Measurement of ropeway tower deformations

Using Motion Amplification

Student

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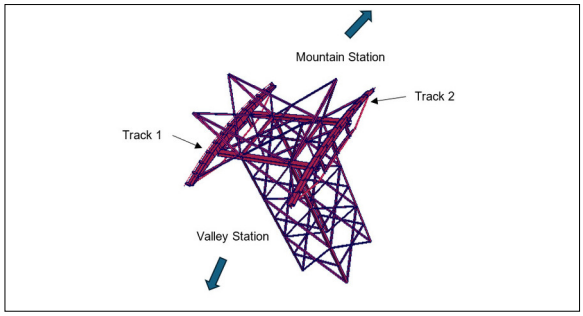
Introduction: Since the mid of the 2010 the technology of video motion amplification is development for commercial use. This technology uses the differences of camera pixels to measure the movement of an item, which cannot be identified just by the eyes. This technique is mostly used to detect vibrations of pumps, motors or similar machinery, but it is also possible to measure motions of very large objects like bridges. The institute IPEK of the Eastern Switzerland University of Applied Science (OST) does have such a camera equipment to apply motion amplification.

Objective: The goal of this project is to find out if this could be an affordable method to measure the motions of a ropeway tower while a carrier drives over the tower.
These measurements can help to validate the results of static calculations of towers and, since aerial ropeway towers are not easy to access and sometimes are very high (up to 188 m), with this method it would be much easier and quicker than doing measurements with gauge strips.
The measures were done on the towers nr. 2 and 5 of the aerial ropeway 15-ATW Flüelen-Eggberge (Canton of Uri / Switzerland). Tower 2 has a height of about 10 metres, is made from steel and carries rope spans of about 500 m on lower and upper span.
Tower 5 has a height of about 12 metres, is made of concrete and carries rope spans of about 50 m on lower and upper span.
To verify the results of the motion amplification camera there were placed magnetic strain gauges on the towers and the expected deformations were calculated with a self-developed rope calculation program and a structural analysis model.

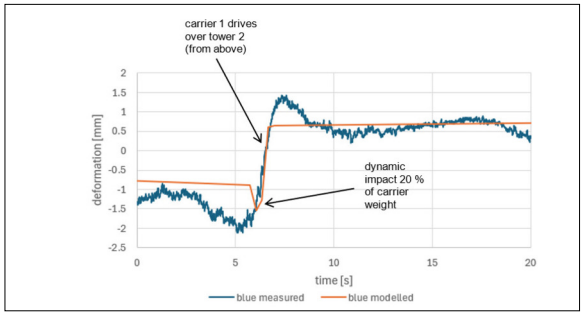
Result: The measures at the tower 2 agreed very good with the calculations, which were calibrated with the measurements from the strain gauges. But the measures showed also that the sunlight and the movement of the carrier can distort the measurements. The measurements at tower 5 agreed only perpendicular to the ropeway axis relatively good with the calculations. In the vertical axis and in the direction along the ropeway axis there was measured much higher deformations than the calculation has proposed. Further investigations are necessary to find out why the motion amplification camera measured much higher deformations in vertical direction than there should be according to the calculations. This work showed that it is possible to measure the deformations of a ropeway tower using a motion amplification camera, if certain conditions are considered, such as the sunlight and an appropriate placement of the camera. But it must also be said that for a standard ropeway tower constructed as a steel truss, measurements with strain gauges are more reliable since they are not depending on the weather conditions, the free sight on the tower and appropriate locations to place the camera.

Structural analysis model of tower 5 in it's natural environment
Own presentment

Structural analysis model of tower 2
Own presentment



Comparison of the calculated and measured deformation with the Motion Amplification camera at tower 2
Own presentment



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Subject Area
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