Validation of MBD-CFD Co-Simulation for Corrugating Machine

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Introduction

Corrugated board boxes are the most familiar form of packaging and are a key part of the world's logistics and commodity distribution systems. Mitsubishi Heavy Industries, Ltd. (MHI) has been manufacturing corrugating machinery since 1955. In this paper, we will validate the co-simulation between multibody dynamics model simulating the motion of corrugated board inside the counter-ejector portion of corrugate machine as shown in Figure 1, and fluid dynamics model simulating the fluid blown from the top duct over the cardboard sheet for robust stacking. Using validated model it will be possible to find operating condition that improves stability and reliability for transport and stacking of large cardboard sheet at high operating speed.

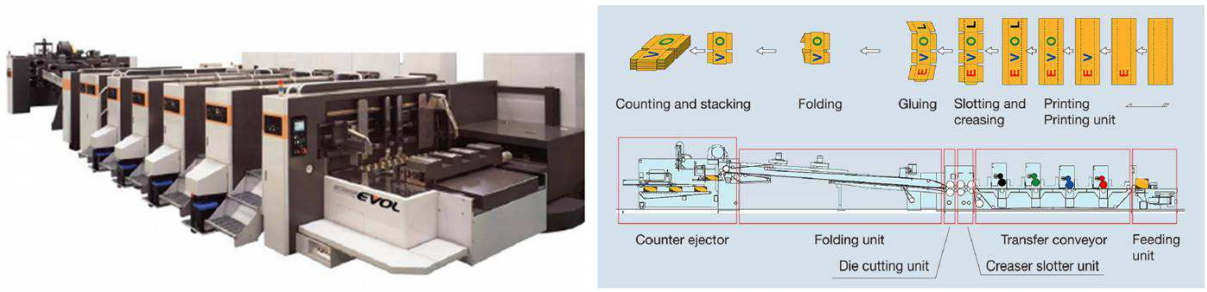

Figure 1: Basic configuration of a corrugated board box making machine

Simulation of cardboard through counter ejector

Cardboard is modeled as a discrete beam model which is fed into counter ejector through rotating rollers. As it passes, air blowing from duct pushes the cardboard down so that it gets stacked before the next cardboard enters the counter ejector section. Collision with front stoppers damps the kinetic energy of the cardboard. Co-simulation is done between multibody dynamics solver (MSC ADAMS) and fluid dynamics solver (ANSYS Fluent) through in-house coupling tool[1] which transfers force and deformation between different software while ensuring energy conversation at the coupling interface.

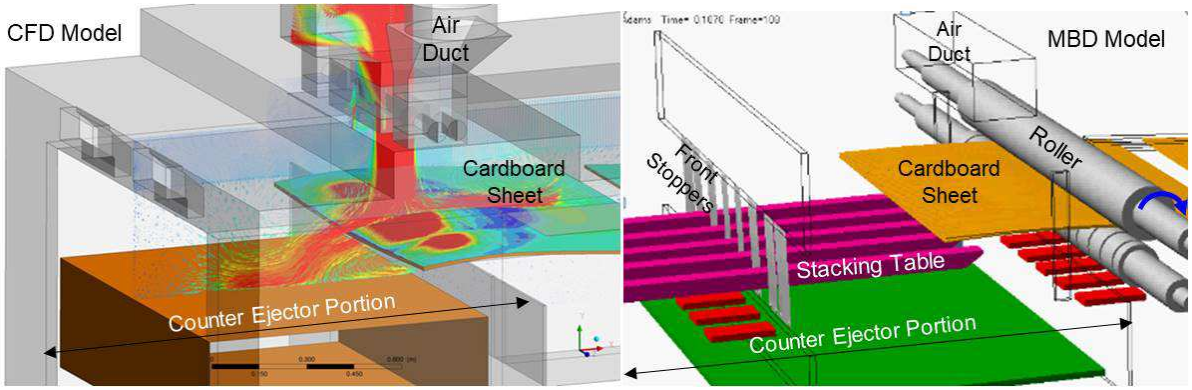

Figure 2: Representative CFD and MBD model of cardboard passing through counter ejector

Validation

Calibration of simulation model was done by measuring elemental stiffness and damping of cardboard sheet, pressure of airflow inside the counter ejector and various other contact parameters. After that trajectory of cardboard sheet was measured using laser sensors and video imaging as shown in Figure 3 for different size of cardboard sheets with transport speed and gap between rollers as experimental parameter. We used the collected data for validating the model in order to confirm the prediction capability of co-simulation.

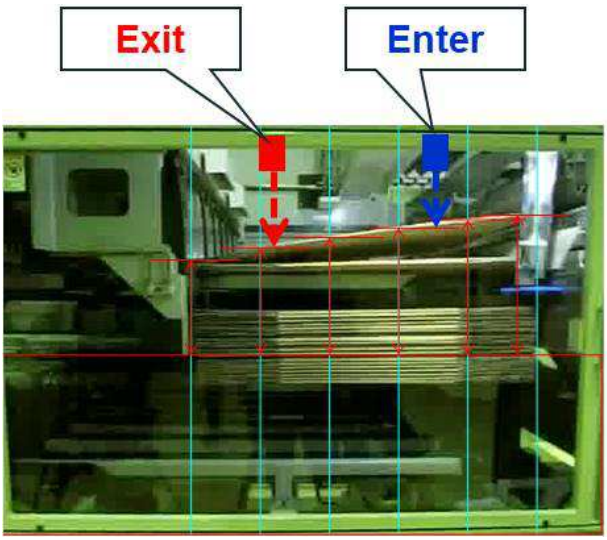

Figure 3: Deformation measurement through laser-sensor and video capture

References

[1] Arora, R.; Kanazawa. H.: Multibody, FEA and CFD simulation code coupling for fluid-solid interaction with large motion and non-linear deformation ,The 9th Asian Conference on Multibody Dynamics, 2018