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THE EXPERIMENTAL ANALYSIS OF CHOSEN SUPPORT ELEMENTS OF BELT CONVEYER

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The collator has worked almost for 30 years continuously. In this article the authors want to show the corrosion influence on the collator considering mainly the strength of construction parts at critical points stress. For that purpose strength computations were realized by classical and also modern FEM and also experimental methods (tensometric measurements), ultrasonic methods of measurement of decrease in material at selected point of the steel constructions.

Introduction

The portal bar construction with belt conveyer is used for collation and homogenization of cokeable energetic coal and blast furnace coke, at the store surface into bulks, through a throw off from the rubber strip of the collator. The main task is the collation at continuous movement of the throw off with a coal hopper along the main construction girder and at continuous movement of the portal. View to the supporting construction is in fig.1.

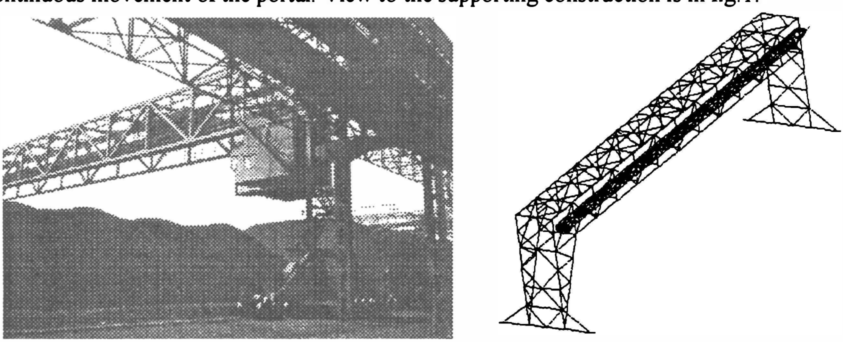

Fig.1

The collator has worked almost for 30 years continuously. The atmospheric actions, actions of working time and other unforeseen circumstances caused a bad technical condition of the device. The truss construction is joined by welded and riveted joints. In this article the authors want to show the corrosion influence on the collator considering mainly the strength of construction parts at critical points stress.

For that purpose strength computations were realized by classical and also modern FEM at primary dimensions of elements and their cross section characteristics, and also experimental methods, ultrasonic methods of measurement of decrease in material at selected point of the steel constructions and strength calculations by FEM at consideration of decrease in material by corrosion.

Judgment of the steel construction with classical computing procedures

For destination of extremely stressed points and strength judgment of the steel construction we follow the basic computation to fig.2.

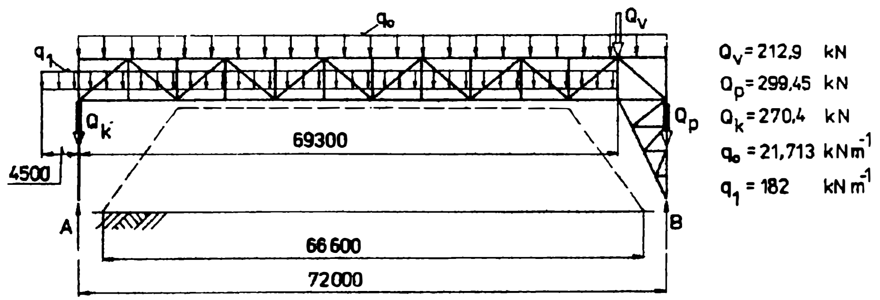

Fig.2

The computation scheme (fig.2) is used for determination of stress from horizontal side forces and from vertical effects by classical calculation methods. The designation are as follows:

H_{tp} - horizontal forces from the crossing,
Q_v - gravity of the throw off,
Q_P - gravity of the steady leg (fig.1),
Q_k - gravity of the swinging leg (fig.1),
q_0 - uniform continuous load from the own gravity of the main girder, rubber strip, supporting construction of the belt conveyer, roller stands and the other machine devices,
q_1 - continuous load from the transported material H_{tp} = 169,8 kN was determined from wheel pressure (fig.2) with standard procedure. The point zero shift force x=39,94m (see fig.2) corresponds to the value of local extreme bending moment. At this cross section according to fig.3 (to consider on the right from axle „z" the same profiles at the upper and lower corner as there are shown on the left) there are tensions from:

- vertical effects 128,2 MPa,
- forces H_{tp} 23,8 MPa,

- wind 5,0 MPa.

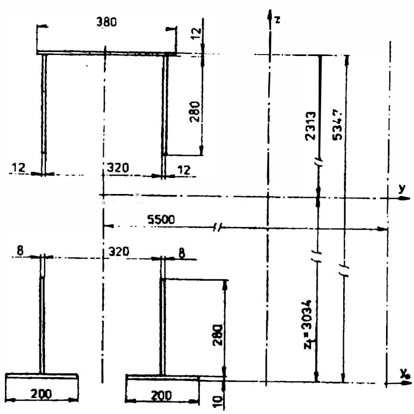

Fig.3

Considering standard coefficients for the own mass, load from the weight load from horizontal forces and wind load the resultant maximum tension at the point of maximum bending moment is:

$$\sigma_{max} = 128{,}2 \,.\, 1{,}11 + 5{,}0 \,.\, 1{,}2 + 23{,}8 \,.\, 1{,}1 = 174{,}5 \text{ MPa.}$$

Judgment of the steel construction by FEM

On the basis of shape analysis, loading of construction and boundary conditions the application of FEM was proposed. At modeling of the construction double bar and girder elements were used, altogether 1686 elements and 1039 knots. The calculation was realized for load from own gravity of the steel construction, belt conveyer, drives, throw off, transported material, transverse horizontal forces determined by standard it means H_{tp} =169,8kN, and wind pressure. The tension fields from own gravity and the gravity from transported material along the whole steel construction of the collator are shown in fig.4.

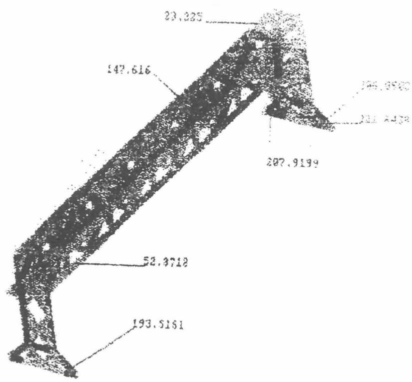

Fig.4

At point $x = 39{,}94$ m on the main girder according to FEM the tensions are as follows:

- from vertical effects 146,6 MPa (fig.4),
- from forces H_{tp} 29,4 MPa,
- from wind 9,0 MPa.

Considering standard coefficients as classical computation method the maximum tension at point x_0 by FEM will be:

$$\sigma_{max} = 147{,}6 \,.\, 1{,}11 + 9{,}0 \,.\, 1{,}2 + 29{,}4 \,.\, 1{,}1 = 207 \text{ MPa}.$$

Evaluation of decrease in primary material of supporting construction by corrosion influence

Portal bar construction with belt conveyer and throw off (collator) is after 30 years of working in atmospheric conditions considerably by corrosion influence was followed. Because of spacious construction, the decrease in material was watched only at the most critical points on the main girder, in the steady and swinging leg and the lower crossrails. The method of verifying the real thickness was based on ultrasonic principle. The used device was KRAUTKRAMER BRANSON DME DL with measuring probe up to 25 mm thickness. The comparation sample of nominal thickness and real thickness measured after corrosion of the collators main girder is in shortened tab. 1.

Tab.1

The point of measurement (supporting member)		Thickness [mm]	
		nominal	real
Join sheet in knot 5		12	11
Flange knot 5		12	7
upper flange in knot 5	outside	20	17,9
	inside	20	18

Decreases in thickness of material are from 10% to 45%.

At measurements by ultrasonic methods it was necessary to remove the corroded layers so it was not possible to measure really the real thickness of all supporting elements of the collators construction. Because of this fact, at the points, where the decrease was more than 10%, detracted thickness of supporting members were introduced to calculation models. FEM was realized at detracted thickness at load from vertical force, the constructions own gravity and also gravity of transported material at load from horizontal forces $H_{tp} = 169{,}8$ kN from crossing and wind. Fig.5 shows tension fields from own gravity of transported material along the whole steel construction of the collator.

Fig.6 shows tension fields from horizontal forces $H_{tp} = 169{,}8$ kN along the whole steel construction of the collator. Again at the point $x_0 = 39{,}94$ m on the main girder according to FEM the values of the tensions are as follows:

- from vertical effects 184,13 MPa (fig.5),
- from horizontal forces H_{tp} 32,48 MPa (fig.6),

- from wind 11,9 MPa.

Considering defect coefficients as classical computing procedures the maximum tension at point x_0 (fig.2) determined by FEM with consideration of decrease in material by corrosion is:

$$\sigma^K_{max} = 184 \,.1{,}11 + 11{,}9 \,.1{,}2 + 32{,}5 \,.\, 1{,}1 = 254{,}3 \text{ MPa.}$$

Tab.2 shows the results of calculations of maximum tension on the main girder at the point of extreme defective moment. At non corroded state of the steel construction by FEM higher tensions were located at places of extreme bending moment than by classical computations.

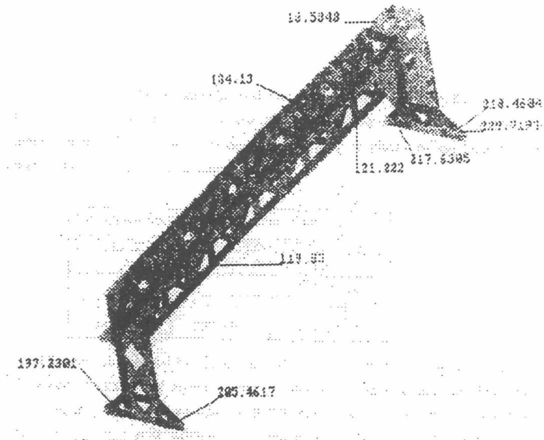

Fig.5

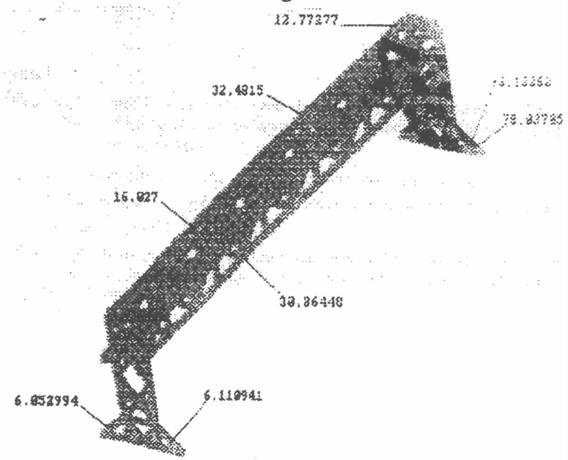

Fig.6

tab.2

Computed determination of maximum tension at the place of extreme bending moment (fig2)		
State of steel construction		
Original		Corroded
Classical	FEM	FEM
174,5 MPa	207 MPa	254,3 MPa

Decrease in material by corrosion and its introduction in computing model of FEM caused an increase of tension at place of maximum bending moment about 23%. Considering that the corrosion was measured only in selected points it is possible to say, that the value of max. computed tension is relatively high. Static fatigue of the collator constructions is expected and so the further usage is not recommended (because of its corrosion).

Literature

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