Side Extender Flapping Issue

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INTRODUCTION

- Side extender helps truck cabin aerodynamics
- Part made of ABS plastic and has premature failure due to flutter-induced fatigue
- Understand how to model flutter by using CFD and FEA software to support fluid-structure interaction (FSI) analysis
- Provide a standard operating procedure (SOP) for FSI validated by data collection from wind tunnel

PROBLEM STATEMENT: A way to create and validate a fluid-structure interaction model for PACCAR truck side extenders that flutter in crosswind conditions at highway speeds

CORE FUNCTIONS

- Computational and experimental model show flutter
- The computational and physical models capture strain results
- Turbulent flow run at 60, 80, and 100 mph
- High quality mesh is needed to capture wake and vortex shedding

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DESIGN AND DEVELOPMENT

Figure 1: Wind Tunnel Testing Model

Wind Tunnel Testing

- Foam ramp profile creates a bluff body to create turbulent flow
- Extender modeled with aluminum material in 1/8th inch, 12-gauge, and 20-gauge thicknesses
- Extender angled 9.5 degrees - pressure differential induces flutter
- 5 evenly spaced strain gauges on the plate's underside for wind tunnel testing

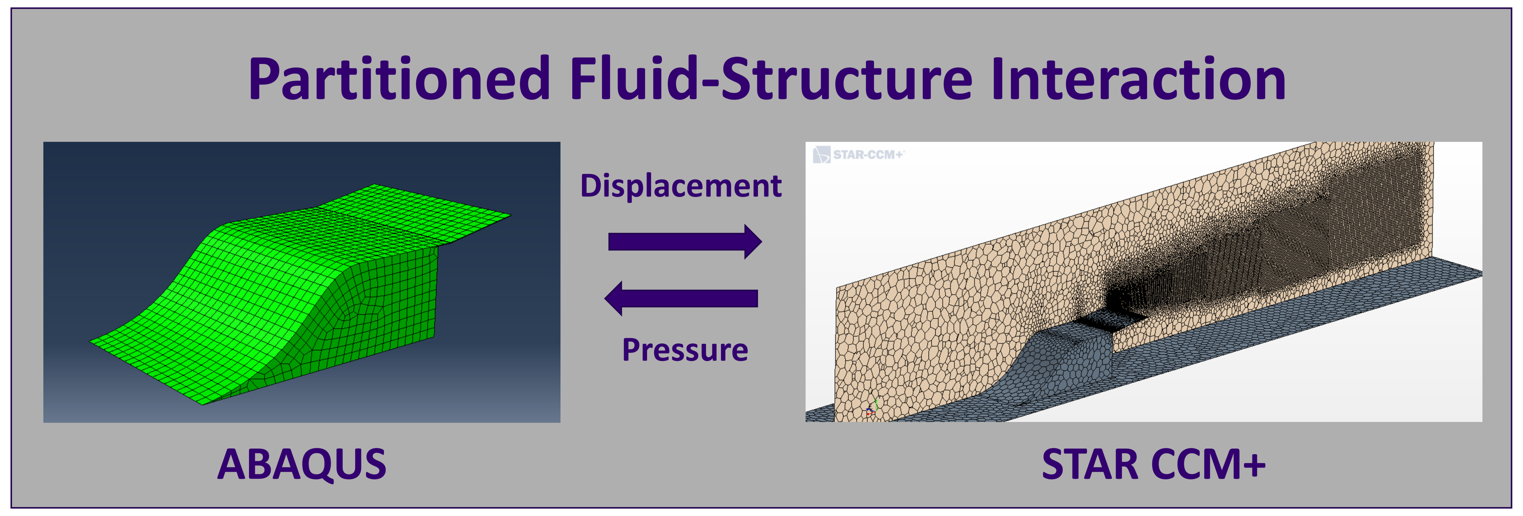

Figure 2: Exchange field diagram of the coupled solvers

Workflow of Coupling Solvers for FSI Simulation

- Develop stand-alone simulation for Abaqus and STAR CCM+ (Meshing, boundary condition, and specifying FSI boundary)
- Run each simulation for convergence
- Modify Abaqus input file and prepare STAR CCM+ for co-simulation
- Launch and execute co-simulation from STAR CCM+

RESULTS/VALIDATION

	1/8th in				12 ga				20 ga			
Type	Strain (10^{-6})	60 mph	80 mph	100 mph	Strain (10^{-6})	60 mph	80 mph	100 mph	Strain (10^{-6})	60 mph	80 mph	100 mph
Experimental Data	**Average**	16	28	41	**Average**	42	64	91	**Average**	144	188	196
	Peak	24	37	53	**Peak**	66	80	126	**Peak**	203	264	297
FEA (Abaqus) Data	**Static Load**	20	36	56	**Static Load**	46	83	129	**Static Load**	309	549	857
FSI Data					**Average**	20	32	46				
					Peak	36	55	76				

Table 1: Wind Tunnel Average Strain Results

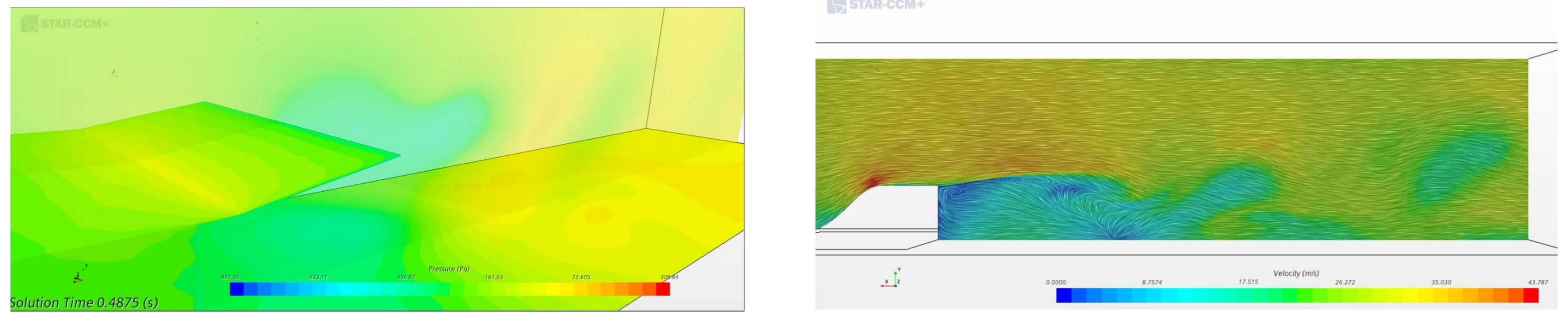

Figure 3: Pressure and Velocity in FSI Simulation

- As thickness decreased and speed increased, theoretical and observed strain diverged
- 12-gauge had similar strain at 60 mph to FEA
- FSI strain is half the magnitude of test results indicating room for improvement

Plate Thickness	FEA 1st Mode Frequency (Hz)
1/8th in	41.6
12 ga	26.99
20 ga	10.74

Table 2: FEA 1st Mode Frequency Results

CONCLUSION & FUTURE WORK

- FSI increases accuracy at cost of meshing and set up time
- Continue refining mesh and boundary conditions to align with theoretical results
- Applications in current and future aerodynamic studies to reduce the simulation time

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