Numerical study on the effects of river bank stabilization

Sheikh, Maha; Crosato, Alessandra; Chavarrías, Víctor; Werner, Micha

Publication date
2023

Document Version
Final published version

Citation (APA)
Sheikh, M., Crosato, A., Chavarrías, V., & Werner, M. (2023). *Numerical study on the effects of river bank stabilization*. 33-34. Poster session presented at NCR Days 2023, Nijmegen, Netherlands.

Towards 2048: the next 25 years of river studies

Book of Abstracts
NCR DAYS 2023
12-13 April | Radboud University

Netherlands Centre for River studies

Wilco C.E.P. Verberk
Frank P.L. Collas
Gertjan W. Geerling
Marie-Charlott Petersdorf (eds.)

NCR Publication: 51-2023

NCR DAYS 2023

Towards 2048: The next 25 years of river studies

Wilco Verberk, Frank Collas, Gertjan Geerling & Marie-Charlott Petersdorf (eds.)

Organising partner:

Radboud University

Conference venue

Lindenberg Cultuurhuis
Ridderstraat 23
6511 TM Nijmegen
The Netherlands

telephone: +31 24 327 39 11
e-mail: info@delindenberg.com
www: https://www.delindenberg.com

Contact NCR

dr. ir. K.D. Berends (Programme Secretary)
Netherlands Centre for River Studies
c/o Deltares
Boussinesqweg 1, 2629 HV Delft
P.O. Box 177, 2600 MH Delft
The Netherlands

telephone: +31 6 21 28 74 61
e-mail: secretary@ncr-web.org
www: http://www.ncr-web.org

Cite as: Wilco Verberk, Frank Collas, Gertjan Geerling, & Marie-Charlott Petersdorf (eds.) (2023), *Towards 2048: The next 25 years of river studies: NCR DAYS 2023 Proceedings*. Netherlands Centre for River Studies publication 51-2023

Photo credits cover: F.P.L. Collas

Numerical study on the effects of river bank stabilization

Authors:
Maha Sheikh[a],
Alessandra Crossato[a,b]
Victor Chavarrias[c]
Micha Werner[a]

Highlights

- A 2D numerical model developed in Delft 3D to study the effects of river bank stabilization
- Stabilizing the outer river bends results in a less sinuous and narrower channel with sharper bends.
- The river morphological behaviour to bank stabilization should be kept in mind while planning the land use nearby rivers

Overview

The purpose of bank stabilization is to prevent lateral shift of rivers caused by bank erosion (Julien 2012). However, changes in river morphology after bank stabilization often result in damages and long-term drawbacks. For instance, shift in the river bank line increases the risk to nearby structures and agricultural land and the deepening of the river bed near the protected bank results in the failure of the bank protection structures (Minor et al., 2007; Tomohiro, 1996). Lack of knowledge about cross sectional and planimetric changes in rivers after bank stabilization intensifies the risk of damages to structures and land.

To the best of author's knowledge, no reliable numerical study is available till date to study the effects of bank stabilization on river morphology. This served as the main motivation of this study as this research aims at developing a numerical model for predicting the changes in river planform and thalweg profile after bank stabilization. We conducted a Delft 3D numerical study inspired by the work of Friedkin, (1945) . We set up model an initially straight channel with a transverse plate acting as forcing with the same bed materials, valley slope, variable discharge. Cycles of flow transformed the straight channel into a meandering river that reached a morphological state similar to that of Friedkin's experiment # 1 of Part-II as shown in Figure 1b. The results of calibrated model are shown in .a Results **of Calibrated model, b**a. The model was validated against Friedkin's experiment # 2 of Part-II. After it reached to a morphology as in the experiment, the banks were stabilized by revetment and differences were observed. This morphological configuration was then considered the starting point of the investigation. Several scenarios with longitudinal bank stabilization were simulated and the results were compared to base case with freely erodible banks.

Affiliations

[a] *Department of Water Resources and Ecosystems, IHE Delft Institute for Water Education, P.O Box 3015, 2601 DA, Delft, The Netherlands*
[b] *Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, The Netherlands*
[c] *River dynamics and inland water transport, Deltares, Delft, Netherlands*

References

Friedkin JF (1945) A Laboratory study of the meandering of alluvial rivers. U.S Army Corps of Engineers Waterways Experiment Stations, Vicksburg, MS, USA

Julien PY (2012) River Mechanics. Cambridge University Press

Minor B (2006) Barbs (Submerged Groynes) for River Bend Bank Protection: Application of a Three-Dimensional Numerical Model. Department of Civil Engineering, University of Ottawa

Minor B, Rennie CD, Townsend RD (2007) 'Barbs' for river bend bank protection: Application of a three-dimensional numerical model. Can J Civ Eng 34:1087–1095. https://doi.org/10.1139/L07-088

Tomohiro S (1996) Morphological Changes due to River Bank Protection. MSc Thesis, UNESCO-IHE, Delft, The Netherlands

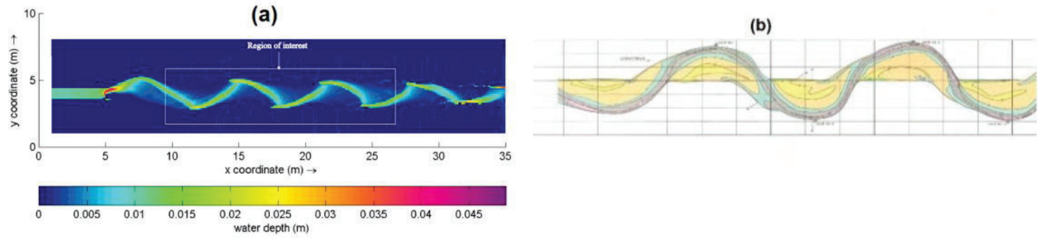

Figure 1.a Results of Calibrated model, b. Results of experiment # 1 of Part-II (source: Friedkin, 1945)

Preliminary Results

The model was used to analyze the effects of bank stabilization on different planimetric and cross-sectional parameters such as sinuosity, bend length, meander wavelength as chord lengths, meandering index, radius of curvature were compared with and without bank stabilization. Some preliminary results for the Friedkin's case i.e. case with each outer bend stabilized near the thalweg except the last one are reproduced in

and **Error! Reference source not found.**. In this case, it can be observed that bank stabilization restricts both the longitudinal and lateral movement of the river bends within a certain corridor and results in a smaller sinuosity as compared to a river without bank stabilization (base case). Therefore, bank stabilization on each outer bend results in reduced bend length, chord length and in some cases, it produces smaller sharp bends with reduced radius of curvature. In addition, decrease in the width of the channel and increase in the depth of thalweg was also observed.

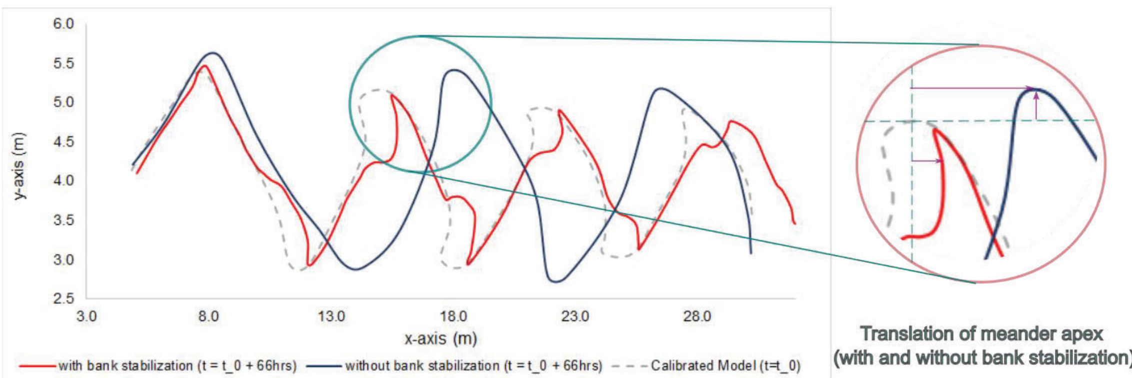

Figure 2: Planform changes (top view of thalweg) with and without bank stabilization

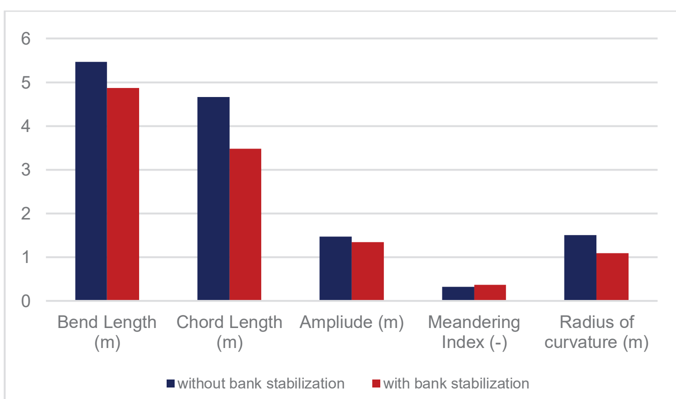

Figure 3: Comparison of modelled planimetric parameters with and without bank stabilization

The results produced by the model qualitatively agree with the experimental results of Friedkin and the field observations in real rivers. The analysis will be extended to analyze and compare the flood conductivity of rivers due to different configuration of bank stabilization. The study can also be extended