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LONG-TERM MONITORING OF MECHANICAL DAMAGE ON THE HISTORICAL STRUCTURES

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Abstract: *Important information for the risk assessment of some damages on the historical structures represents data of failure development. Cracks in the load-bearing walls are one of the observed failures. This article focuses on remarkable method of damage measurement, their long-term monitoring and devices used for measurement.*

Keywords: ***Long-term monitoring, linear variable differential transformer, crack on the wall***

1. Introduction

Long-term monitoring of crack movement in load-bearing walls and arches is one of the methods for a diagnosis of historical structures. Decision about reconstruction or structural adjustment of walls, ceilings or even bases is based on the results from the monitoring of the damage development. Changes that have to be monitored are very slow and relatively small. So that the long-term crack monitoring and data recording is necessary for determination of the crack development.

The automatic measurement by the linear variable differential transformer has emerged as the most suitable method. High resolution, accuracy and measurement stability are the most important advantages of the method.

A used device has to be able to measure the displacement in units of micrometers, because the change of the crack dimension in the walls is generally tens or hundreds of micrometers for a period of several months. The chosen method can also allow measuring the temperature in an area of the crack, temperature outside and relative humidity of the air altogether because all the information is relevant while evaluating the damage development.

2. Reasons for use of LVDT

The linear variable differential transformers (LVDT) have certain significant features and benefits, most of which derive from their fundamental physical principles of operation or from the materials and techniques used in its construction.

3. Data acquisition system

Most of the data loggers available on the market fulfilling the requirements of the long-therm monitoring exceeds with its price level of 100 000 CZK. It would be uneconomic to use them for capturing date at hourly intervals, because they are designed for demanding measurements in laboratories or in situ. Therefore the DAM logger of price about 30 000 CZK was chosen. It was developed as a “low-cost” option of data logger for requirements of building geology workers. It is used for many years in situ for monitoring various physical parameters (temperature, relative humidity, pressure, displacements, etc.). It can be equipped with up to 6 modules for measuring those variables and it measures in 18-bit resolution.

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4. Practical applications of LVDT in monitoring

The above mentioned system was already used in many projects related to reconstruction and preservation of historical monuments.

5. Examples of monitoring results

5.1 Monitoring of failures in the vaults in the Franciscan monastery in Kadaň

Monitoring of the structure was going on from 2006 to 2008. The vaults in monastery chapter hall has been disrupted by a net of cracks, see Fig. 1**.** The positions of LVDT sensors 1, 2 and 3 are also marked in the picture.

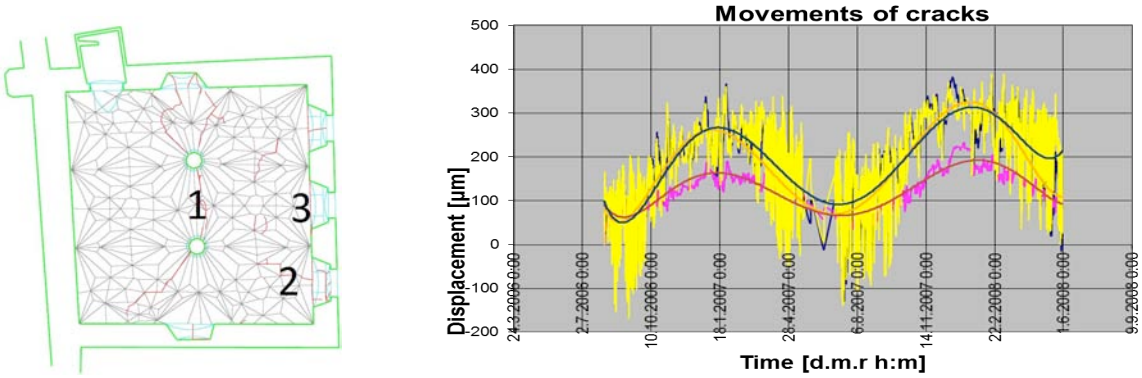

Fig. 1: Crack net in the vaults and 2years movements labeled cracks 1 to 3

5.2 Monitoring of cracks in the south wall of St. Jacob's Church in Kutná Hora

Monitoring in the structure is going on nowadays simultaneously with the reconstruction of the roof that started in 2011. There are large cracks in the south wall of the object, therefore monitoring of their development during the reconstruction has been suggested. The sensor set up is shown in the Fig. 2.

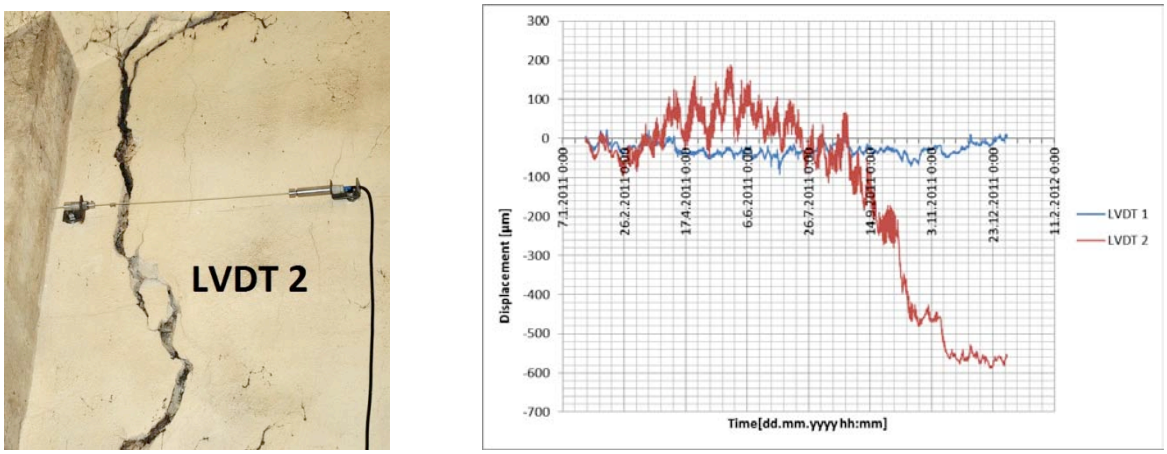

Fig.2 : LVDT set up, on inner side of the load-bearing wall and its movement

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