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FORMWORK DEMANDS ON CRANE OPERATION

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Abstract

Before the construction outset it is not possible to precisely define the demands on the crane operation. Nevertheless, it is necessary to define the real demands as precisely as possible. The only way to reach this is to determine the process that will require the biggest demands during the construction. System formworks in monolithic assembled constructions appear to be very demanding. The article shows the requirements during the mounting of system formwork by cranes. It further indicates considerable differences among time norms in planning programs. Time norms in the planning programs are compared with the time reality in certain constructions at the end of the article.

Keywords: *Operation, element, system, construction, transfer*

INTRODUCTION

Recently system formwork has belonged to the most used formwork types. Traditional formwork has been substituted by the system formwork for several reasons. The most important reason for its frequent usage is the speed of montage of system formwork elements and their reusability. Nevertheless, system formwork has more advantages such as a wide range, higher strength of system formwork elements and also a higher safety thanks to a complex solution of proposed systems. The above mentioned advantages have changed well-established procedures in construction.

TURNOVER RATION OF FORMWORK

In case of formwork it can be said that the most expensive formwork is the formwork that is insufficiently used. It is very important to rent only the amount of formwork elements that will be effectively used. In order to be able to determine what amount of formwork will be needed, the designer must perfectly know the project and construction process. Another important advantage appears to be working experience. In order to have effectively used formwork it is necessary to count with a turnover ratio of about two days for framed wall formwork. Furthermore, it is necessary to count with the turnover rate of about 1-2 days for mast formwork and approximately 10-15 days for ceiling formwork.

Nevertheless, it is crucial to realize the factors that affect the formwork turnover. Such factors are for example weather, static construction design, used materials, experience of the construction company and the least predictable factor appears to be the engineering supervision.

LIFTING MECHANISM

A person who is in charge of lifting mechanism proposal in construction should have profound knowledge of working processes in construction, used materials and the person should also know accessible machines. Such person should be sufficiently experienced. However, even a specialist can make mistake in the planning phase. Such mistakes often cause great financial and time loss. It is crucial to prevent such mistakes. The basic mistakes seem to be the most frequent ones although such mistakes are not often considered in advance. That is why basic ways of formwork transfer that is necessary to be specified during lifting mechanism design, is described further in this article.

Main factors that must be taken into account in design:

- Range – whether the machine can handle the required construction
- Resistance - the ability to transport the element of a certain weight to the storage location (set of related elements)
- Time of usage - whether it is advantageous to have a machine in a construction site throughout the whole construction period
- Price – whether or not to choose either a smaller or an older machine type

To exemplify that the price is a very important factor, a table below supports the claims from the above.

Crane type	Time of usage [months]	Lease [thousands CZK]	Operators [thousands CZK]	Power Consumption [thousands CZK]	Other Costs [thousands CZK]	Total Costs [thousands CZK]
MB 1030.1	1	40	33	5	170	248
30/30/8	3	120	100	15	170	405
	6	240	201	30	170	641
Liebherr 63K	1	60	35	4	189	288
40/30/6	3	180	105	12	189	486
	6	360	210	24	189	783
MB 2043	1	140	37	7	215	399
55/60/12	3	280	111	21	215	627
	6	420	222	42	215	899
Potain 386	1	100	35	2	199	336
50/30/4	3	300	105	4	199	608
	6	600	210	8	199	1017
MB 27431	1	170	40	7	225	442
60/55/14	3	510	120	21	225	876
	6	1020	240	42	225	1527

Tab. 1 Examples of financial costs for certain tower cranes

The table shows how important it is to use the proposed lifting mechanism as effectively as possible and to have the lifting mechanism in the construction site only for the time needed. Most planners use various software for time planning and that is why it is appropriate to ask whether man-hours in certain budget programmes are correct and reliable. After several basic software programmes were examined it was found out that man-hours in different budget programmes vary a lot. That can lead to either overrating or underrating of the construction time, which in the end can lead to significant complications and the associated financial losses.

The following table supports the above mentioned facts. The table shows randomly selected labor input values from several budget programmes and literature.

Element	Activity	Build power [man-hour]	Gross + Callida [man-hour]	Literature [man-hour]	Maximum difference
Ceiling	Formation	0,650	0,511	0,650	0,139
	Removal	0,170	0,266	0,170	0,096
Mast	Formation	0,700	0,859	0,680	0,179
	Removal	0,300	0,237	0,310	0,073
Foundation	Formation	1,600	0,364	0,270	1,330
	Removal	0,320	0,201	0,110	0,210

Tab. 2 Basic man-hours

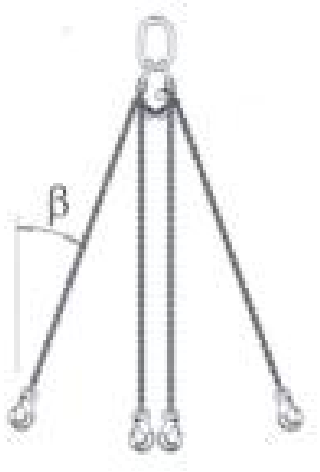
The table shows that it is necessary to determine certain man-hours for certain formwork types and various manufacturer types should be considered too.

FORMWORK TRANSFER

There are several basic types how to safely transfer system formwork in the construction site. This chapter shows basic transfer types and it also emphasizes suitable supplements that should be used during the elements transfer.

4.1 Spoke Crane Chain

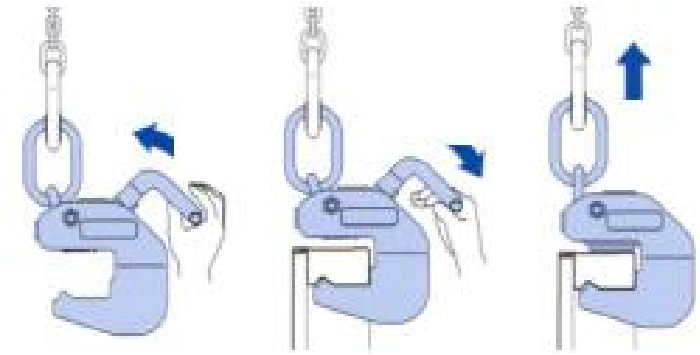
This chain is attached directly to the crane hook. As the name suggests, it is a chain composed of four lifting attachments. It is not necessary to use all the lifting attachments in order to suspend the element. Load capacity is very important. Maximum load capacity of spoke crane chain is usually about 2400 kg and the working angle is not higher than 30°.



Pic. 1 Spoke Crane Chain

4.2 Crane Eye

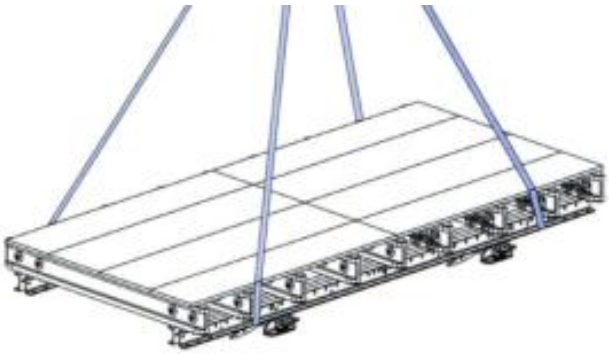
Crane eye is most commonly used element for transporting printed formwork elements. Mostly, more crane eyes are often used in combination with spoke crane chain. Maximum load capacity of one eye is often around 1000 kg. Crane eyes are provided with a safety lever that prevents accidental disconnection of the eye during transport or assembly of elements. It is therefore very important to monitor the proper security before handling the components. The following figure shows the control lock levers on the shackle.



Pic. 2 Controlling the locking lever on the crane eye

4.3 Carrying Strap

Carrying strap is used for loading, unloading, transportation of formwork elements and possibly to transport assembled formwork tables. Standard strap length is about 13 metres and maximum load capacity is about 2000 kilograms.



Pic. 3 Transfer with the help of carrying straps

4.4 Adjustable Carrying Fork

Carrying forks are used mainly for formwork tables transport. Their main advantage appears to be the adjustable fork width and vertical extension allowing the transport between floors. Maximum load capacity is often about 1500 kilograms.



Pic. 4 Carrying Fork

4.5 Transfer of individual elements

The transfer of larger elements is preferred to smaller elements. However, it is important to transfer single elements. If we have to use this type of transfer, it is necessary to know how to correctly attach the element to the lifting mechanism. The crane eyes are often used for the attachment. When the size of an element is smaller than 60 centimetres, it is possible to use only one crane eye. On the other

hand, in case of an element that is larger than 60 centimetres, it is always necessary to use two crane eyes. Crane eyes location must be always over a flitch plate, thereby preventing lateral displacement.

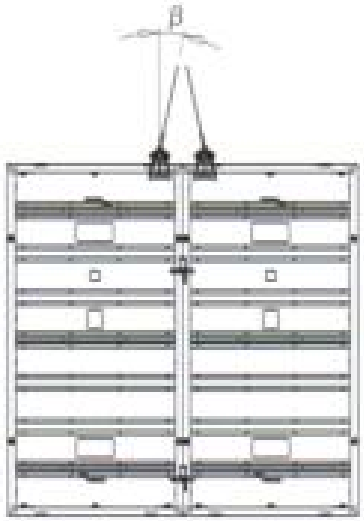


Pic. 5 Transfer of elements smaller and larger than 60 cm

4.6 Transfer of a Set of Connected Elements

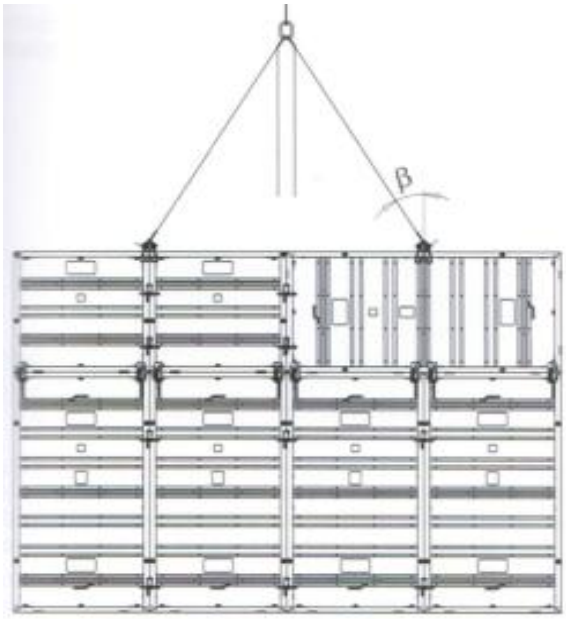
This transfer type is the most frequently used type in construction. It means a considerable time saving both for the lifting mechanism and for the workers providing mounting. The important fact that has to be considered is the fact whether it will be possible to transfer the element to the determined place as the sets are often very heavy. At the same time the sets are often strained and there appears a threat of their snapping. The sets can be suspended always symmetrically and it is necessary to ensure that the angle of inclination must not be greater than 30 °.

When transporting two identical assembled elements, crane eyes are placed near the center of the assembly, which helps to prevent lateral shifts of shackles.



Pic. 6 Transport of two identical elements in a set

If a set of more components is transferred it is necessary to try to fit shackle always on the connection of two elements, which in turn prevents lateral shifts. There exists an exception in placing crane eyes near the elements that are placed in the set horizontally. The crane eye has to be placed through a transverse profile as shown in the following figure.



Pic. 7 Transfer of a set

CONCLUSION

To conclude, it is necessary to emphasize the importance of profound knowledge of used materials both for designers and all other workers that will participate in construction. Every system has its own examples of utilization and only perfect knowledge of such details can lead to easy and safe montage of this system.

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