

## Efficient Local Deformation Recognition on Highway Bridges

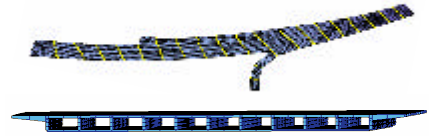
Dipl.-Ing. Thomas Schäfer  
Technische Universität München  
Chair of Geodesy

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## Bridge Construction

- + Much frequented highway junction to Munich's Airport
- + Pre-stressed concrete bridge consisting of 20 spans
- + Box girder bridge with a cross-section of 10 cells
- + Length = 600 m, Width ~ 40 m



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## Bridge Construction & Damage Type

- + Water containing chlorides penetrated the construction since the 1960's
- + Because of holes in the webs the water was able to infiltrate large areas
- ? Strong Corrosion
- ? Reinforcement Failure!
- ? Bottom slab separated from the web



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## Numerical Simulation of the Damage

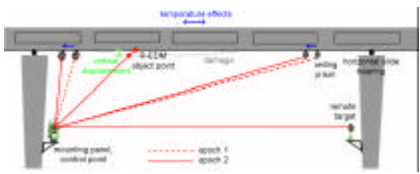
- + FE Simulation: expected vertical displacement for a failure of the shear reinforcement on two webs over a length of 10 m
- + Vertical displacements (between damaged and undamaged system) of up to 8 mm can possibly occur on the bottom of the bridge
- + Appearing crack width is = 1 mm and hardly to observe
- + Concept: Surveying of the bottom slab surface with reflectorless EDM



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## Geodetic Surveying Concept

- + 2 x Leica TCRA1101+ (specification:  $s_{R-EDM} = 3 \text{ mm} + 2 \text{ ppm}$ )
- + Motorized tacheometry using self-developed measuring applications
- + 2800 R-EDM object points (grid: 2x2 m<sup>2</sup>)
- + Installation of 72 prisms underneath the ceiling to detect horizontal deformations caused by temperature effects
- + Local control network: 22 control points
- + Removable aluminium panels mounted directly on the bridge columns




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## Control Points & Mounting Panels





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## Monitoring Sequence





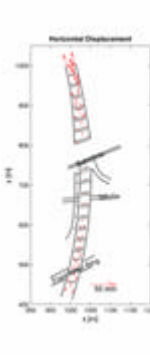
Tachymeterstandpunkte

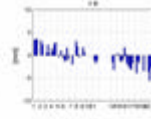
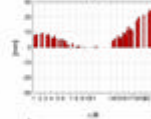
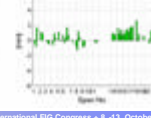





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## Results : Displacement of the Reflectors



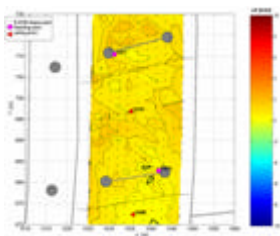






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## Vertical Displacement of Object Points



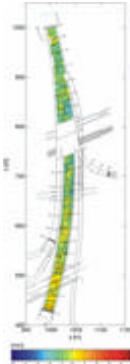
- + Visualisation concept: vertical surface displacement map of bridge spans
- + Contour lines:  $\Delta H = 0.5 \text{ mm}$   
? surface smoothness gives an impression of the internal accuracy
- + Instant recognition of local deformations is possible



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## Conclusion




- + **Reliability**  
Multiple measurement shots to object points  
Increase of internal accuracy (= 1 mm)  
Robust GeoBASIC Software-Design
- + **Efficiency**  
Surveillance of 21.000 m<sup>2</sup>  
Fully automated „One-Man-Solution“  
Campaign takes 33 hours of field work
- + **Advanced:**  
Customizable to related monitoring tasks  
Combination with Terrestrial Laserscanning Data  
Outlook: Automatic recognition of damages



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## Questions ?



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