DESING AND CALCULATION OF THE SCISSORES-TYPE ELEVATING PLATFORMS

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Abstract: This paper is the result of the need for dynamic analysis of certain elevating platforms. Project engineers research institute of Faculty of Mechanical Engineering in Pristina. Platform supporting structure is specific because of its purpose to hole and to transit the loads, as well as the kinematics of lifting mechanism. This paper started with briefly review of the scissors – type stationary platform construction and transportation system. After that, the procedure for creating the model for the leverage calculation is exposed. Strength, and the scarring capacity of construction, is proving by the structure analysis by Finite Element Method.

Key words: calculation, design, structural analysis, elevating platform, finite element

1.0 INTRODUCTION

The scissors-type elevating platforms are made for human and/or load vertical transport.
They are of great use for the assembly works, the maintenance of constructions or they can be used as parts of the inner material transportation system. If mounted on the right truck or vehicle they will become mobile, i.e. adaptable to different purposes.
The specificity in designing and calculating of the structure of this type of devices, come from necessity that carrying structure has to hold and transmit the loads up to the right supports as well as to ensure the right kinematics of the mechanism. Besides, the carrying structure has to be projected to achieve required performances (carrying capacity , platform working surface, height of lifting and lifting time), and its overall sizes have to be as small as it be.
Material Handling Institute, as a part of Faculty of Mechanical Engineering in Pristina (Hamidi [2]), developed different constructions for the scissors-type platform. In the next chapter, the review of the constructive solutions for the basic subassemblies, as parts of stationary platforms for inner transportation in scope of the PTT transportation system (Petkovic [6]) ,and the procedure for calculation of the basic elements of construction, are given in brief

2.0 REVIEW OF THE STATIONART HYDRAULIC PLATFORM CONSTRUCTION

Stationary hydraulic platform (SHP) with its carrying capacity of 2000 kg ,maximal height of lifting of 5.4 m and lifting tame t= 84 s, Fig1, is used for lifting and lowering of transportation coaches and containers.

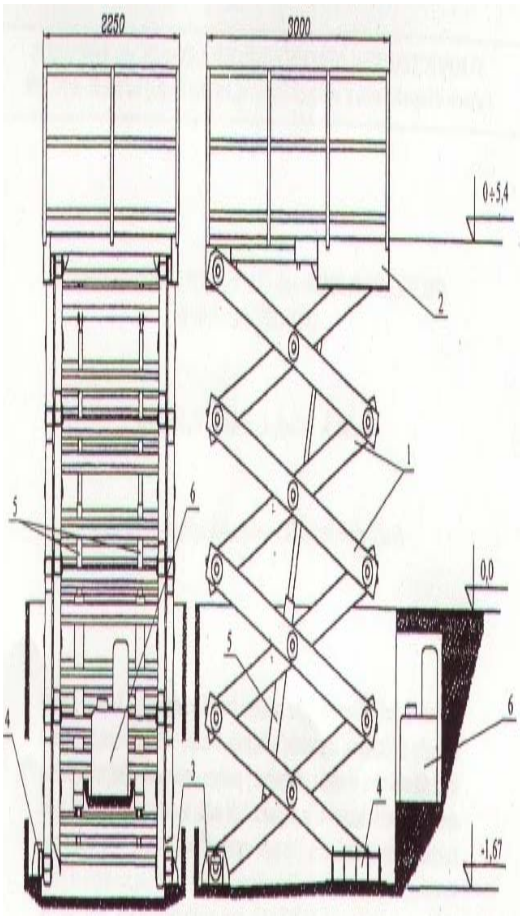

Fig. 1. – The stationary hydraulic platform, carrying capacity of 2000 kg and height of lifting of 5,4m. 1. leverage; 2. basis; 3. and; 4. supporters; 5. telescopic hydro cylinder; 6. hydraulic aggregate.

Lever are made of 220x120x8mm box –hot –shaped profiles .Leverage rigidity is ensured by cross beams made of 120x80x5 mm box-cold-shaped profiles. Joints of levers with cross beam are welded. Cylindrical joints accomplish necessary leverage mobility, fig.2.
The basis, fig.3., is made as welded steel construction.
Its tread surface dimensions are 3000x2250mm.
Connection of the basis with leverage is realized in four points. In two supporting points the cylindrical joints are mounted, whereas in other two, wheels support the basis.

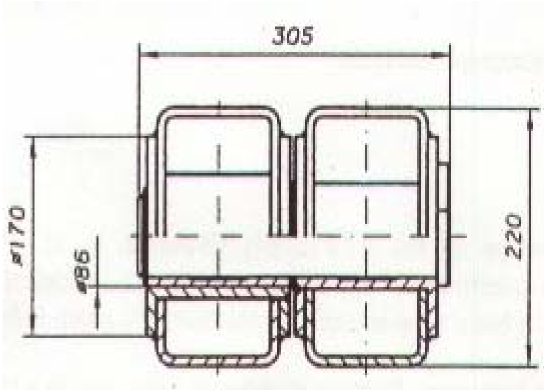

Fig.2. The leverage joint assembly.

Basic elements of hydraulic power transmission system are: hydraulic driving unit, two telescopic hydro cylinders, control panel and distributor with its accessories.

3.0 FEM MODEL OF LEVERAGE

All necessary calculations for the supporting structure of the leverage are made by the finite element method (Norrie [3]).
The global state of stress analysis is accomplished by using the line –type finite elements, whereas the local state of stress analysis is accomplish by using the solid-type. In the next section the global state of stress analysis is exposed.
The finite element model of the leverage, fig .4, is made of two truss-elements (hydro cylinders), 140 beam-element (levers, propping, lever spindles).
The finite element model of the leverage, fig.4, is made of two truss-elements (hydro cylinders), 140 beam-elements (lever, propping, lever spindles), 14 boundary elements for determination the supporters reactions, and 116 nodes.
The calculation is made for eight specific leverage positions, tab. 1.

Table 1- the leverage positions determined by calculation

Position	1	2	3	4	5	6	7	8
α [◦]	7,5	10,0	15,0	20,0	25,0	30,0	35,0	41,0

4.0 THE LEVERAGE EXTERNAL LOAD ANALYS

The leverage is exposed to the dead weight, the basis and hydro cylinders weight and the live loads. In the analysis of the load distribution over the leverage, caused by live loads and basis weight, Fig. 5, the following is considered:

- position of the line of attack of he basis weight and the live load, to the wheel is variable and depend on the leverage configuration,
- position of the live load is eccentric to the basis vertical plane of symmetry.

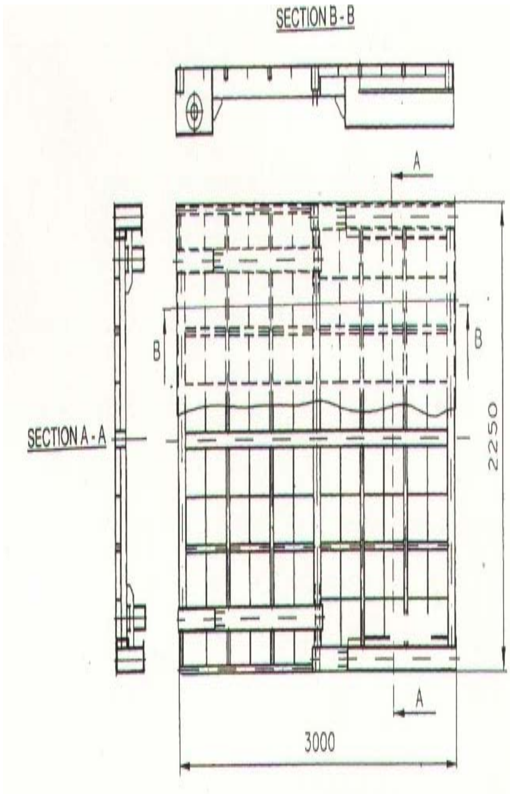

Fig. 3. The basis of the stationary hydraulic platform.

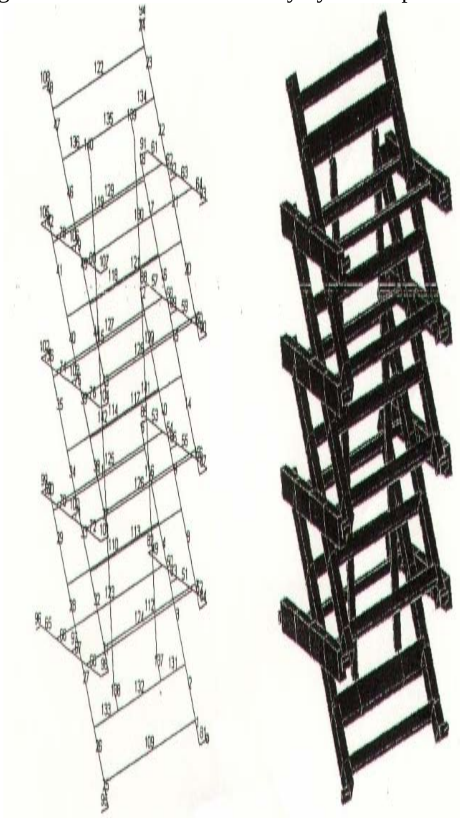

Fig. 4 - FEM model of the leverage.

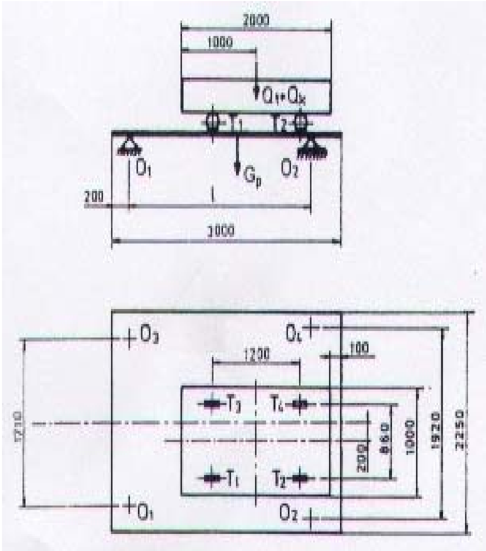

Fig.5. –The leverage load distribution caused by live load and basis weight.

Loading distribution in the nods where the basis loads are reduced in leverage, for all eight positions are given in table 2.

Table 2-The leverage external loads coursed by the live load and the basis weight.

Position	F_{v99}	F_{v100}	F_{v103}	F_{v104}
	kN			
1	-5,8	-9,3	-4,6	-6,8
2	-5,8	-9,3	-4,6	-6,8
3	-5,6	-9,5	-4,4	-7,0
4	-5,3	-9,8	-4,2	-7,2
5	-5,0	-10,1	-3,9	-7,5
6	-4,5	-10,6	-3,6	-7,8
7	-3,9	-11,2	-3,1	-8,3
8	-3,0	-12,1	-2,4	-9,0

5.0 LEVERAGE STRENGTH CALCULATION

Leverage model elements loading are determined by routine SUPERSAP (ALOGOR) (Norrie [3]).

5.1 The levers

In the first position, i.e. when the lever inclination to the horizontal line is minimal, the values of the lever loads are the biggest. Strength calculation is made according to the recommendations in (Hamidi [2], Timosenko [1]).

The diagrams and the stress distributions for the most loaded lover are given in Fig.6 (next page).

The greatest value for the referent stress is in node 1

$$\sigma_u^{(1)} = \sqrt{\left[\sigma_{Fx} + \sigma_{My}^{(1)} + \sigma_{Mz}^{(1)}\right]^2 + 3\cdot\left[\tau_{Mx} + \tau_{Fy}^{(1)} - \tau_{Fx}^{(1)}\right]^2} = \sqrt{\left[1{,}7 + 1{,}0 + 7{,}3\right]^2 + 3\cdot\left[0{,}7 + 0{,}3 - 0{,}07\right]^2} = 10{,}1\frac{kN}{cm^2}$$

and is lower than the permitted one,

$$\sigma_u^{(1)} = 10{,}1\frac{kN}{cm^2} < \sigma_{dop1} = 24{,}0\frac{kN}{cm^2}$$

5.2 The lever spindles

The critical lever spindles cross section is exposed to transversal force Ft =127,4 KN and flexural momentum 169,8 kN cm. When determining partial factor of safety, the dynamic durability with variable load is adopted as critical load. Total factor of safety for composite strain v=2,3 satisfy, i.e. guaranty the secure platform action.

6.0 CALCULATION OF CARRYING CAPACITY OF LEVERAGE BEARING JOITS

Considering that FEM model of the leverage is made analog the systematic lines of beams and taking the construction of the slide bearing into consideration, one can conclude that the transversal forces applied in corresponding nodes, are equally distributed on bearings, whereas the momentum's are decomposed on couple of forces, Fig. 7.

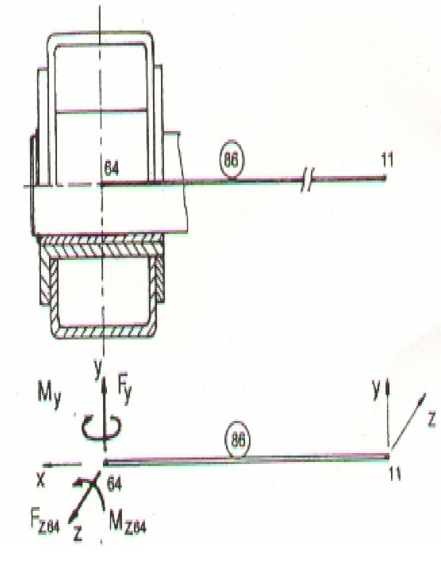

Fig.7. The bearings loads.

In considered case the values for the radial forces on bearing exposed to greatest load, are

$$F_{ry} = \frac{F_{y64}}{2} + \frac{M_{z64}}{12{,}2}, \quad F_{rz} = \frac{F_{z64}}{2} + \frac{M_{y64}}{12{,}2},$$

Since the value of the sliding velocity is $4{,}9 \cdot 10^{-4}\ m/s$, the plastic yielding limit of the bearing bush material can be adopted as the carrying capacity criteria (Harti, Rubinstajn [5]).

If the pressure is distributed over the contacting surface due to the sinus law, the factor of safety against the plastic deformation of the bush will be 2,3.

7.0 CONCLUSION

The carrying structure of the scissors-type of platform is relatively specific, primary because of its purpose to hold and to transmit the load on the fundament as well as to provide the required kinematics. Therefore, the elements of supporting structure are in the same time the mechanism parts, as well. From above mentioned, it

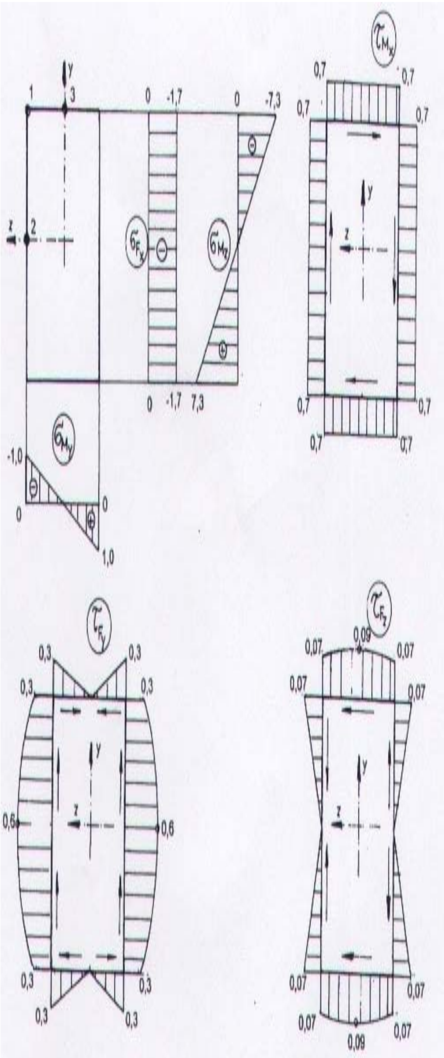

Fig.8. The stresses in lever.

Can bee conclude that platform structure calculation had to be done for several different configurations, to determine the component loads of the individual elements of construction? Thus, the extreme loading of elements of the construction is not in the same system configuration. Application of the structure analysis method, i. e., FEM enable the relatively fast determination and its state of stress, and thus the verification of considered solution.

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