Prof. Ing. Dario Pozzetto

Department of Engineering and Architecture – University of Trieste

Via Valerio, 10 –34127 Trieste – Tel: 040.558.3805 / 7982 Fax: 040.558.3812

E-mail: pozzetto@units.it

INDUSTRIAL PLANTS

Chapter thirteen:

Bridge crane

DOUBLE DEGREE MASTER IN

“PRODUCTION ENGINEERING AND MANAGEMENT”

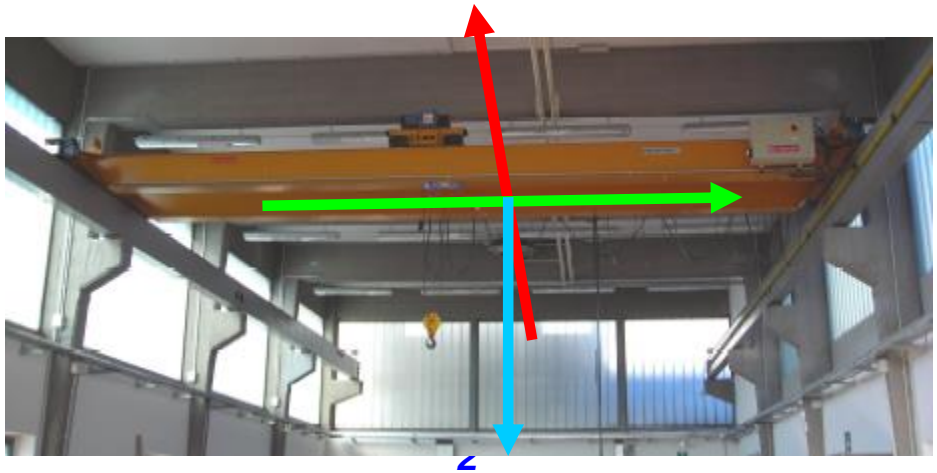
SEAT OF PORDENONE

UNIVERSITY OF TRIESTE

Generality

The **bridge crane** is a transport system designed for lifting-displacement of material and goods, with movements restricted and confined areas, both indoors and outdoors of the factories for the transfer of semi-finished and finished products from one department and another or towards the loading and unloading area of the supply chain. It is essentially a hoist or a winch mounted on a trolley that moves on a metal structure (bridge) which slides on two runways elevated. The movements typical are:

- longitudinal of the bridge;
- transverse of the trolley;
- vertical (lifting and lowering the load) made by a crane or a truck-winch.

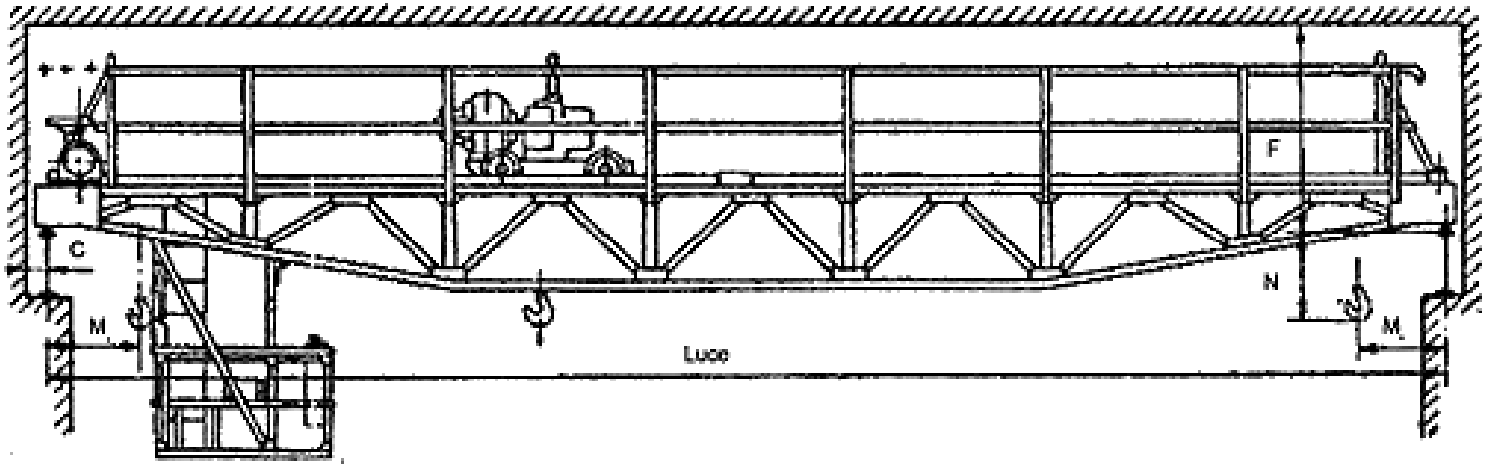


Generality

At winches are applied one or more cables which, with a system of pulleys, gears and hooks allow the lifting or lowering of loads in the form of packages or bulk materials in place of the hook when you have the appropriate implement (for example a bucket).

Several can be the structures kind of crane, including:

- bridge at truss structure and truck-winches motorized, that is suitable for small loads and large spans;



Generality

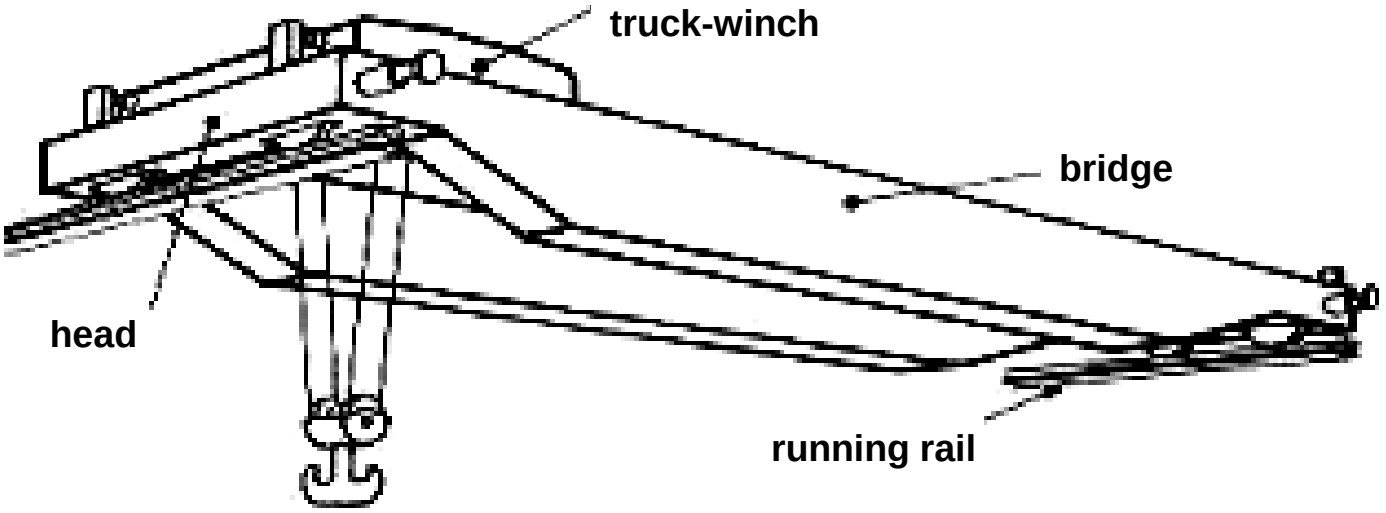
Several can be the structures kind of crane, including:

- bridge at truss structure and truck-winches motorized, that is suitable for small loads and large spans;

Generality

Several can be the structures kind of crane, including:

- bridge with two girders at full soul and truck-winches sliding to the beams above them suitable for high capacity and intensive services;



Generality

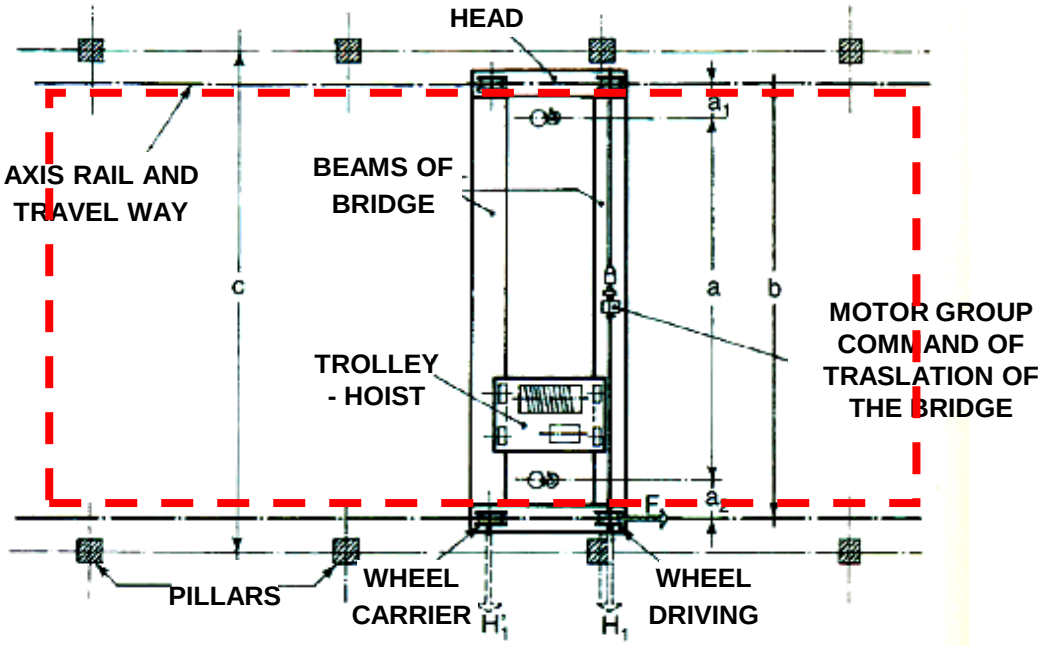
Several can be the structures kind of crane, including:

- bridge with two girders at full soul and truck-winches sliding to the beams above them suitable for high capacity and intensive services;

Generality

The bridge crane carries a transport:

- discontinuous;
- bound to an operational area of rectangular shape;
- vertical and horizontal (sliding winches and hoists).

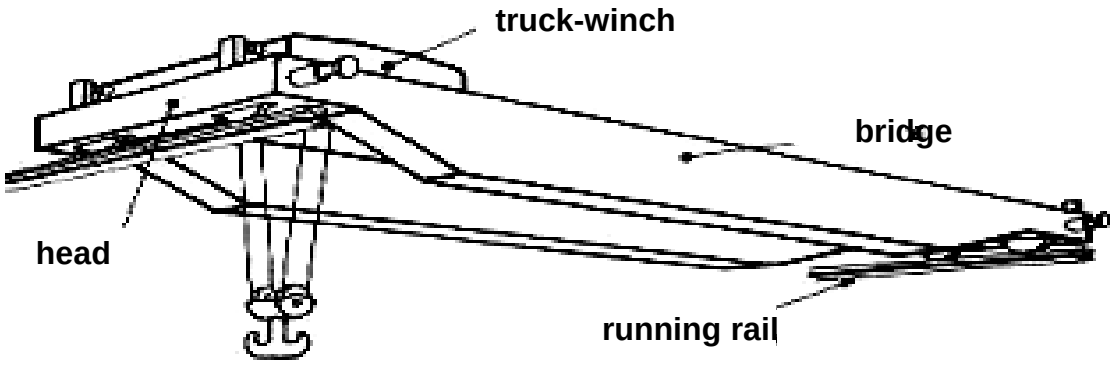


a	=	maximum stroke horizontal of the hook;
a_1 a_2	=	juxtapositions side of the hook;
b	=	wheelbase of rails of scroll;
c	=	wheelbase of pillars the building;
F	=	braking action;
H_1	=	trasverse actions normal to the runways.

Generality

The main components of a bridge crane are:

- hoist or truck-winch;
- bridge;
- heads of the bridge.



The bridge crane is a lifting construction that is subject to specific regulations that periodic verification. There are bridge cranes for loads ranging from tens kN to hundreds of kN (tens of tons).

In the bridge crane motorized, the operator operates on a suitable spray booth placed on the crane or standing on the ground.

Project data

For the design or verification of a bridge crane is necessary to define some key elements:

- the maximum load to be moved (capacity useful or nominal);
- the wheelbase between the running rails (improperly light or gauge of the bridge crane);
- the type of bridge crane;
- the type of rails used;
- the speed of lifting the load, of carriage movement and of translational motion of the bridge;
- the acceleration corresponding to the lifting, the translation of the carriage and the translation of the bridge;
- the maximum vertical travel required by hook or by implement;

Project data

For the design or verification of a bridge crane is necessary to define some key elements:

- the type of control (cab suspended from the bridge, from the ground with switch to cart, at bridge or sliding along the bridge);
- the supply voltage and the frequency of the electrical energy;
- the mode of transmission of motion to the drive wheels of the trolley and of the bridge (are preferable ones that make it independent);
- the arrow of elastic deflection of the bridge (they have different maximum values for the different types of beam);
- the class of the bridge crane.

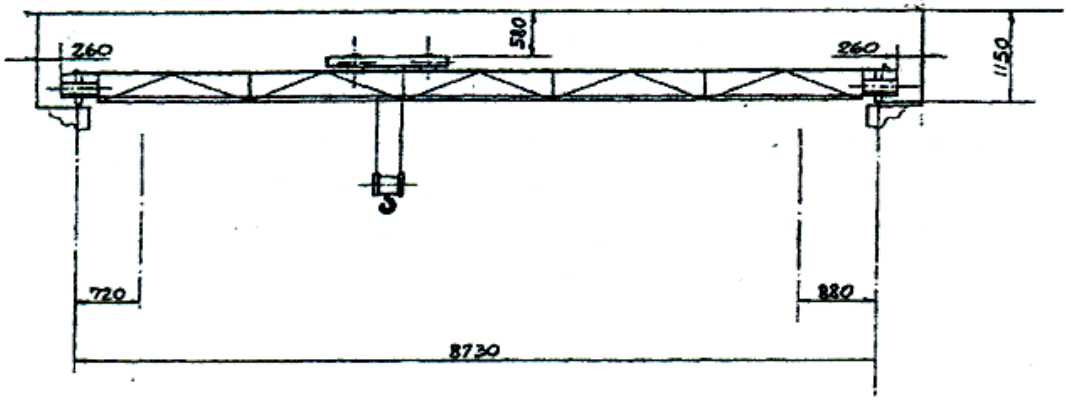
Project data

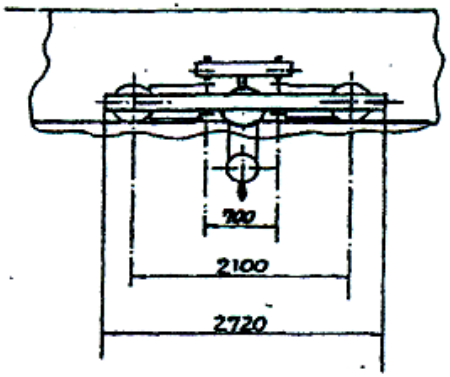
Consider a bridge crane of the nominal capacity of 30 kN (FU). The bridge crane is constituted by two I-beams (IPN 30), Fe material 360, with the permissible solicitation of σ_{amm} = 16 N/mm^2, bracing externally with a reticular structure. The two cylinder heads port-wheel are made from two C-profiles welded opposite each of the same material of the beams at double T. The cart is made with heads of similar construction to those of the bridge, while the connecting beams are constituted by C-profiles of the same section and of the same material. The structure is joined by welding connections in the most critical.

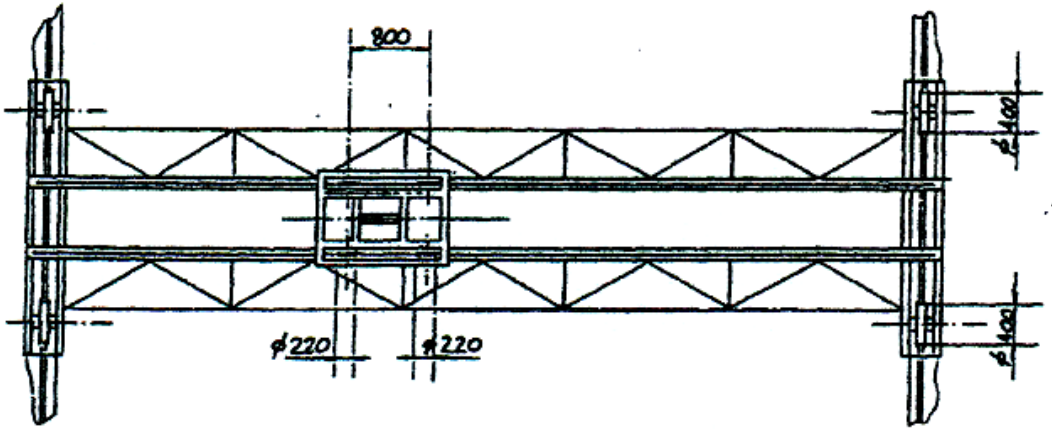
The sliding movements of the bridge and of translation of the carriage are driven manually by means of chains and reduction gears, to decrease the force required to move the wheels. The lifting movement is instead powered by an actuator which allows a lifting speed from 0.5 to 2.5 m/minute (v_s) and its drive system uses a control a panel.

Project data

The scheme of the bridge crane is as follows:







Project data

The principal dimensions are as follows:

- wheelbase between the running rails (inappropriately light or gauge of the bridge crane) = 8.730 mm (s_p);
- step of the wheels of the bridge = 2.100 mm (p_p);
- gauge of the trolley = 700 mm (s_c);
- maximum juxtaposition of the wire of the wheels of the bridge = 720 mm (a_p)
- step of the wheels the trolley = 800 mm (a);
- maximum juxtaposition: left 700 mm and right 800 mm;
- diameter of the wheels of the bridge 400 mm and of the cart 200 mm.

Project data

With regard to the weight of the structure we have:

- lifting equipment, hook block, hook, rope etc. F_E = 1 kN;
- carpentery of cart = 2 kN;
- hoist of lifting = 8 kN;
- trolley-winch = 10 kN (P_C);
- single main beam of the bridge = 6 kN (P_T);
- single bracing of the bridge = 2,5 kN;
- single head of the bridge = 1,2 kN;
- total of the bridge = 19,4 kN (P_P).

Classification of the bridge crane

The rules CNR 10021, ISO 4301 and F.E.M. 1001 divided the cranes and bridge crane in classes according to their intended service.

To determine the class of membership shall be considered:

- the total number of load cycles that operating the bridge crane will in the course of its useful life (n). It depends on the frequency of use of the unit and the rules set ten conditions of use:

Condition of use	Number of cycles n
U0	$0 < n \leq 16.000$
U1	$16.000 < n \leq 32.000$
U2	$32.000 < n \leq 63.000$
U3	$63.000 < n \leq 125.000$
U4	$125.000 < n \leq 250.000$
U5	$250.000 < n \leq 500.000$
U6	$500.000 < n \leq 1.000.000$
U7	$1.000.000 < n \leq 2.000.000$
U8	$2.000.000 < n \leq 4.000.000$
U9	$4.000.000 < n$

Classification of the bridge crane

The rules CNR 10021, ISO 4301 and F.E.M. 1001 divided the cranes and bridge crane in classes according to their intended service.

To determine the class of membership shall be considered:

- the regime of load K_p, which depends on the loads P_i that the crane will move during the exercise and the number of times in which it occurs n_i. The value of K_p is determined by the relation:

$$K_p = \sum \frac{n_i}{n} \cdot \left(\frac{P_i}{P_{\max}} \right)^3$$

where:

n = total number of load cycles;

n_i = number of times that the load is lifted P_i;

P_{max} = maximum value of the load P_i.

The rules F.E.M. reported four areas of possible change in regimes of load:

Regime of load	Value of parameter K_p
Q_1 (light)	$K_p \leq 0{,}125$
Q_2 (moderate)	$0{,}125 < K_p \leq 0{,}250$
Q_3 (heavy)	$0{,}250 < K_p \leq 0{,}500$
Q_4 (very heavy)	$0{,}500 < K_p \leq 1{,}000$

Classification of the bridge crane

On the basis of the intervals U of the total number of cycles and of the variation range of the regime of load Q is obtained the class of the apparatus:

Regime of load	Number total of load cycles									
	U0	U1	U2	U3	U4	U5	U6	U7	U8	U9
Q_1	A1	A1	A1	A2	A3	A4	A5	A6	A7	A8
Q_2	A1	A1	A2	A3	A4	A5	A6	A7	A8	A8
Q_3	A1	A2	A3	A4	A5	A6	A7	A8	A8	A8
Q_4	A2	A3	A4	A5	A6	A7	A8	A8	A8	A8

For each class corresponds to a value of the increase coefficient M that is applied, in the structural calculation of the bridge crane, to the forces induced by its own weight and by the load of the service, and the horizontal forces of acceleration and deceleration of the bridge crane:

Class	A1	A2	A3	A4	A5	A6	A7	A8
Coefficient M	1	1,02	1,05	1,08	1,11	1,14	1,17	1,20

Classification of the bridge crane

In agreement with the reference standards, the classification of the structure of the bridge crane in question is obtained by the following parameters:

- number of load cycles = 50.000 (U_2)
- spead of load = Q_1 (light) with K_p = 0,1

The class of the equipment appears to be the A1 which account for a coefficient of increase of the load M = 1.

Phases characterizing the design of a bridge crane

The phases that characterize this design are:

a) evaluation of the regular forces (service load, weight, vertical and horizontal inertia forces), forces occasional (forces due to the winding, wind, snow, etc.) and forces to be considered in the calculation of exceptional design and verification of the structures of bridge crane

b) elements of design and verification of the bridge crane:

- trolley-hoist
- main beam (determination of resistance, fatigue assessment, verification at jamming soul, verification of concentrated loads and verification the buckling)
- beam of the trolley (verifying at resistance and fatigue assessment)
- ropes
- drum, pulleys and balancer
- diameter of the wheels of the bridge and of the trolley
- electric motor of lifting
- braking torque