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Wrapping Machine with Integrated Manipulator

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Abstract. Goal of project solved with company Pragometal, s.r.o. is to create a new design of integrated wrapping palletizer. This machine will have new design properties such as integrated manipulation with goods into carrying structure of wrapping machine, new controlling system, new conception of running of roll and device for ending and welding of film. Newly design machine is based on unique join of two separated machines (palletizing and wrapping) into one workplace. This integration requires high demands on precision of kinematic, preliminary and checking calculations of individual machine components. Components of carrying structure and machine are designed with help of FEM calculations. These calculations are experimentally verified on real prototype of machine before series production is started. This verification is needed to ensure demanded operating reliability and life of newly designed machine.

Introduction

During development of new conception of wrapping machine newly designed parts are optimized with help of finite element method (FEM) calculations. These calculations are needed to ensure demanded operating reliability and life of newly designed machine. For verification of correctness of FEM calculations (behavior conditions, position of center of mass, etc.) experimental measurement was made.

Division of Machine into Subassemblies

For easier processing of measured data and results was complete assembly of machine divided into several subassemblies (Fig. 1) which were further divided into other subassemblies (Fig. 2).

Subassemblies shown in Fig. 1 are following: 1 – Main frame of machine, 2 - Frame of rotating ring, 3 – Rotating ring, 4 – Right unit for cutting and welding of film, 5 – Left unit for cutting and welding of film, 6 – Unit for automatic application of top sheet for dust or water protection in the middle of wrapping cycle.

Subassemblies shown in Fig. 2 are following: 3.1 – Carrying part of rotating ring, 3.2 – Switchboard, 3.3 - Frame of reels.

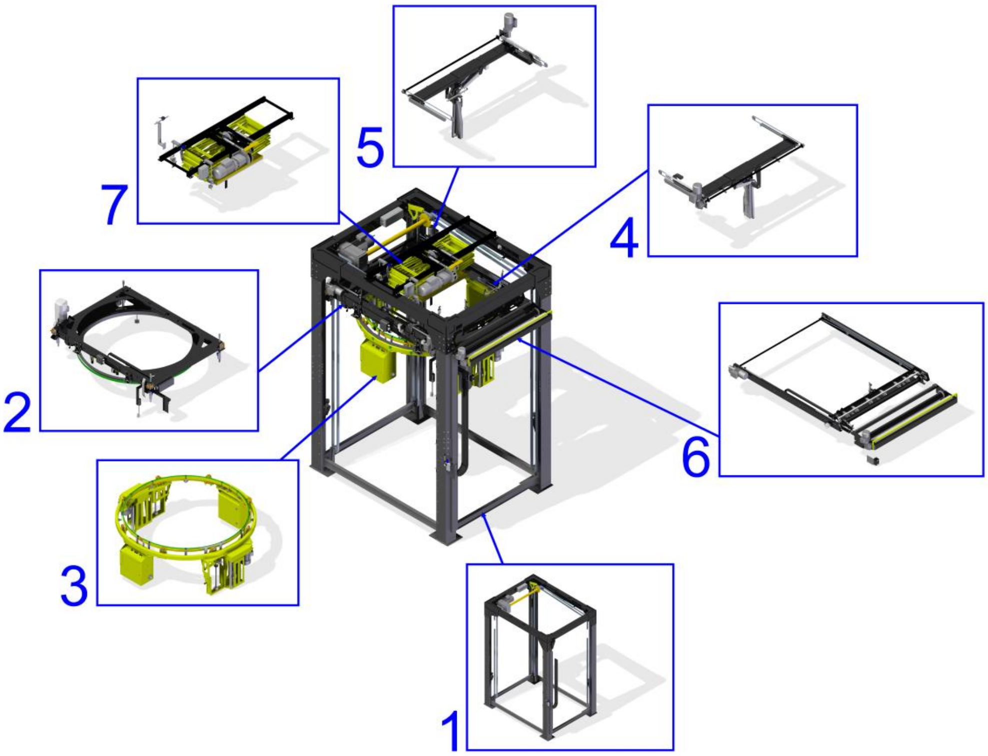

Fig. 1: Division of machine in subassemblies.

Description of measured points

In this article the measured points on rotating ring will be described in detail. Measured points on the model of machine are shown in Fig. 2 and marked by numbers 8 and 9 which correspond to marking used during measurement. Measured points are also marked in Fig. 3 which shows distribution of equivalent stress according to FEM calculation. Strain gauges placed on real machines are shown in Fig. 4 and Fig. 5.

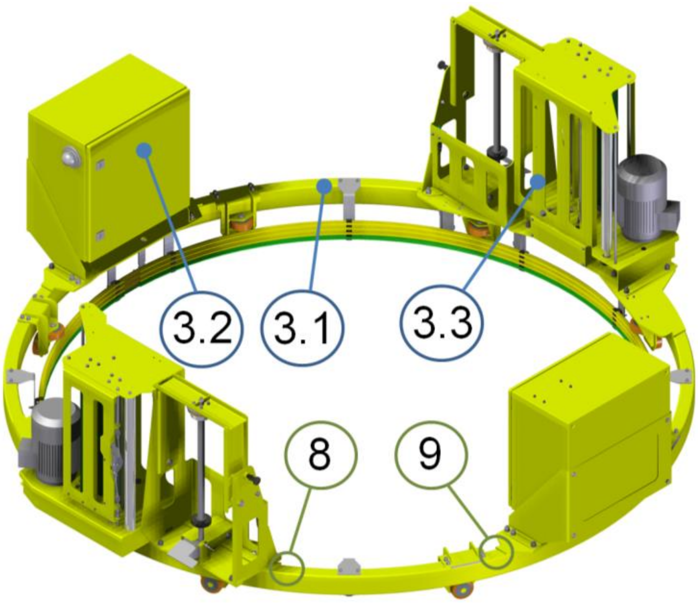

Fig. 2: Model of rotating ring subassembly.

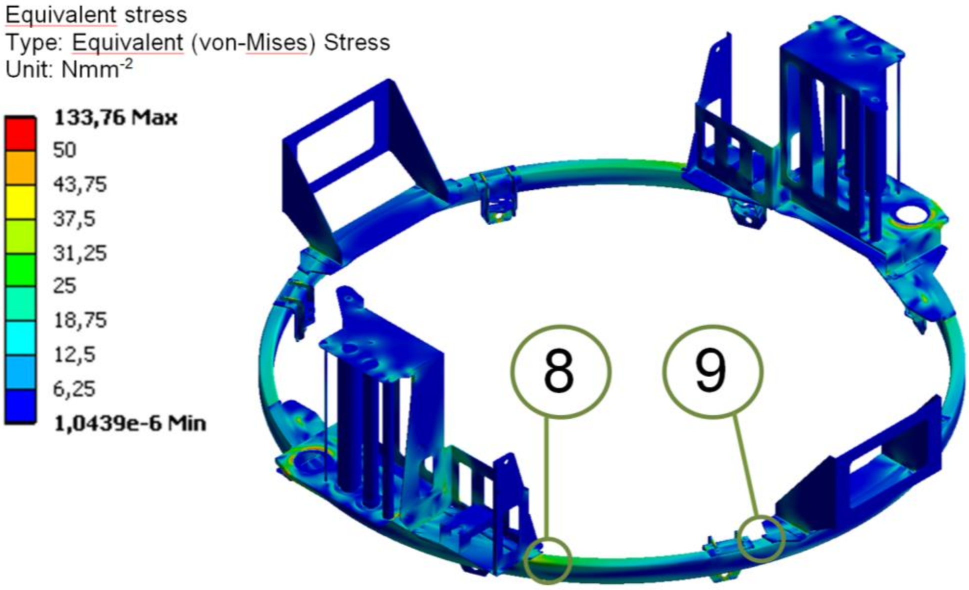

Fig. 3: FEM model of rotating ring.

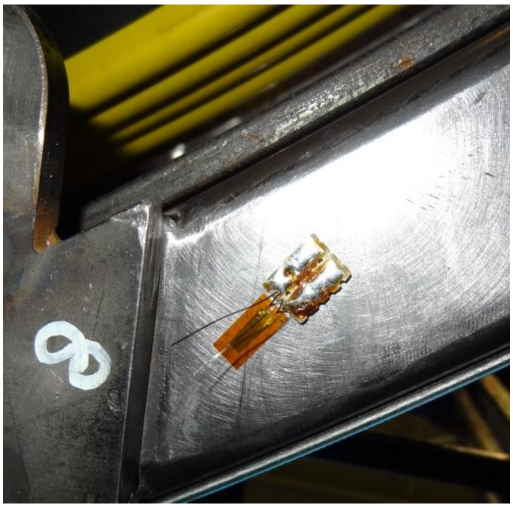
Fig. 4: Measured point 8.


Fig. 5: Measured point 9.

Strain gauges are placed on rotating part which makes measurement more difficult.

During rotation of the ring all devices and parts placed on it are additionally loaded by centrifugal acceleration 5g. For measuring of mentioned points was used Wi-Fi chassis NI cDAQ-9191 with module NI 9237 from National Instruments Corporation (Fig. 6) which allows online wireless measuring. As supply of chassis was used power supply on switchboard on rotation ring.

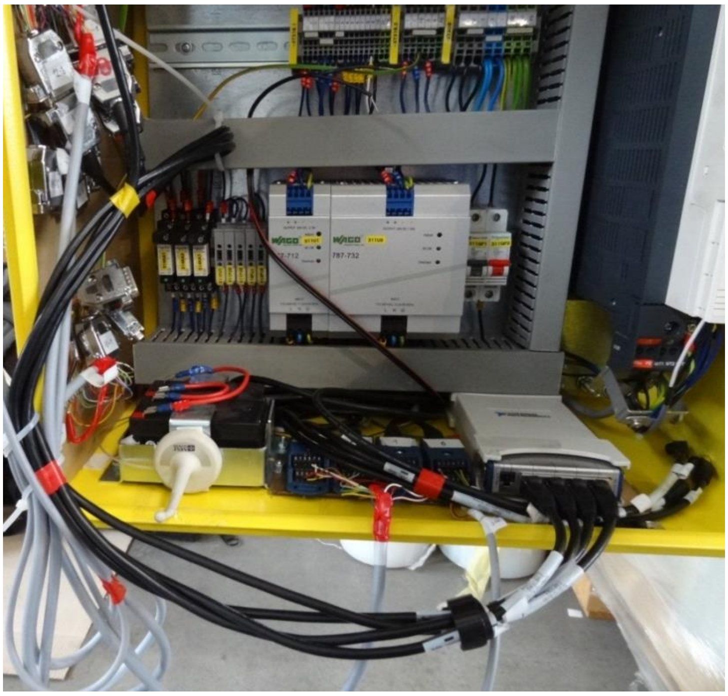

Fig. 6: Chassis cDAQ in switchboard of rotation ring.

Comparison of values gained by FEM calculations and by measuring.

In Table 1 are compared results from FEM calculations and values measured during experiment.

Table 1

Measured point	Strain ε (measured) [m/m]	Strain ε (MKP) [m/m]	Stress σ (measured) [Nmm^{-2}]	Stress σ (MKP) [Nmm^{-2}]	Error of stress ΔMKP [%]
8	$2.67 \cdot 10^{-4}$	$2.77 \cdot 10^{-4}$	53.5	54.6	2.1
9	$1.53 \cdot 10^{-4}$	$1.28 \cdot 10^{-4}$	30.6	26.8	12.4

Summary

For optimization of construction designed FEM models and their results were verified by experimental measurement. Above mentioned table shows that deviation of value gained by FEM calculation is by 2.1% higher than value measured by strain gauge marked as 8 and deviation of value gained by FEM calculation is by 12.4% lower than value measured by strain gauge marked as 9. These results are considered as sufficient for further optimization of construction with usage of current FEM model.

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