NUMERICALLY SIMULATED AGAINST REAL OBSERVED CROWD LOADS

ARTUR ADAM SOCZAWA-STRONCZYK
DR. NIKOLAOS NIKITAS, SCHOOL OF CIVIL ENGINEERING, UNIVERSITY OF LEEDS
DR. MATEUSZ BOCIAN, UNIVERSITY OF LEICESTER

INTRODUCTION

Despite recent advancements in computational techniques, modelling crowd walking on flexible structures remains a formidable challenge to the structural engineers. Specifically, it is still unclear what factors influence the pedestrians' behaviour and how they translate into the structural response. Therefore, further research on this subject is deemed to be necessary.

AIMS

The aim of this project was to establish whether a crowd simulation software, in this case MassMotion, once supplemented with a pedestrian loading model, could be a suitable tool for the analysis of human-induced vibrations of structures.

BRIDGE TESTING

The Centenary Bridge in Leeds was chosen as a test bed. The aim of the test was to extract the

Fig. 1: First three consecutive mode shapes in the vertical direction of the CB.

modal parameters of the structure and to gain insight into pedestrian behaviour while crossing the bridge. This was achieved by means of a set of wireless motion monitors [1] deployed on the bridge and cameras recording the in- and out-coming pedestrian traffic.

MODELLING CROWDS

The data gathered from video recordings allowed patterns of pedestrian behaviour to be identified which were then compared with MassMotion predictions. The focus was on pedestrian collision avoidance and overtaking manoeuvres. The pathways of pedestrian motion were also extracted to which a force was assigned and used within a created modal model of the structure.

Fig. 2: Real observed crowd (left) and the crowd simulation (right).

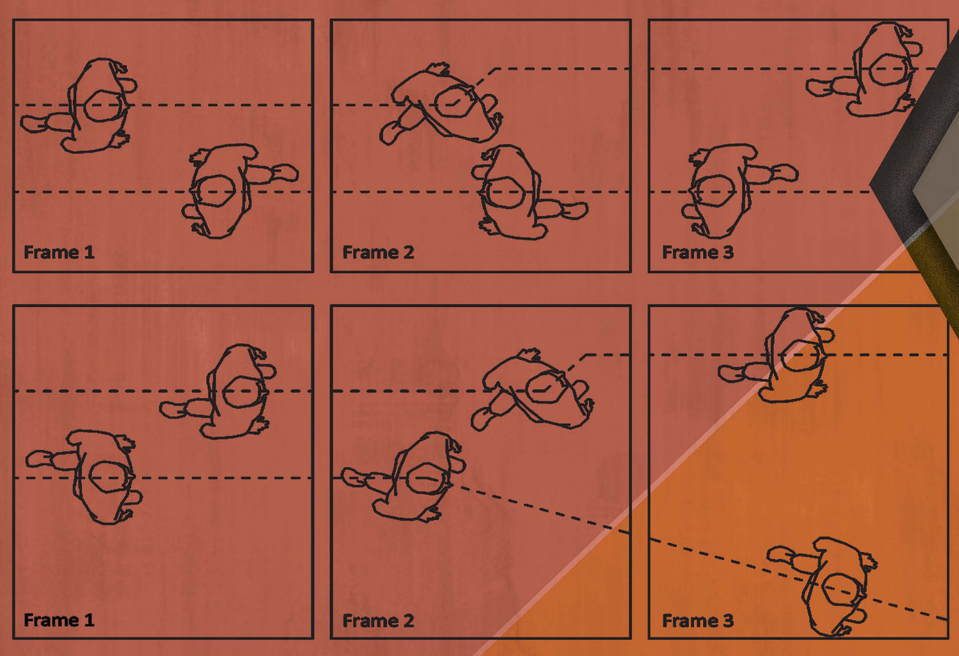


Fig. 3: Passage (top) and overtaking (bottom) manoeuvres observed in the simulated environment

RESULTS

Qualitative and quantitative assessment of MassMotoin was carried out based on the results from the bridge test and the modal model of the structure. The main differences identified in pedestrian behaviour between the real and simulated environment pertain to: headlock; passage and overtaking manoeuvres; group behaviour. The match between the simulated and observed bridge response was not achieved. This is likely to the pedestrians introducing additional damping to the structure which is associated with human-structure interaction, which cannot be accounted for when the pedestrians' force is modelled as purely external force to the structure.

BIBLIOGRAPHY

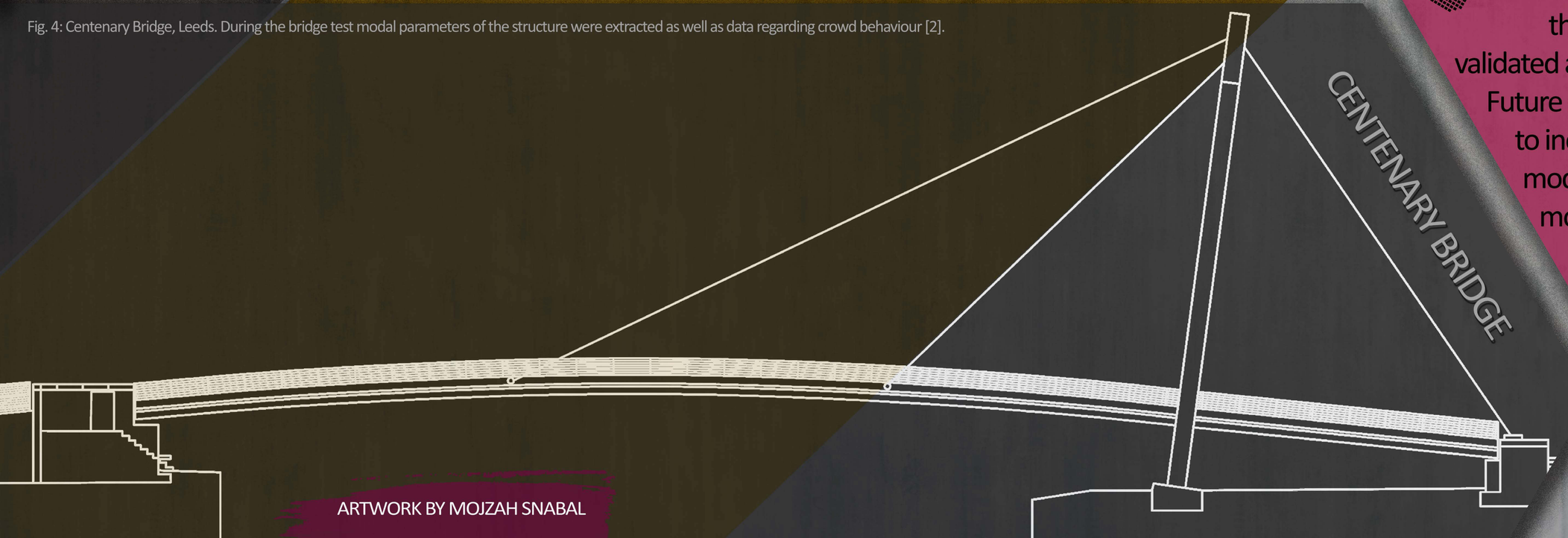
[1] J. M. W. Brownjohn, M. Bocian, D. Hester, A. Quattrone, W. Hudson, D. Moore, S. Goh and M. S. Lim, "Footbridge system identification using wireless inertial measurement units for force and response measurements," Journal of Sound and Vibration, vol. 384, pp. 339-355, 8 December 2016.

[2] Ove Arup & Partners International Ltd, "River Aire Footbridge," 1991.

CONCLUSIONS

The social force crowd models, such as the one implemented in MassMotion, are a promising tool for modelling crowd behaviour and the associated structural loading and response. However, in order to gain confidence in these models, they need to be validated against real-life observations. Future studies will explore how best to incorporate pedestrian loading models within social force crowd models and calibrate simulated crowd behaviour against data from full scale structures.

Fig. 4: Centenary Bridge, Leeds. During the bridge test modal parameters of the structure were extracted as well as data regarding crowd behaviour [2].



ARTWORK BY MOJZAH SNABAL

The Institution of Structural Engineers