46th International Scientific Conference EXPERIMENTAL STRESS ANALYSIS 2008
Department of Mechanics of Materials, VŠB - Technical University of Ostrava
June 2 - 5 2008, Horní Bečva, Czech Republic

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ENSURANCE OF CASTING PEDESTAL OPERATION ON THE BASE OF RESULTS GAINED BY THE METHOD OF EXPERIMENTAL MECHANICS

ZABEZPEČENIE PREVÁDZKY LIACIEHO STOJANA NA ZÁKLADE VÝSLEDKOV ZÍSKANÝCH METÓDAMI EXPERIMENTÁLNEJ MECHANIKY

Abstract

Supporting structure of pedestal used for transport of casting pan up to weight 280 t was produced with using of joints with bolts and sunk keys. The joints were released during the operation. Behaviour of pedestal was analysed by experimental and numerical methods and improvements in design were suggested for ensuring reliability of operation during prescribed life time.

Abstrakt

Nosná konštrukcia stojana využívaného na prepravu liacích panví o hmotnosti až 280 t bola vzhľadom na svoje rozmery navrhnutá a vyrobená využitím klinových a skrutkových spojov, ktoré sa počas prevádzky často uvoľňovali. Využitím experimentálnych a numerických metód bolo posúdené namáhanie konštrukcie stojana a navrhnuté úpravy s cieľom zabezpečenia spoľahlivej prevádzky počas jeho požadovanej životnosti.

1 INTRODUCTION

Continuous casting of slabs is at the present time the most spread method of steel production. During this process the liquid steel is casted from the pan to the container and successively it is distributed through number of jets to continuous production line [6,8]. Transportation of liquid steel from the converter to the container is provided by pans and casting pedestal (Fig.1). During operation of casting pedestal the joints consisting bolts and sunk keys were released. Actual state of pedestal was analysed by analytical, numerical and experimental methods [1,2,4,7].

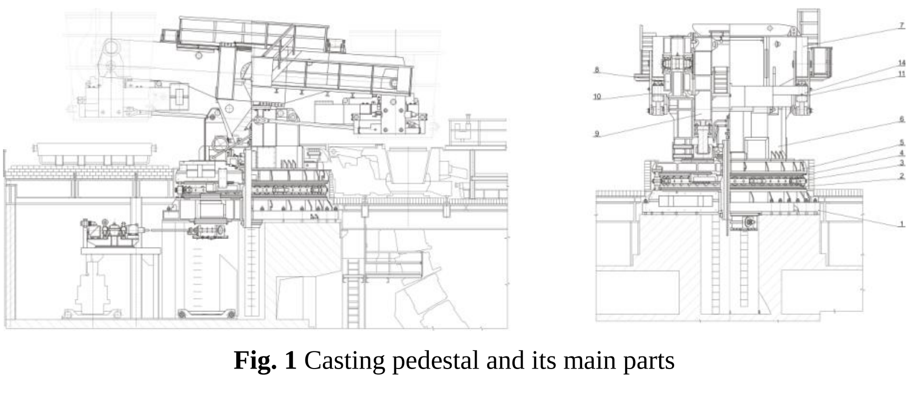

Fig. 1 Casting pedestal and its main parts

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2 SUPPORTING STRUCTURE OF CASTING PEDESTAL

Main supporting part of casting pedestal is the traverse consisting of two beams jointed with middle part with arms for toothing by bolts and sunk keys (Fig.2). During the operation of casting pedestal are in hinges A, B or C, D given the pans by hinging supporting baskets. Process of casting results to the following loading combinations of traverse: hinges A, B- full pan, hinges C, D- pan with rest of steel; hinges A, B- full pan, hinges C, D- without pan; hinges A, B- without pan, hinges C, D- pan with rest of steel. Due to the symmetry of pedestal are the hinges A, B and C, D interchangeable. For the solution was considered weight force for full pan 2 800 kN, weight force for empty pan 700 kN and weight force for pan with the rest of steel 1 200 kN.

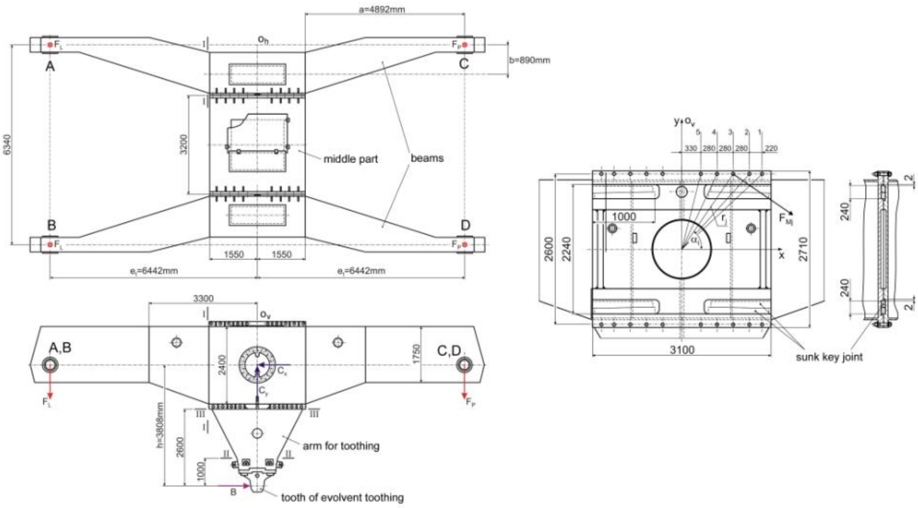

Fig. 2 Traverse of casting pedestal and joint with bolts and sunk keys for fastening of traverse beams with the middle part

During the casting are in hinges of traverse placed pans in above given combinations. Transportation of liquid steel from converter to container is realized by turning of casting pedestal (together with traverses) around vertical axis o_V (Fig.2) by 180°. Full pan in hinges A, B (reserve position) is transported to hinge positions C, D (casting position). Pan in hinges C, D (mostly with rest of steel) is moving to reserve position from which is taken (hinges C, D are without pan). Short time before steel casting from pan in hinges A, B is given full pan to hinges C, D and the process repeats. During operation the traverse of casting pedestal provides rickety rotational movement still by 180° around axis o_V. During casting traverse has additional rickety rotational movement around horizontal axis o_H so that pans are moved in vertical direction. Rotational movement around vertical axis o_V is realized by rollers on which is given whole casting pedestal (Fig.1), rotational movement around horizontal axis o_H is realized by teeth on the arms for toothing and four hydraulic piston [3].

Beams of traverse are jointed with the middle part by bolts and sunk keys (Fig.2), which are during operation of casting pedestal (as a result of alternating and irregular loading of its arms) released.

3 COMPUTATION OF STRESSES IN SUPPORTING PARTS OF PEDESTAL BY THE FINITE ELEMENT METHOD

Model of traverse (with respect to the symmetry was considered only one half – beam and middle part with arm of toothing) is given in Fig.3.

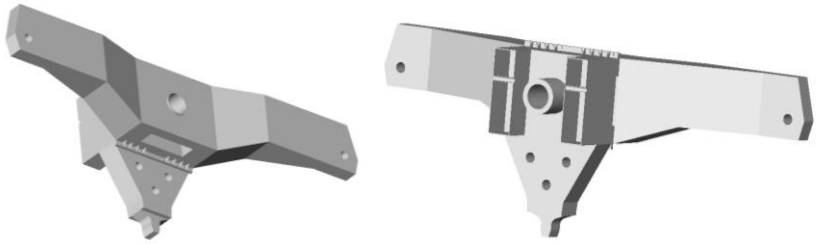

Fig. 3 Computational model of casting pedestal traverse

Computation of traverse was realized for all load cases given above. In Fig. 4 is shown the field of principal stresses σ_1 in location of bolts and sunk keys for loading of traverse by one full pan. In Fig.5 are given principal stresses σ_1 in the arms of toothing for the same loading. In Fig.4 is seen shift of traverse beam in with respect to the middle part of joint.

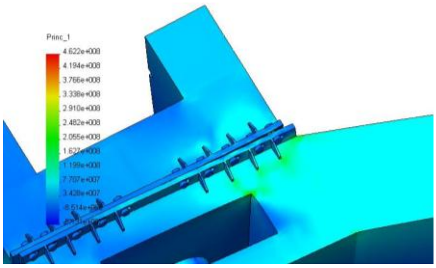

Fig. 4 Principal stresses σ_1

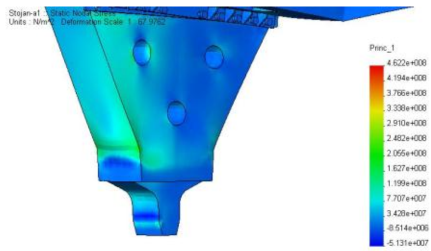

Fig. 5 Principal stresses σ_1

4 STRAIN GAGE MEASUREMENT OF TIME DEPENDENT STRESSES

For the strain gage measurement was used apparatus SPIDER 8 [5]. Strain gages were applied in ten locations of carrying structure of casting pedestal. In Fig.6 are given only locations of strain gages (1 to 4) on traverse beam where detected maximal stresses were by the finite element method computations. Further strain gages were applied on arms of toothing and on hinging supporting baskets.

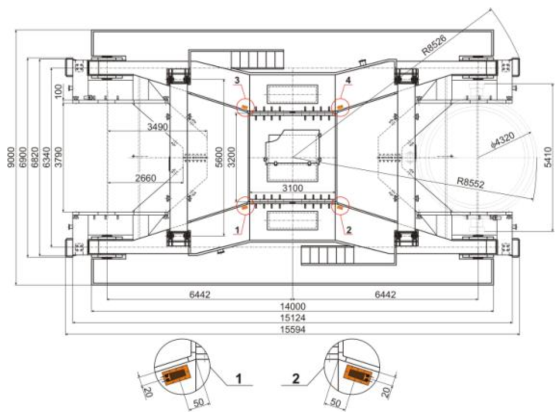

Fig. 6 Location of strain gages on traverse

Measurement of time dependent strains was realized for simulated regimes (with pans of weight 230 – 240 t – full pans and 55,6 t – empty pan) and for operation of casting pedestal. In Fig.7 are given stresses for one measurement with simulated regime. In Fig.8 are stresses for the measurement during operation.

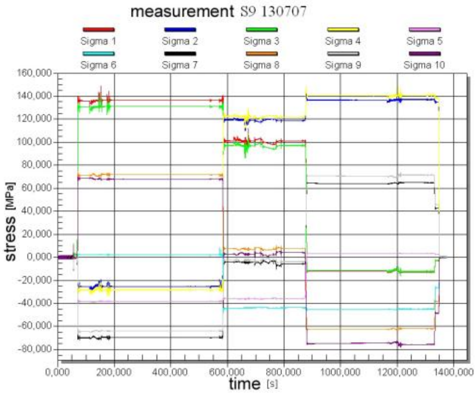

Fig. 7 Time dependent stresses for simulated regimes

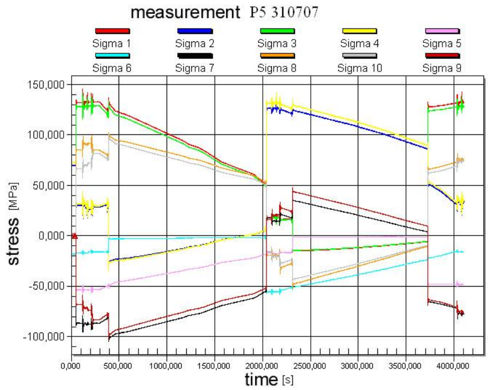

Fig. 8 Time dependent stresses during operation

5 CONCLUSION

On the base of results from analytical, numerical and experimental procedures can be stated that: Analytical computation concluded that joint of traverse beam with the middle part is problematic. Sunk keys transfer 80% of loading. Their releasing follows to danger of failure of the whole joint. Analysis by the finite element method proves that the most dangerous loading case is during manipulation with one full pan. Maximal values of equivalent stresses in traverse beam reach 150 MPa. From the strain gage measurement results that maximum stresses are in traverse beams and their reach approximately 175 MPa. In order to prevent sunk keys releasing during operation of casting pedestal it was suggested to fix the sunk keys by bolts with lock. At the same time it was recommended to increase prestress in bolted joints (with possible increased diameter of bolts). For the increasing of life time of pedestal was recommended to exclude casting pedestal from regime – one side of pedestal with full pan, second one without pan. With respect to previous operation and theory of loading accumulation was determined residual lifetime to 4,3 years. Pedestal works with the above-mentioned improvements safe for more than 8 months.

This work was supported by project VEGA No. 1/0004/08 and No. 1/4163/07.

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