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DESIGN OF EXTENSOMETRICAL TRANSDUCERS

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Abstract: The paper summarises some results obtained at design of extensometrical transducers for indirect measurement of forces, namely at rolling stands and slab shears in conditions of heavy plates rolling mills. Two basic methods of experimental stress analysis were used at design and verification of properties of these transducers - planar two-dimensional photoelastic measuring and strain gauge method. We have performed simultaneously also indirect measurement of rolling forces on rolling stand roll housings.
Keywords: Extensometrical transducer, force measurements, experimental stress analysis.

1 INTRODUCTION

In cases where it is impossible to perform direct measurement of forces with use of transducers located in direction of the resultant of their function it is necessary to use indirect measurement of these forces by extensometrical transducers. A typical example is measurement of rolling forces on older rolling stands where due to insufficient space it is impossible to situate the dynamometric transducers between the set screws and roll bearing housings. In such case it is possible to realise measurement of rolling forces with use of extensometrical transducers, fixed to the rolling stands or by direct sticking of strain gauges on these rolling stands. Due to very severe conditions in heavy plates rolling mills it is necessary to pay special attention to project and design of such transducers.

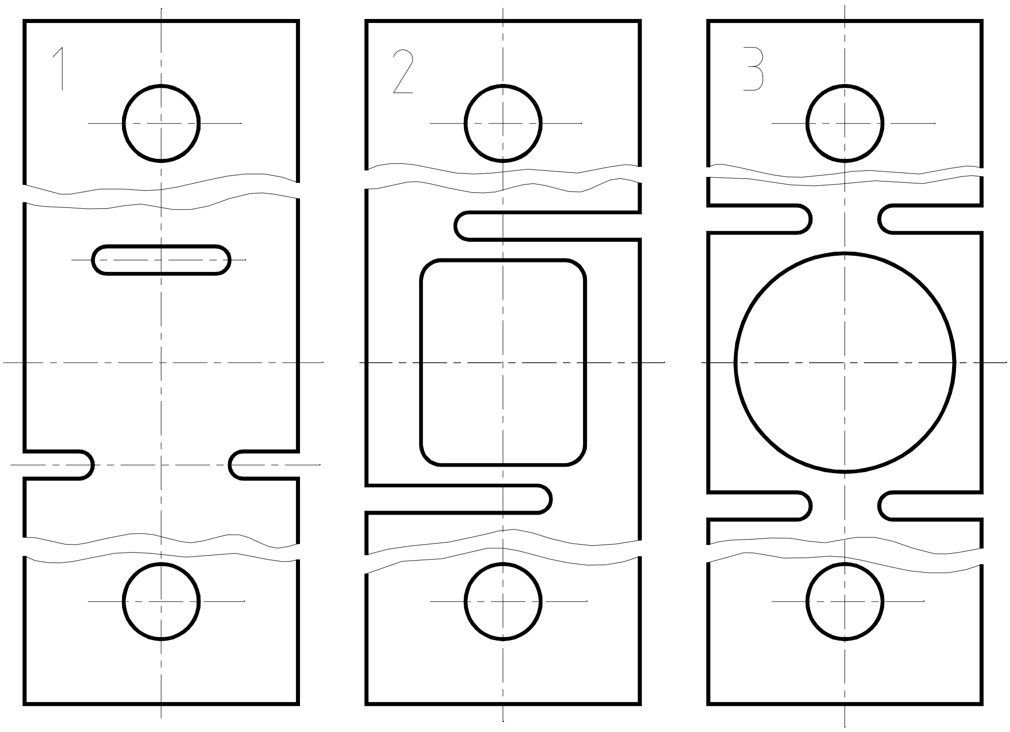

Figure 1. The original design of extensometrical transducers

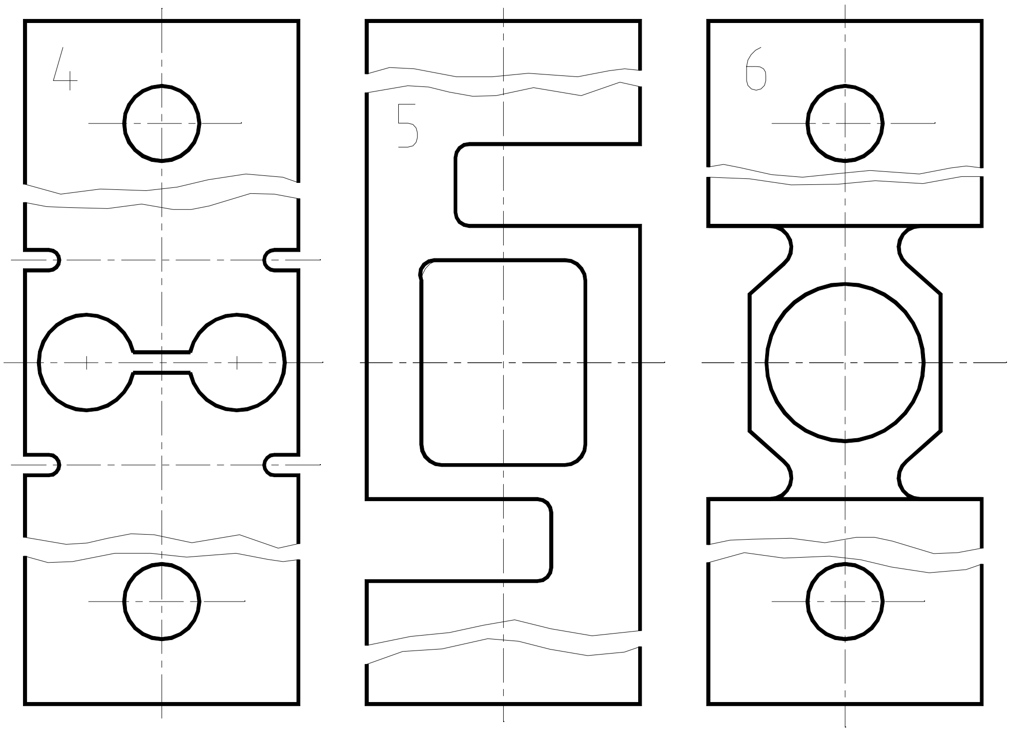

Figure 2. Design of prepared extensometrical transducers

2 DESIGN OF EXTENSOMETRICAL TRANSDUCERS

The first project of transducers contained three types, which are schematically illustrated in Fig. 1. On the basis of the projected transducers there were manufactured models from optically active material CT 200 and photoelastic measurements were made in order to determine components of the stress tensor and to select suitable spots for gluing of resistance strain gauges. On the basis of these measurements there were modified shapes of transducers No. 2 and No. 3, and instead of transducer 1 with comparatively low sensitivity there was designed new type No. 4, which is shown together with

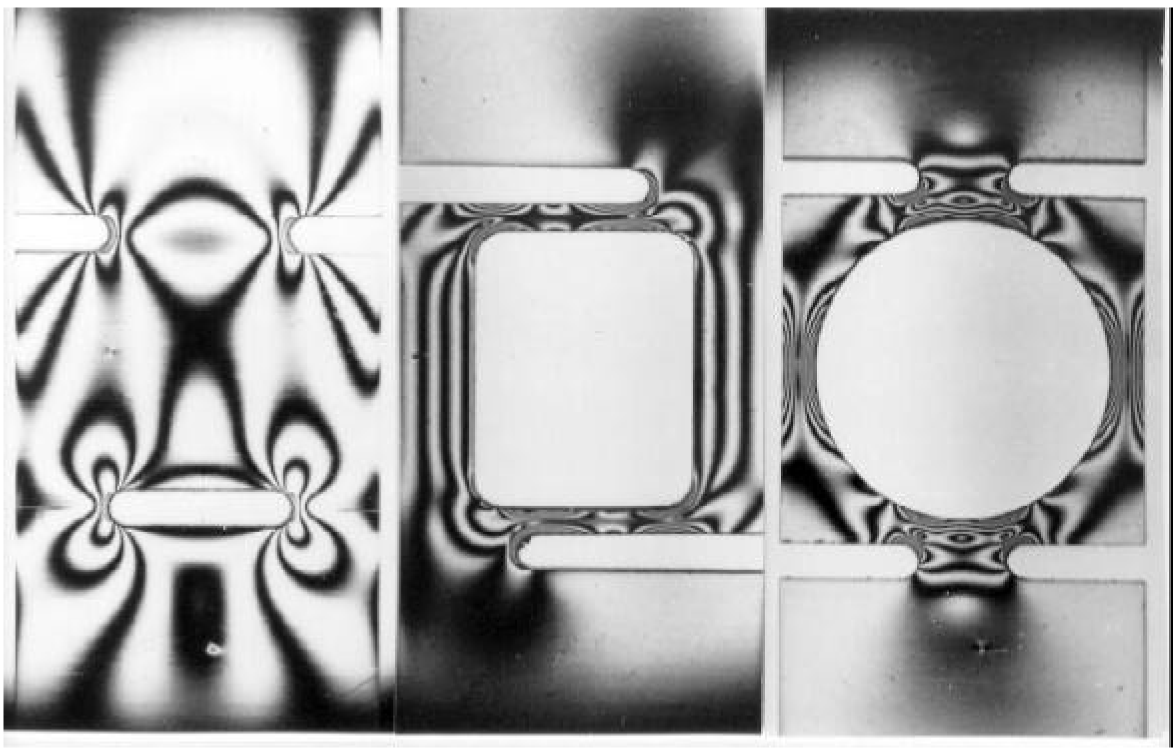

Figure 3. The courses of isochromatic lines in models of transducers

modified transducers No. 2 and No. 3 in Figure 2. Prototypes of metallic extensometrical transducers were made already in accordance with the Figure 2. Resistance strain gauges were glued to selected spots of these transducers and strain gauge measurements were made.

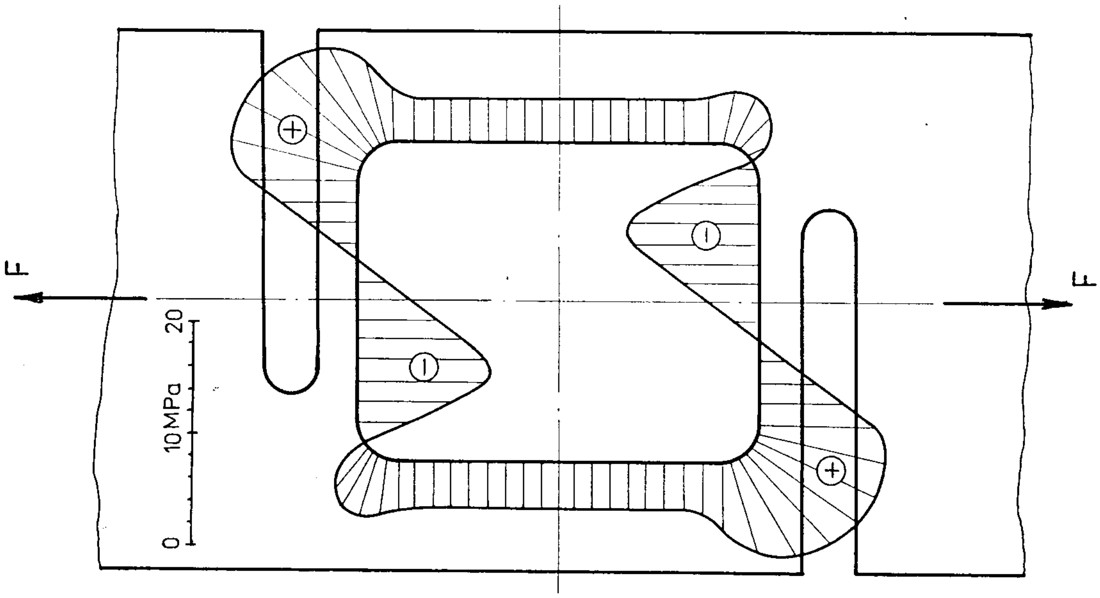

Figure 4. The evaluated courses of stress in transducer No. 2

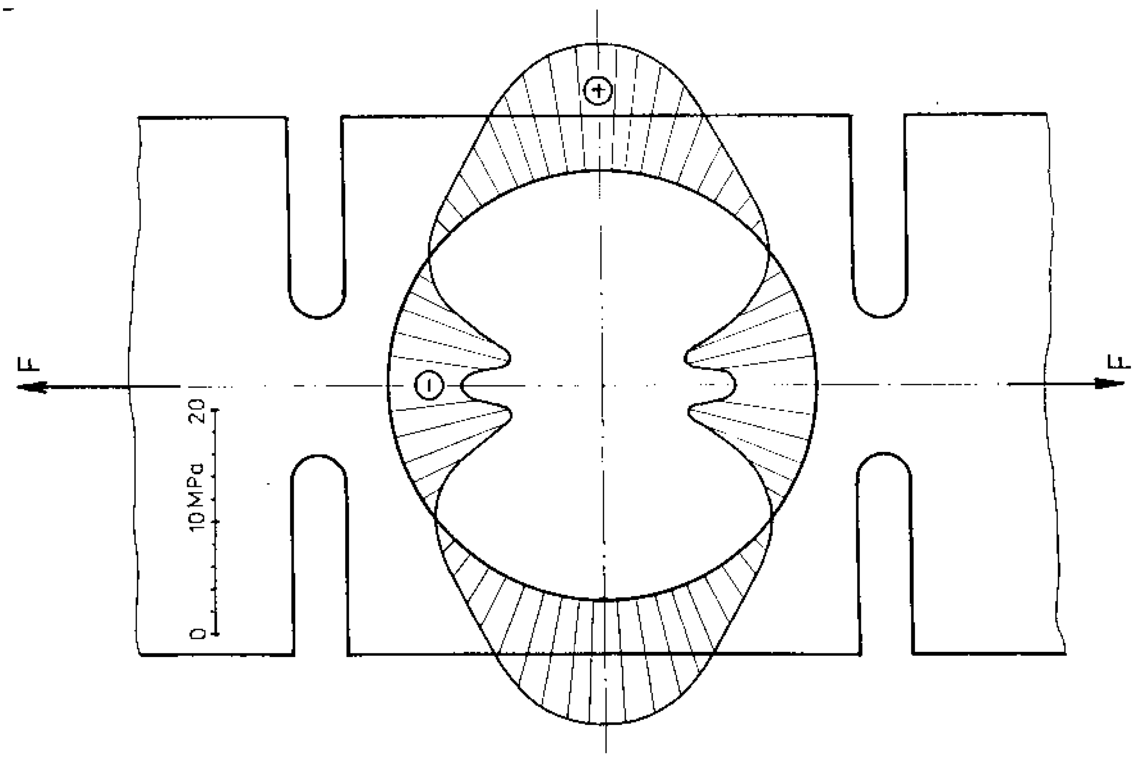

Figure 5. The evaluated courses of stress in transducer No. 3

3 CHARACTERISTICS OF EXTENSOMETRICAL TRANSDUCERS

Properties of the first three designed types of transducers according to Figure 1 were ascertained by photoelastic measurement in such a way, that the models were loaded by such load, which ensured that their elongation is identical. The obtained courses of isochromatic lines are shown in Figure 3. On the basis of these lines we evaluated courses of stress along the lightening holes; Figure 4 shows as an example the obtained course of stress at the transducer No. 2, Figure 5 shows course of stress at the transducer No. 3. Since at the transducer No. 2 the zone with maximum tensile stresses lies in glued to external side of the square hole. The obtained stress courses in this area are also shown in Figure 6. Final modification of this type of transducer and the prototype thus made is shown in Figure 2. Original shape of the transducer No. 3 was similarly modified to the final shape shown in Figure 2 and metallic prototype was made. Additionally we designed still another type of transducer No. 4 and we made strain gauge measurements on all prototypes - see Figure 2.

Loading of prototypes of extensometrical transducers was performed with use of tensile testing machine. The transducers were clamped between special clamps, which were fixed to the tensile testing machine pillar. Strain gauge measurements of all prototypes of transducers were made under the same loading force of tensile testing machine, so relative elongation on the tensile testing machine pillars was identical. The tensile testing machine pillar is not, however, stressed by simple tension or pressure, but by combined load of tension or pressure and bending. That's why it was necessary for obtaining of comparable results to situate the clamps for fixing of the transducers always into the same position in respect to symmetrical axes of tensile testing machine. In order to determine unevenness of stress distribution in tensile testing machine pillars the strain gauges were glued also to its perimeter.The results of strain gauge measurements on prototypes of transducers enabled us to assess their mechanical strengthening of the measured comparatively low deformation.

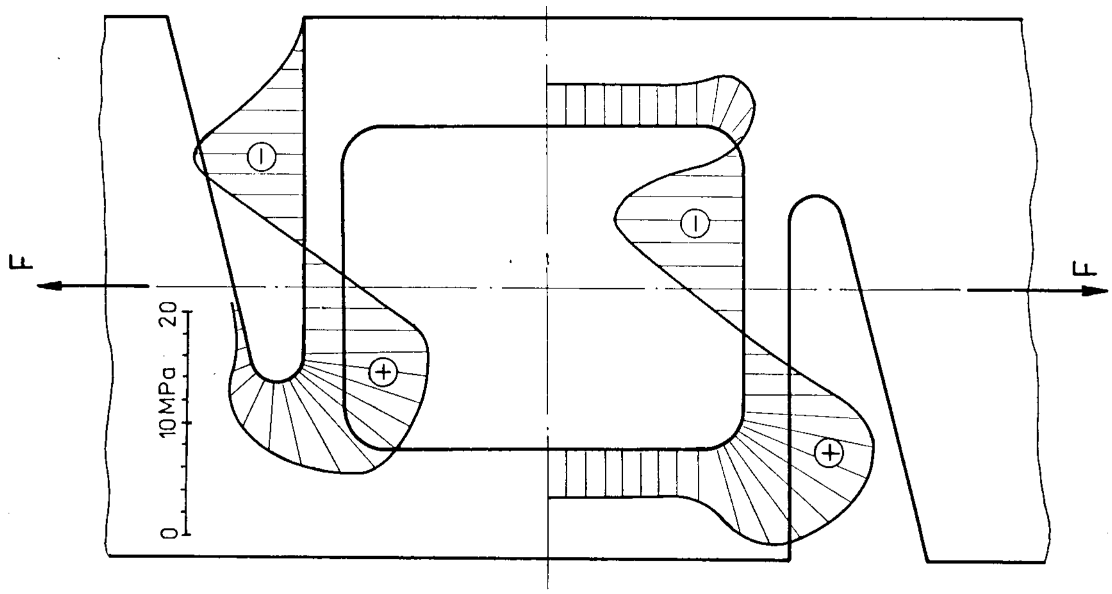

Figure 6. The evaluated courses of stress in prepared transducer No.2

4 CONCLUSION

The selected types of extensometrical transducers passed afterwards long-time testing in industrial operation conditions. For example the transducer No. 3 was for 2 years built-in into the roll stand of 4-high rolling mill 3,5 in VÍTKOVICE, where it served for auxiliary measurement to the direct measurement of rolling forces with use transducer situated between the set screws and bearing housings of top backing rolls. Congruence between the obtained by direct and indirect measurement of rolling forces was very good. Industrial application of extensometrical transducers only for measurement of shearing forces at slab shears is realised at the Ukrainian plant Kommunarsk. At present there is carried also research of indirect measurement of forces without extensometrical transducers by strain gauge measurements on rolls stands of rolling mills.

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