EAN 2013
51th conference on experimental stress analysis

QUALISYS system applied to industrial testing

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Keywords: QUALISYS, measuring, testing, deformation, loading, supporting structure, refrigerating rack

Abstract. Qualisys is a camera system designed initially for 3D record of body motion that is firmly marked with special points called markers. Qualisys uses infrared range of frequencies and the main advantage of the system is the fact that it records coordinates of markers and therefore the need of complicated and often not accurate image analysis is not necessary.
The system was used for measuring of properties and strength of partial supporting structure of refrigerating racks and for testing of completed prototypes.
Strength and deformation resistance that were specified by maximal force of safe structural changes was determined during the testing. The loading capacity of prototypes was tested using by the producer described and standardized procedure.
Monitoring of deformation propagation in different components and also the completed rack was performed using the Qualisys system which allows continuous measuring over a period of loading and unloading. The results of tests enabled to verify analytically or FEM gained preliminary results of calculations easily and promptly.
This work should contribute to discover utilization of alternative measuring technologies that are common in many other branches. The application of these systems may influence significantly technical complexity of some solved issues.

Introduction

This text deals with the use of system Qualisys in a special application in industrial testing of different constructions. Although the primary usage of Qualisys is rather different, many advantages of the system may be taken in industrial testing. Example of Qualisys application is the testing of support structure of refrigerated racks and their components, which were designed and manufactured in some variants differing in important details. Prior the factual testing, analysis of a current produced refrigerated rack version was made, concurrently many calculations and simulations using FEM were performed. The analysis helped to find and define critical places of the supporting structure which were necessary to be improved in the following design. Many variants of a new conceptual design of the critical places were proposed. Concerning strength of construction, as well as technological and economic aspects, six variants of the critical supporting component were produced and subjected to the test. Based on the results, three complete prototypes of the refrigerated rack were produced and tested according to the specific procedure.

Description of the Qualisys System

The Qualisys system is a special device for kinematical analyses of moving bodies. Because the system works with specific markers, not with video recordings, the output data – coordinates of the markes - are very clear. The basic structure is well seen from fig. 1.

Fig. 1, The Qualisys system operation (taken from www.qualisys.com)

The Qualisys system is based on synchronous recording of the markers motion by at least 2 cameras to acquire coordinates in 3D space. In the right part of the fig. 1, the measuring space is shown. All cameras are fixed around and the space must be calibrated by special utility with known dimensions. The reached precision of the recognition of the actual marker position is usually around 0.5 mm for spaces from 1 to cca 20 m large. The used version of the Qualisys system has worked with 6 cameras and allowed a synchronous video record by one of the cameras with sampling frequency of 1000 Hz if needed.

Testing of components of refrigerated rack

Selection of tested component. The whole supporting frame of the refrigerated rack consists of many sheetmetal components, that are connected together using different methods (welding, riveting etc.). The side stem, especially the bottom connection of two profiled sheetmetal parts of this stem, was selected as a critical component of the whole support frame. Six different design versions of the component with the critical place were subjected to the test and verification.

Measurement procedure. The tested side stem was measured in the position that is same as the real placement of the component in the complete supporting frame of the refrigerated rack. The side guides were used to eliminate the undesired tilting of the vertical part during the loading. The fixation of the stem was same for all tested samples because of the measurement comparability. The measurement scheme is shown in figure 2.

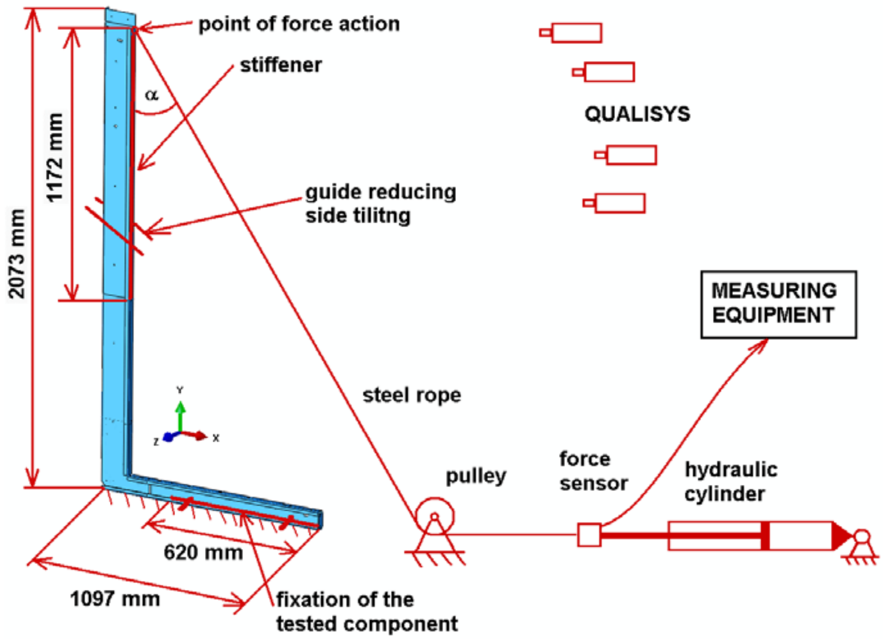

Fig. 2, Measurement scheme

Loading was applied by a hydraulic cylinder and transferred to the desired point of action by a steel rope. Same as the fixation, the point of force action was the same for all measured samples. The force was measured by a force sensor. See figure 3 for real configuration of the working place.

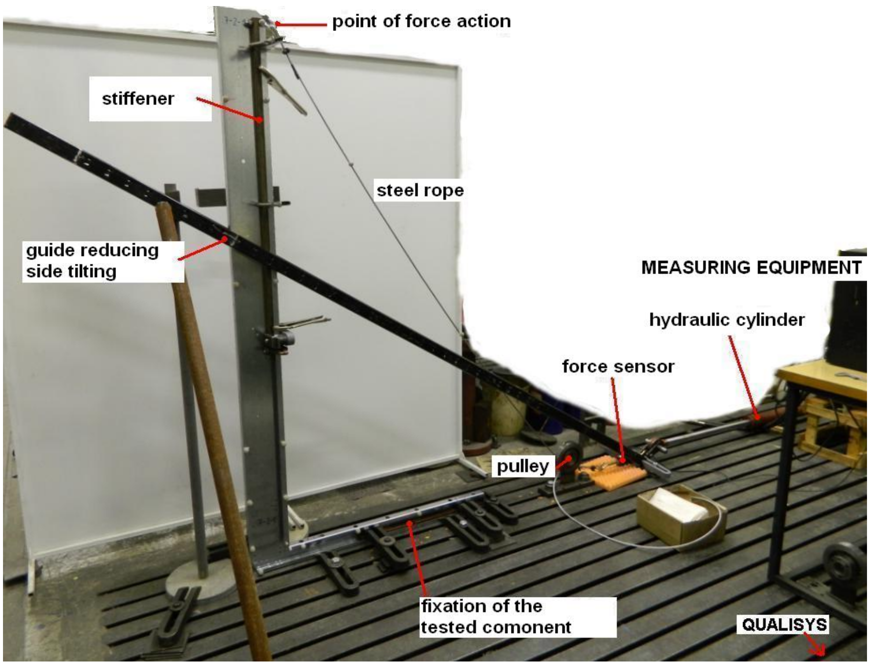

Fig. 3, Real configuration of working place

Deformations were measured by the Qualisys, that enabled the deformation tracking of selected points of the stem during the whole loading with sufficient accuracy. The selected points where the deformation was tracked are shown in figure 4. See the higher density of tracked points in the critical place of the components where two parts are connected.

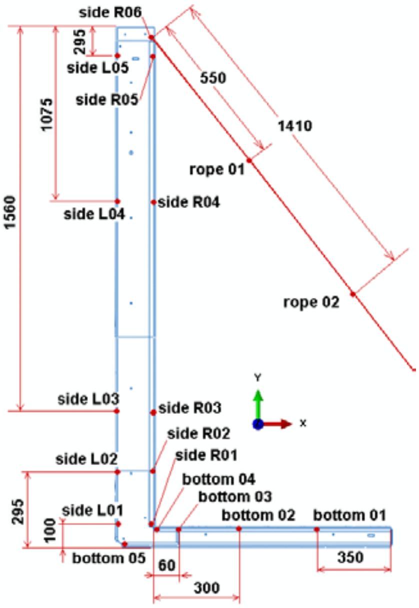

Fig. 4, Position of points for deformation tracking

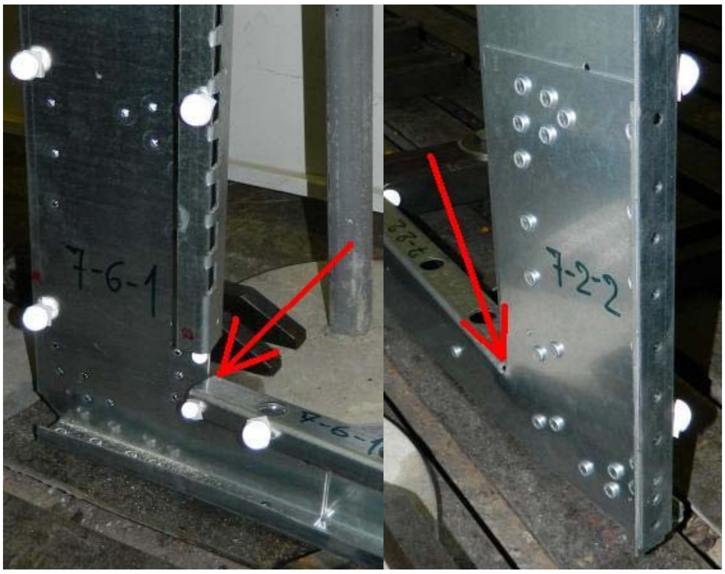

Fig. 5, Critical place of the tested component

Procession of the measured data. The data of the tested samples were graphically processed, the measured quantities were used for verification of designed variants of the side stem. Time behaviour of loading and deformation, maximal loading, maximal deformation and the time behaviour of the stem during the loss of stability were main indicators for comparison of the variants. The loss of stability was indicated by a decrease of the measured force and rapid transverse deformation of a point in the critical place of the stem, see figure 5.

Testing of completed rack prototypes

The measurement of completed prototype racks followed after the laboratory measurement of the component and its evaluation. The results were used to selection of the best design variant of the side stem. The testing of three rack prototypes with different variants of support structure was performed in the premises of the producer which required the simple and reliable measurement of deformation. The advantages of the Qualisys were emphasized during this “terrain” measurement.

Measurement procedure. The procedure was same for all tested samples which allowed the comparability of the results. The testing was based on the loading of the racks with barrels filled with water and synchronous measurement of the rack frame deformation in many selected points during the states of loading and unloading. The Qualisys was used for deformation measurement. The loading and deformation of the refrigerated racks are shown in figure 6, the selected tracked points in figure 7.

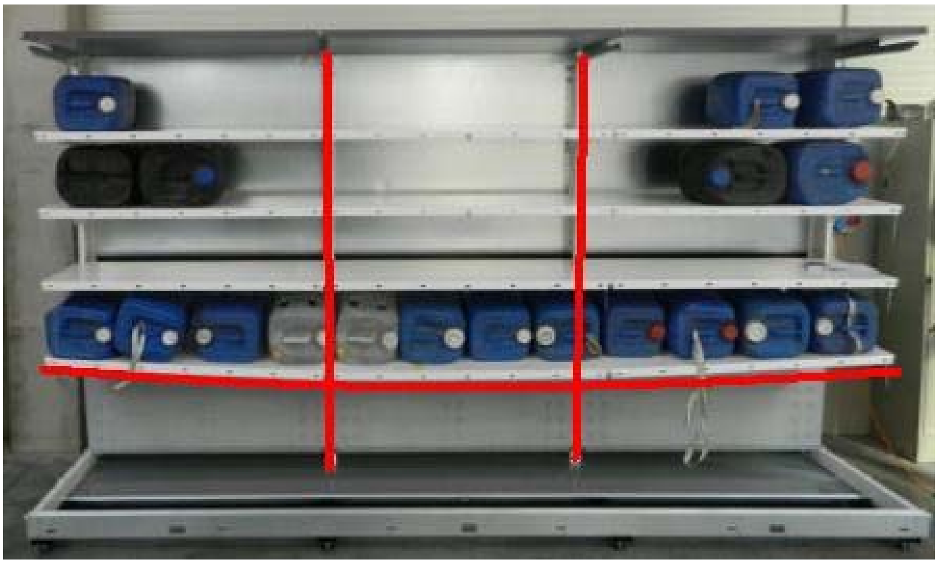

Fig. 6, Loading and deformation of the rack during testing

Fig. 7, Selected tracked points of the rack

The evaluation of the measurement, i.e. the loading and the corresponding deformation, showed the real behaviour of three variants of the support structures. Main parameters for the comparison between three variants were maximal load until the loss of stability, the rigidity of the structure and the deformation of the rack during the loading. The loss of stability was identified by the excessive deformation in selected tracked points or the total collapse of the frame.

Verification of FEM analysis and testing

Six proposed variants of tested rack component were subjected to the FEM analysis to determine their strength and deformation behaviour. The analysis also helped to optimize the final details design of the critical place of the side stem. The consequent testing of the six manufactured variants of the side stem enabled to verify the FEM results. Mainly total deformation and deformation of selected points in critical place were used for this verification. Also the total load capacity of the tested component was calculated using FEM and verified by measurement. The examples of the FEM results are shown in figure 8, the first figure shows the stress distribution in the critical place of the component and the second figure shows the distribution of deformation vectors. The comparison of the results of FEM analysis and laboratory testing lead to the conclusion that the accuracy of the FEM results noticeably depended on the used simulation model, its accuracy and boundary conditions.

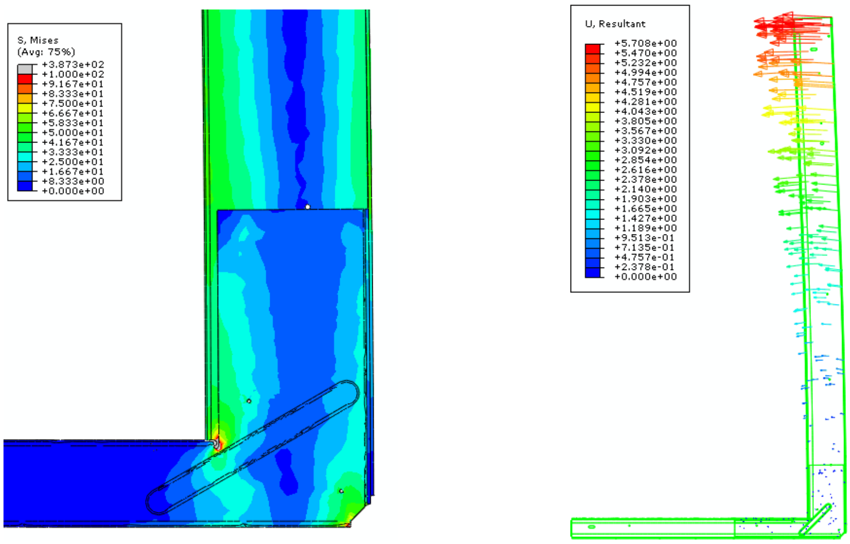

Fig. 8, Results of FEM analysis of the component

Summary

The main advantage of the usage of the Qualisys in the special industrial testing is the possibility of monitoring the deformation propagation on the large components with the sufficient accuracy during the whole measurement. The application of the system helped to carry out the testing in a complex way and significantly reduced the time demands of both measurement and data processing.

References

[1] Information on http://www.qualisys.com

[2] P. Maly, V. Dynybyl, F. Lopot, F. Stary, P. Kubat, P. Kubovy, Measurement report of side stem of refrigerated rack

[3] P. Maly, V. Dynybyl, F. Lopot, P. Kubat, P. Kubovy, Measurement report of support frame of refrigerated rack