jez	21m	Heřmanov čp. 106	9m
Tomíkovice	12m	Všemily	21m
Veselé	15m	Dolní Habartice	21m
Životice - hospoda	21m	Heřmanov čp. 126	12m
Životice - zámečnictví	15m	Rousínov	12m
12 mostů	**219m – 18,25 m/bridge**	Heřmanice	18m
		Raspenava	18m
		Nová Ves	24m
		Mařeničky	12m
33 bridges		Chrastava ZŠ a MŠ	12m
576m – 17,45 m/bridge		Chrastava čp. 11	12m
		Chrastava Frýdlantská	18m
		Brniště	24m
		21 mostů	**357m – 17 m/bridge**

2 TEMPORARY BRIDGE MS

Bridging set MS is standardized portable steel bridges with two primary truss and lower bridge deck. It is used only for one-way traffic lane with maximum carrying capacity 60 ton. It is the most suitable to build one span bridge with length 21 m (carrying capacity 60 ton). One of the advantages of MS type is that it is not necessary to do special modification of banks for placing the bridge and ramp. The ramp is created by folding ramps which belong to the end bridge bay. These ramps are suitable for short time traffic. The bridging set MS is usually provides for use for two years period. In some cases are bridges used for longer time than two years and it would be better to use different solution for end of the bridge in these cases, because the ramps

are very vulnerable to long term traffic. In some cases it is necessary to do building banks modifications and folding ramps could be damaged.

Fig. 1 End bay of the bridge MS with folding ramps

The MS bridging set was modernized in 2005 and new set was called MMS. Among other things the modernization consisted in changing the way of the crossing on bridge construction. This crossing on the bridge is handled through so-called Support component (Fig. 2). This component solves crossing problem. To compensate height difference between base plate where the construction is placed on and the deck is wedge of soil, concrete or asphalt, which leans toward the bridge structure and the Ending wall. The Safeguard vertical is used to protect pin plates and vertical of the bridge construction. Safeguard vertical is mounted to pin plates of end bay. The bearing consists of an upper bearing plate and base plate. Ending wall is anchored to the base plates.

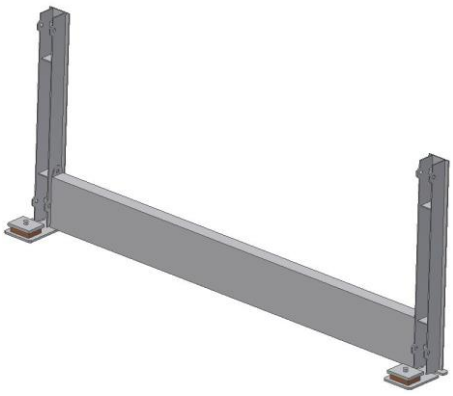

Fig. 2 Support component

Proposal draft is based on Support component from MMS bridge set, but it consists only from two parts – Ending wall and Safeguard vertical (Fig. 3). It differs from Support component of MMS set in other constructional details, the main are mentioned below:

- Basement is simpler – the construction is not mounted to bearing like MMS Support component.
- The shape and dimensions of MS components differs from MMS components.
- Connection to MS bay is carried out by placing Ending wall on pin plates and screwing to Safeguard vertical. Safeguard vertical is connected to MS bay by pin joint.

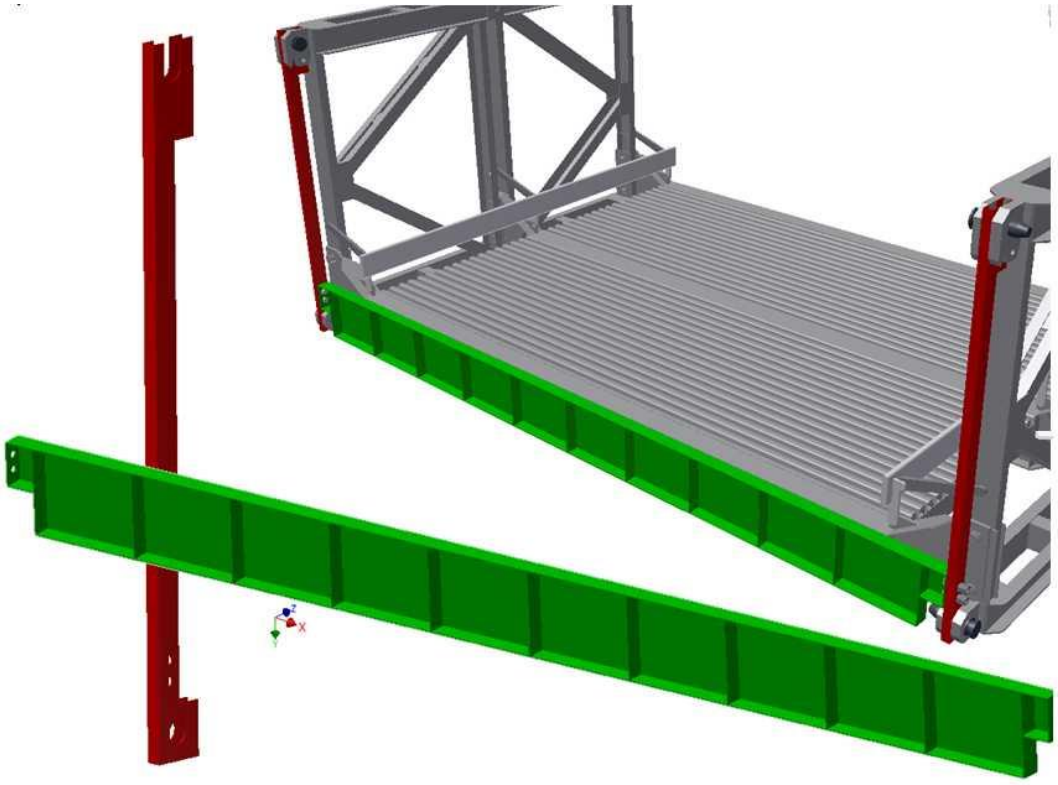

Fig. 3 Ending wall and Safeguard vertical

3 DESIGN AND ASSESSMENT

The first step was to determine the load of the Ending wall. The load is designed according to MLC 90 based on STANAG 2021[4]. The values of the load correspond to the maximum load carrying capacity for which it is possible to use the bridge according to TP [5]. MLC 90 is maximal load capacity for Caution Crossing for bridges to span 21 meters and less (Table 3). Specification of load is shown in Table 2.

Table 2 MLC 90 based on STANAG 2021

90	81.65 TONNES	93.89 Tonnes		27.21 TONNES			

Table 3 MS load carrying capacity according to STANAG 2021

Rozpětí mostu [m]	Normální přejezd		Přejezd s výstrahou		Rizikový přejezd	
	kolové vozidlo	pásové vozidlo	kolové vozidlo	pásové vozidlo	kolové vozidlo	pásové vozidlo
9	MLC 70	MLC 70	MLC 90	MLC 90	MLC 90	MLC 90
12	MLC 70	MLC 70	MLC 90	MLC 90	MLC 90	MLC 90
15	MLC 70	MLC 70	MLC 90	MLC 90	MLC 90	MLC 90
18	MLC 70	MLC 70	MLC 90	MLC 90	MLC 90	MLC 90
21	MLC 60	MLC 60	MLC 90	MLC 90	MLC 90	MLC 90
24	MLC 40	MLC 50	MLC 80	MLC 80	MLC 90	MLC 80
27	MLC 30	MLC 40	MLC 60	MLC 60	MLC 70	MLC 70
30	MLC 30	MLC 30	MLC 50	MLC 50	MLC 60	MLC 60

The Ending wall is bending by heaviest axle of load vehicles - 24.49 tons. We expect centric location of the axle on the Ending wall and transfer all load to the Ending wall from axle to the wall. The final load is 2510 kN/m^2. The load for calculation is 200 kN/m on beam. Scheme of the load and its size is shown in Figure No. 4.

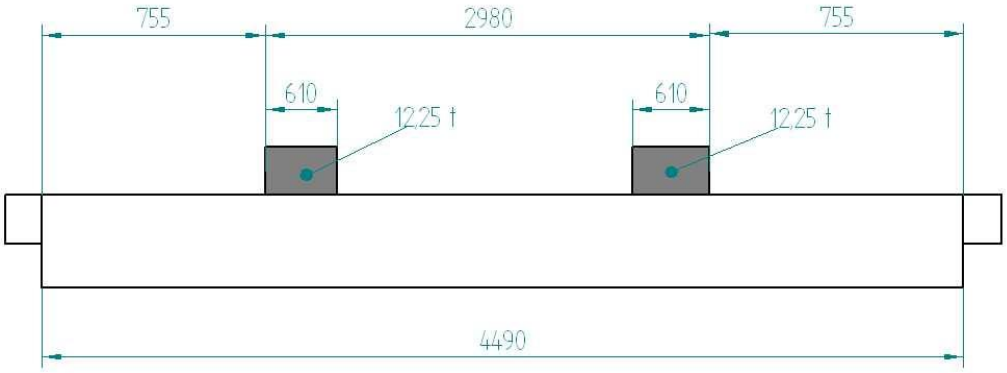

Fig. 4 Scheme of the load

Ending wall dimensions are shown in Figure No. 5. All plates are 10 mm thick. The whole component is a weldment of these plates. The Ending wall will be made from steel S 355. If we chose low-alloy steel with high strength as material of the Ending wall, the weight of this component will be about 200 kg. Calculation model for Ending wall is designed like simple beam with one fixed support and one free support. In fact, the Ending wall will be placed on pin plates on both sides of the bridge bay. Stability of Ending wall will be ensured by screwing to the Safeguard vertical.

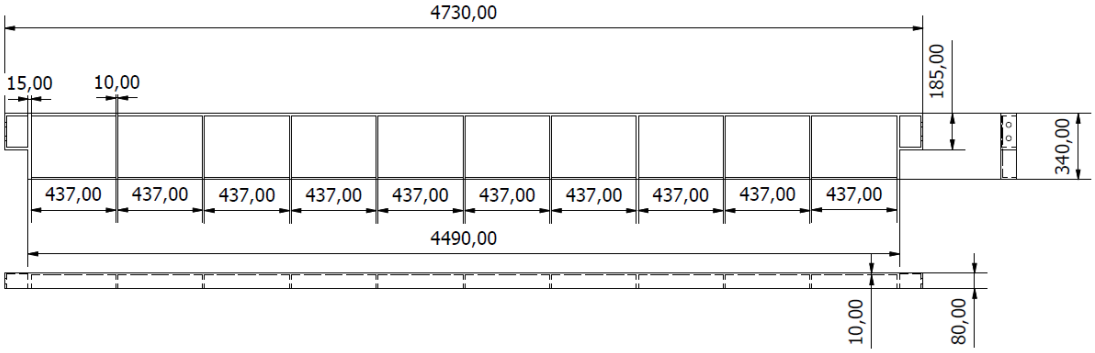

Fig. 5 dimensions of the Ending wall

4 PRELIMINARY CALCULATION

The calculation starts with classification Ending wall profile. It is a U-shaped profile with a flange thickness of 10mm and a width of 80 mm and the wall thickness of 10mm and a height of 340 mm.

Classification

a) Flange

$$\frac{c}{t_f} = \frac{80}{10} \leq 10.\varepsilon = 8{,}1 \qquad \text{true – class 1} \qquad (1)$$

b) Wall

$$\frac{d}{t_w} = \frac{340}{10} \leq 72.\varepsilon = 58{,}32 \quad \text{true – class 1} \qquad (2)$$

Cross section module

$$W_{el,y} = 4{,}17.10^{-4} m^3 \qquad (3)$$

$$W_{pl,y} = 5{,}20.10^{-4} m^3 \qquad (4)$$

Moment capacity (calculation without loss of stability)

$$M_{pl,Rd} = \frac{W_{pl,y} \cdot f_y}{\gamma_{M0}} = \frac{5{,}2\ .10^{-4}.355\ .10^{6}}{1{,}15} = 160\ kNm \qquad (5)$$

Moment induced by load

We assume that the entire axle weight is transferred to the Ending wall.

$$M_{SD} = 129{,}32\ kNm \qquad (6)$$

Shear strength

It is considered extreme shear sectional area of the Ending wall leaning on pin plates of MS bay.

$$A_V = 18{,}5.10^{-4} m^2 \qquad (7)$$

$$V_{pl.Rd} = \frac{A_V.(\frac{f_y}{\sqrt{3}})}{\gamma_{M0}} = \frac{18{,}5.10^{-4}(\frac{355.10^{6}}{\sqrt{3}})}{1{,}15} = 329{,}7\ kN \qquad (8)$$

Shear force induced by load

$$V_{SD} = 122{,}0\ kN \qquad (9)$$

$$V_{SD} \leq 0{,}5.V_{pl,Rd} \qquad (10)$$

Previous relation is valid – there is no requirement for reduction of moment capacity by shear effect. It is not necessary to do assessment for local buckling induced bending moment, because the beam cross-section is class 1.

It is obvious that designed cross section of Ending wall is for applied load sufficient. If we calculate with elastic bending module and with ensuring stability than the moment capacity is near the border for using. It should be added that the load is considerably oversized. Next step will be more precise calculation execute by FEM software SCIA ESA PT. Load will be reduced depending on the location on the surface of the flange Ending wall. Construction of the Ending wall will be designed with thinner elements, especially U profile wall, so that there has been a reduction of weight and efficient use of the elements.

Safeguard vertical is designed as U-shaped with basic dimensions that are shown in the Figure No. 7. Vertical is designed from sheet metal thickness of 5 mm and its weight is 17 kg when we use the same material as the Ending wall. The

assessment of the Safeguard vertical will be done after screws design. These screws will be used to connect Ending wall to Safeguard vertical. Safeguard vertical line is not designed as a load-bearing element. Its role is to fit Ending wall in vertical position.

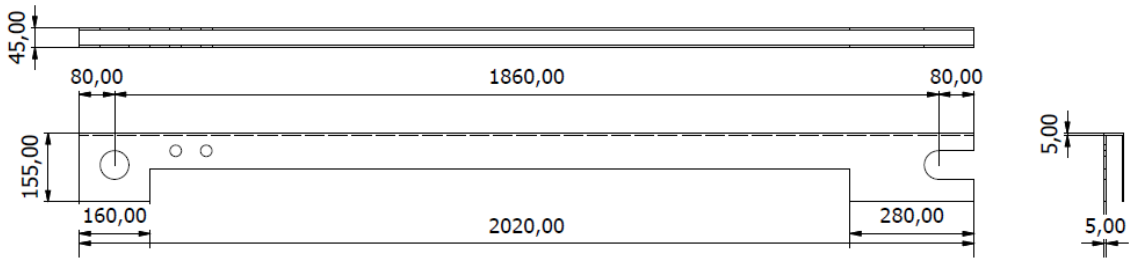

Fig. 6 dimensions of the Safeguard vertical

5 CONCLUSION

It is necessary execute more precise calculation by FEM software SCIA ESA PT. Load will be reduced depending on the location on the surface of the flange Ending wall. Construction of the Ending wall will be designed with thinner elements, especially U profile wall, so that there has been a reduction of weight and efficient use of the elements.

When the final design of the Ending wall is accomplished than we choose adequate screws and finalize the Safeguard vertical design. Safeguard vertical line is not designed as a load-bearing element it means that its own load capacity is not a limiting factor for the whole system Support components.

The system of Support components ensure to use the MS bridge set without end bays with folding ramps. This system has one disadvantage – construction of middle bays. Middle bays have not reinforced transoms to eliminate impact of vehicle that cross over the bridge. Therefore, when using this system it is necessary to reduce the maximum vehicle speed of approach or to design a solution to reinforce existing transoms in the future.

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Článok recenzovali dvaja nezávislí recenzenti.