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Evaluation of transverse currents near locks (Posterpräsentation)

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EVALUATION OF TRANSVERSE CURRENTS NEAR LOCKS

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Abstract
Cross currents were observed at the Main-Donau-Kanal in Germany at the lower side of some of the locks near Nürnberg. As these cross currents had a significant impact on the ships that entered the lock, an investigation was started in order to develop possible remedies. For this task, two different three dimensional numerical models were used to evaluate the developed solutions. Furthermore, the results of both models were compared for cross-validation of the models.

Sommaire
On a observé des courants en travers dans le Main-Donau-Kanal en Allemagne a les écluses près de Nürnberg. Ces courants avez un impact considérable sur les navire qui sont entrés dans l'écluse. Une recherche a été commencée afin de développer les remèdes possibles. Deux modèles numériques tridimensionnels différents ont été employés pour évaluer les solutions développées. En outre, les résultats ont été comparés pour la contre-vérification de cette modèles.

KEYWORDS: Transverse currents, locks, approach, numerical modeling

1. INTRODUCTION

Recently, ship movements on the Main-Donau-Kanal in Germany have been hindered by transverse currents on the lower side of some of the locks. This is due to the fact, that the water management of the channel had to be changed and that now additional water must be transported in the channel to the lower side. The water is transported around the locks in a pipe and injected through the pumping station of each lock. As the constructional elements near the locks were not hydraulically designed for this tasks, adverse effects were observed. Figure 1 (right) shows a photo which was taken at the lower side of the lock, facing to the canal reach. The ripples on the water surface indicate the direction of the cross currents. The BAW had the mission to evaluate those currents and to develop possible remedies. The investigation was performed with different three-dimensional numerical models and the results were used for cross-validation of the models.

Figure 1: Location of the regarded locks (left) and situation in-situ (right)

2. NUMERICAL INVESTIGATION

The numerical examinations were performed with two different computational fluid dynamics (CFD) codes. On the one hand a commercial Reynolds-Averaged-Navier-Stokes (RANS) code ("Comet", courtesy of CD-Adapco), which is based on unstructured hexahedral grids, was used. On the other hand an university developed code ("NaSt3DGP", University of Bonn, Germany), which is based on graded structured grids, was used for comparison. As turbulence models standard-k-ε, RNG-k-ε and k-ω were used with "Comet" and on a fine grid a large eddy simulation (LES) was performed with NaSt3DGP.

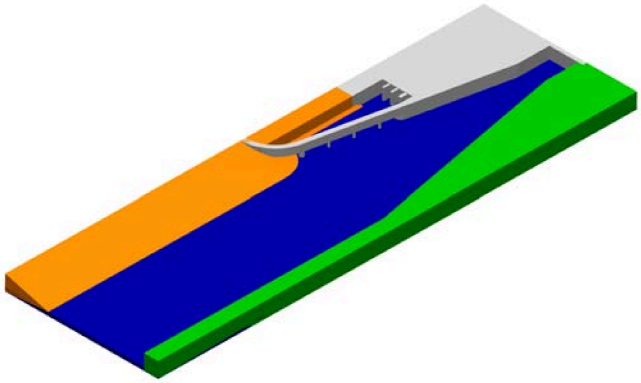

Figure 2: Three-dimensional model geometry of the lower lock approach at one of the investigated locks

For the given locks three-dimensional geometry models were generated, which have an approximate extend of 250 m and smallest hydraulically relevant features of about 0.2 m in size (Figure 2). Bases on these geometries, the computational grids were generated. They had about 1 million elements for the unstructured grids, which were used with Comet and 10 million elements for the structured grids, which were used with NaSt3DGP. All computations were performed on a parallel computer.

3. RESULTS

The results of the RANS approaches agreed sufficiently well with the results from previous measurements and with those from the LES. As expected, the LES analysis provides substantially more information about the magnitude and intensity of peaks and eddies in the velocity field (Figure 3).

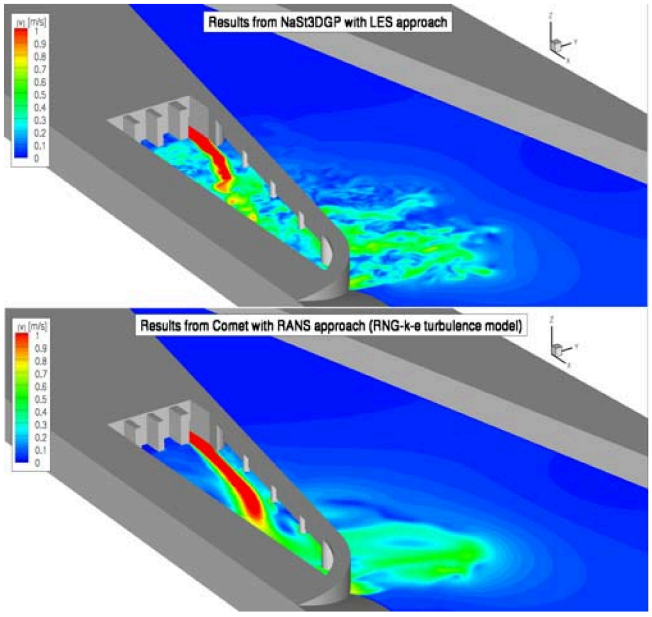

Figure 3: Detail of LES-computed flowfield in two vertical slices near the outlet

Anyhow the amount of information from the RANS approaches is sufficient for the evaluation of the impact on ship traffic, as these are governed by large scale, integral quantities as the resulting forces and torques on the ship. The results were fed into a ship navigation simulator program in order to evaluate the resulting movement of passing ships. But for a highly detailed evaluation of the flowfield near the lock, the results from the LES provide an enormous amount of information, which is a huge benefit for the hydraulic engineer.