Advances in Engineering Research (AER), volume 102
Second International Conference on
Mechanics, Materials and Structural Engineering (ICMMSE 2017)

Crane Runway Beams: Endurance Test

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Keywords: Crane runway beam, Endurance test, Constructions, Durable Construction

Abstract. Article the decision of current challenges in testing the endurance of steel crane girders. This article reflects the results of a lot of work to improve the durability of crane constructions. A detailed description of the special laboratory for testing of steel crane girders due to dynamic effects. On all devices given in the article obtained the patents of the Russian Federation

Introduction

When calculating crane girders industrial buildings and structures necessary to consider the cyclical nature of the dynamic effects of bridge cranes. The accumulation of damage occurs gradually. In the under-rail wall zone developed fatigue cracks, dangerous increase to dangerous levels the possibility of destruction of structures. This process is generally defined as a metal fatigue, and the corresponding called fatigue degradation.

Preventing fatigue failures are critical ha rakter in industry, which lead to catastrophic failure (for example, in the shops of ferrous and nonferrous metallurgy or buildings CHP). The problem priobre-melts more and more important due to the rapid dilapidation of industrial fund the country [1, 2].

The cyclical nature of the forces acting on the crane structure due to local transmission of the effects of the crane wheels (mobile-focused vertical $P^{\ell oc}$ and horizontal $T^{\ell oc}$ of force as well as torques $M_{\text{кр}}^{\ell oc}$

The impacts arise when driving with the load and lifting and lowering; under-rail portion of the beam arises tense state (depending on the provisions of the wheel; there are cycles). This is the main feature of the dynamic effects on the crane wheel crane design [3]. Changing local stress cycles in the beam occurs at the passage of each wheel of the crane. Accumulation of cycles depends on the number of wheels of the crane, and the intensity of the process in the workshop. Often tap reciprocating movement, while at the same beam, so the accumulation of stress cycles of change on the dynamic effects of wheel many times more what the total bending occurring only when the complete unloading of the beam.

Construction works at cyclic effects in the general case is an asymmetric cycle Fig. 1; easily decomposed into medium voltage τ_m and dynamic stress amplitude component with a symmetrical cycle; $A_\tau = 0.5$.

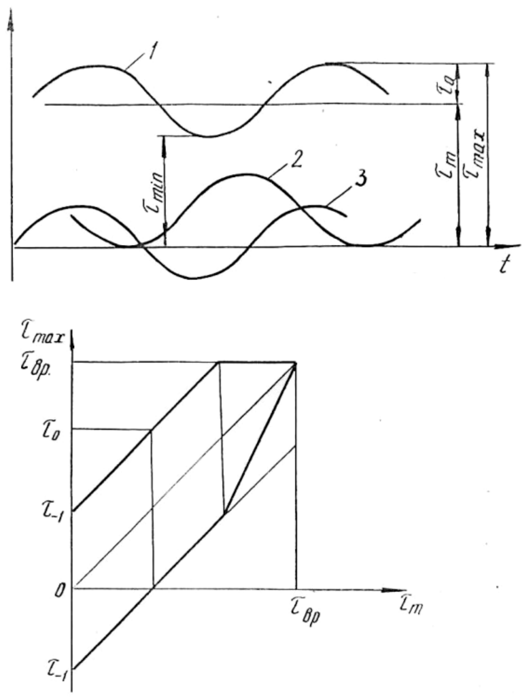

Fig. 1 Cyclic changes in of shear stresses.

In a symmetrical cycle the average voltage τ_m= 0,5 (τ_{max} + τ_{min}), imposed a symmetrical cycle with an amplitude τ_a = 0,5 (τ_{max} – τ_{min}).

Actual and today remains the problem of the origin of fatigue cracks in the crane beams (aggravated in the late 40-ies of XX century). It is known [3], fatigue cracks primarily arise from the amplitude component (magnitude shear stresses vibrations2 τ_a). The amplitude components having the rolling of wheels on rails cranes. They are under-rail deformation zone generate waves moving along with wheels, which was confirmed in numerous surveys (fatigue cracks under-rail beams are concentrated in the zone).

For valuation effects on the crane structure determined the impact of bridge cranes; determined by the carrying capacity of crane beams under the action of jacks-pulsators (specific sections). We define the value of the dynamic factors and the combination effects, the stress state of the walls of I-beams (developed by the head of the relevant sections of SNIP "Loads and effects"). This enabled experimental and theoretical models to explore the large crane girders with dynamic effects (using jacks pulsators-creating power of fixed sections, not moving along the beam).

Experimental

In all studies, fatigue cracks occurred at a high voltage level close to the yield strength of steel (low occurred when local stress $\sigma_y^{loc} \approx 130...160$ МПа in the elastic region of work began; typical for fatigue testing).

Jack-pulsator operates in a fixed section; there are local impacts in a small volume of steel. Wheels, moving reciprocally cause cyclical changes in the effects of a significant volume of a large number of micro-defects as centers of nucleation of fatigue cracks (steel heterogeneous; there are micro-inclusions, pores, dislocations). The occurrence of fatigue cracks increases many times as compared with the action of the jack-pulsator in one of the fixed sections.

As you can see, obviously we need to build stands to simulate the real work of bridge cranes with the development of hardy crane structures. This requires endurance when tested beams:

- Cyclic display of the actual effects when driving the wheels of bridge cranes heavy duty work 7K, 8K;
- Rate of accumulation cycles should be high;

- Area under-rail beams are damaged by fatigue cracks, should be subject to reciprocal influences wheels with such amplitude that this area is completely unloaded from the AC-field oscillations of local shear stresses;
- High performance test and the identity of the loading conditions of several beams;
- Stability of the exposure wheel, regardless of their location on the beam in order to achieve the reliability test;
- Ease of assembly and disassembly of the beams and the convenience of their location for inspection gages and stickers;
- The stand must have a high reliability and stability.

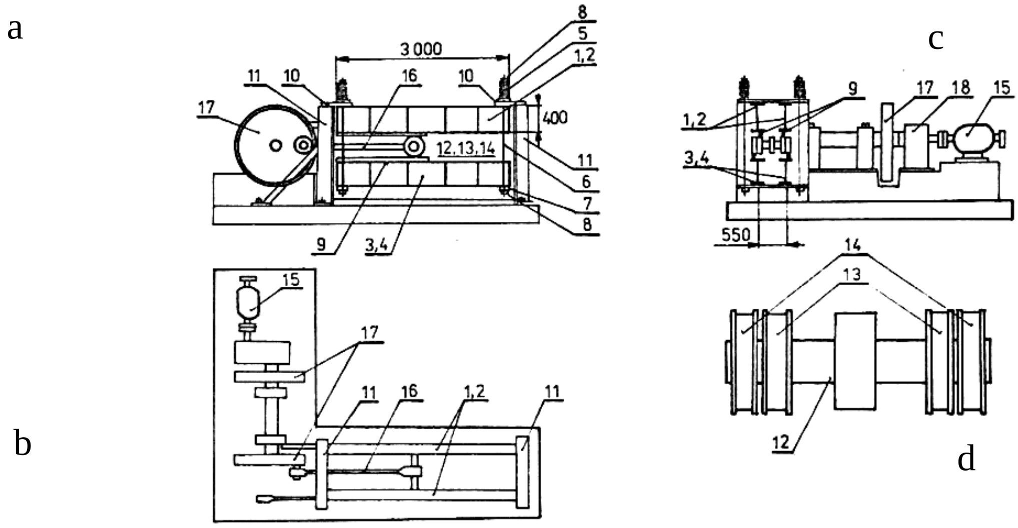

Fig. 2 Stand for testing of crane beams
a- general view of the stand; b - plan; ca- section A-A; d - unit load wheels:
1, 2 - experienced upper beam; 3, 4 - the lower beam experienced; 5 - spring; 6 - traction, compression experienced by the beam with each other; 7 - cross beams connecting beams experienced with each other; 8 - straining nuts; 9 - rails fixed to the beams 1, 2, 3, 4; 10 - hinge leaf whereby experienced suspended beam; 11 - support columns; 12 - a shaft, which is pushed over to the keyed inner pair of wheels 13; 14 - outer pair of wheels on a sub-roller bearings; 15 - electric motor; 16 - a connecting rod; 17 - flywheel pair of wheels; 18 - reducer lowering the number of revolutions of the electric motor

Fig. 3 Stand for testing of crane beams (photo 2016).

In the laboratory, "Endurance crane girders" FGOBU "Penza State University of Architecture and Construction" acts stand (Fig. 2, 3), which imitates the work-conductive bridge cranes heavy operation (under the guidance of prof. K. K. Nezhdanova [4, 5]).

Stand for testing beams endurance consists of upper and lower 1.2 3 4 test beams, tied to each other by means of springs 5, 6 rods, transverse cross members 7 and nuts 8. beams 1,2,3,4 fixed rails 9. The system of the four beams under-veshena through hinges 10 to the support posts 11. On the shaft 12 nasazhana inner 13 and outer 14 pairs of wheels. The wheels are clamped between the beams and interact with them through the rails 9. The engine 15 via a connecting rod 16, 17 and a pair of flywheel gear 18 drives the load wheel block 12 in the reciprocating motion, simulating the effects of bridge cranes. The value of the local impacts of the wheels is controlled by means of dynamometers, mounted in the rod.

Compared with a stand designed by M.M. Gokhberg [6] it has the following advantages:

- It has high performance 3600x24x4 = 345600 cycles per day;
- Provides automated, non-stop operation;
- Has multiple protection, disable it in an emergency;
- Allows simultaneous testing of four crane beams in half natural size (3000x400x200 mm) under identical conditions of loading;

The laboratory is equipped with modern instrumentation, recording varying local deformation occurring in fatigue cracks of damaged beams under-rail zone. Handling changes of local stresses in the time zone of under-rail beams on the computer allows you to get a full picture of their oscillations.

In the future, the stand has been improved, allowing to simulate the effects of horizontal $T^{\ell oc}$ overhead travelling crane and therefore oblique bending crane girders (Fig. 4).

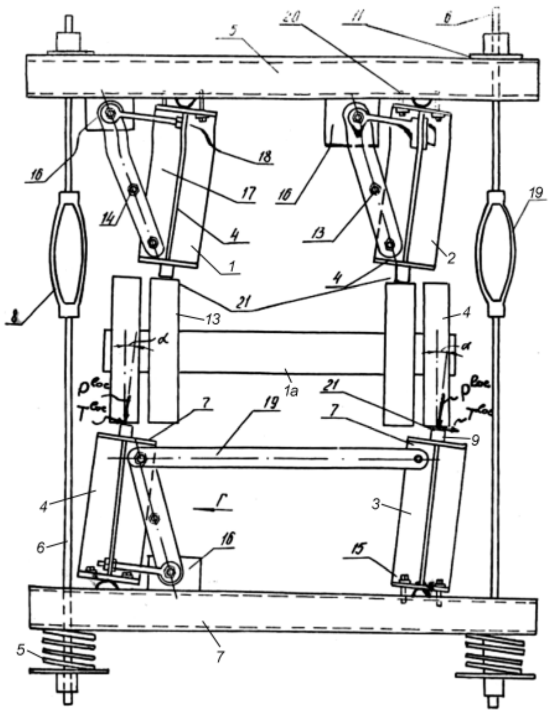

Fig. 4 Stand №1677583 .

Section AA - imitation horizontal effects

1, 2 - experienced upper beam; 3, 4 - the lower beam; 5 - spring; 6 - traction, compressing experienced by the beams to each other; 7 - cross-beams, connecting, testing beams with each other; 8 - straining nuts; 9 - rails fixed to the beams 1, 2, 3, 4; 12 - the shaft, which is pushed over the inner pair of wheels on the dowels 13;

14 - outer pair of wheels on roller bearings; 19 - dynamometers are mounted in the traction and control the impact of the wheels

It should be noted that in actual working beam at an oblique bend, that is, bent in the plane of the wall, and the upper plane of the beam waist.

Currently on the stand being tested models of continuous crane beams made from parts connected to the wall of a high resource bolting.

Result and Discussions.

1. Stand designed by K. K. Nezhdanov, in 1971 for the first time made it possible to simulate the impacts of bridge cranes (and "dial" several million load cycles) under laboratory conditions;

2. At present, tests are conducted of continuous crane girders;

3. Over the years the booth than once to modernize and increase their productivity-shaft, now in one tab will repay simulated -10 beams.

References

[1] I. N. Garkin, I. A. Garkina, Systems approach to technical expertise construction of buildings and facilities, Contemp. Eng. Sci. 8(5) (2015) 213-217.

[2] K. K. Nezhdanov, A. A. Kuzmishkin, I. N. Garkin, Method simulation of dynamic effects of bridge cranes on the crane girders, Mod. Prob. Sci. Edu. 1 (2015), URL: http://www.science-education.ru/121-17975

[3] A. I. Kikin, Increased durability of metal structures of industrial buildings. 2nd ed., Ed. AI Kikin. - M .: Stroyizdat, 1984, pp. 302.

[4] K. K. Nezhdanov. Improving the crane structures and methods of their calculation [Text]:. Monograph, KK Nezhdanov. - Penza: PGUAS, (2008) pp. 288.

[5] K. K. Nezhdanov, A. A. Kuzmishkin, I. N. Garkin. Application dvuhstenchatyh crane girders with dampening effect, Reg. Archit. Eng. 3 (2013), pp. 91-94.

[6] M. M. Hochberg. Reference cranes: The 2m. T.I. Characteristics of materials and loads. Bases for design of cranes, their drives and metal constructions M .: Engineering, 1988 to -536. V.2. Specifications and design schemes cranes. Crane mechanisms, their parts and components. Technical operation of cranes L .: Engineering, (1988), pp. 559.