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Finite Element Analysis of a Friction Clutch System in an Automatic Transmission

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Objective

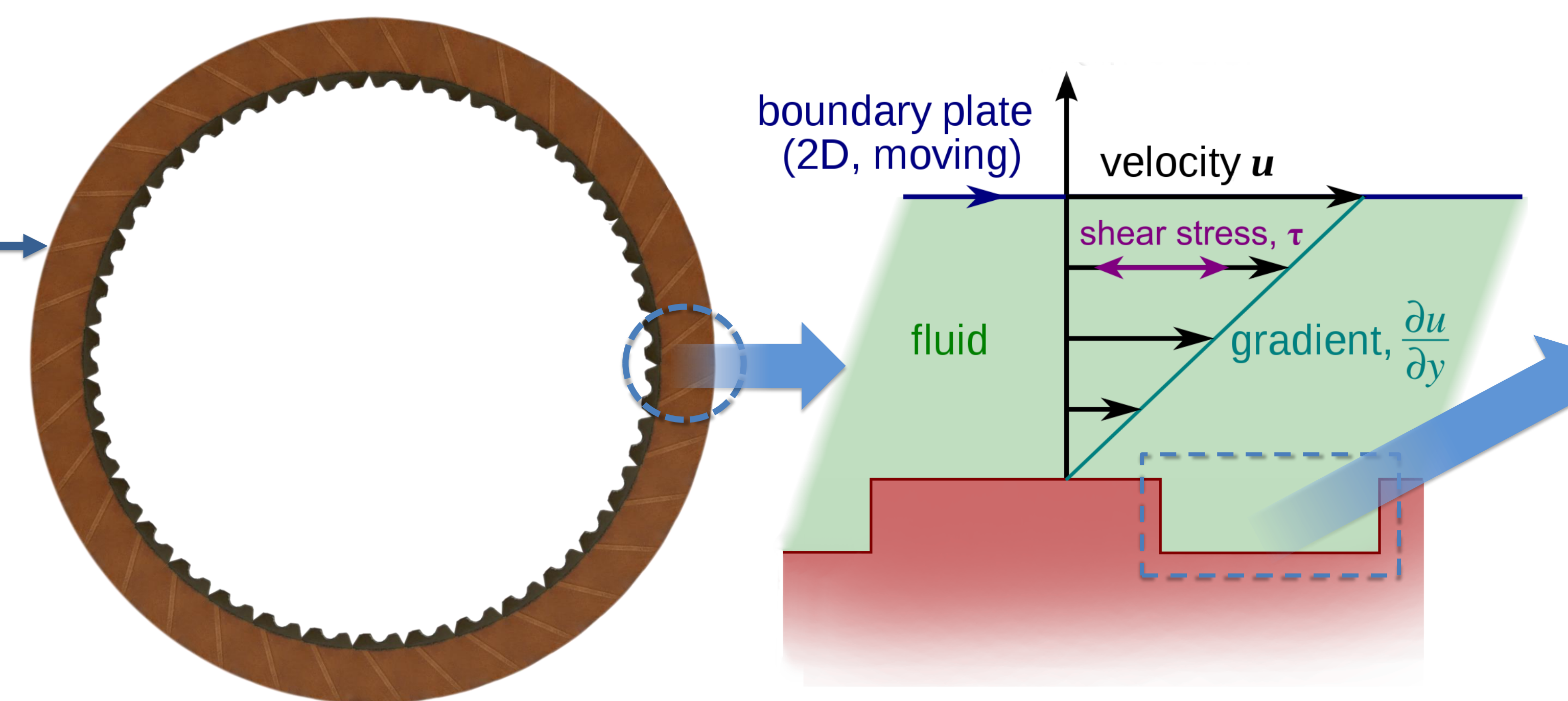
Develop a computational solution to test parameters that affect torque fluctuations in a friction clutch system

Solution

The solution is a two dimensional FEA simulation that is cost effective and time efficient.

Results

The simulation is simple to set up, takes very little time to generate values, and yields accurate results based on prior knowledge in fluid mechanics.



Operating Conditions & Fluid Parameters				
Category	Symbol	Value	Units	Description
Operating Conditions	P_{app}	1000	kPa	Plate-specific apply pressure
	h_0/σ	4	—	Initial film thickness ratio
	$\omega_{initial}$	3000	rpm	Initial Slip Speed
	ω_{final}	0	rpm	Final Slip Speed
	$T_{initial}$	80	°C	Initial Temperature
	T_{final}	250	°C	Final Temperature
	A_{load}	10	%	Percentage of area supporting P_{app}
	t_{end}	4	s	Time for full engagement
Fluid Properties	λ	4.99E-03	Pa·s	Viscosity (at P-v-T conditions)
	α	5	1/GPa	Pressure-Viscosity coefficient
	μ_s	0.14	—	Coefficient of asperity friction
	$d\mu_s/dT$	-4.0E-04	1/°C	Temperature gradient of μ_s
	s	30	nm	Minimum film thickness

Friction Material Properties and Plate Geometry		
Friction Material	E	30 MPa Young's elastic modulus
	σ	6 μ m Surface roughness
	D_a	25 1/mm ² Asperity density
	β	0.25 mm Asperity tip radius
	A_{gro}	5 % Percent groove area
	d	0.5652 mm Thickness
Plate Geometry	K_{per}	1.00E-13 m ² Permeability
	n	6 — Number of friction surfaces
	r_i	46.83 mm Inner radius of friction lining
Plate Geometry	r_o	58.74 mm Outer radius of friction lining
	Rc	53.0 mm Effective clutch radius
	A_N	3950.0 mm ² Friction interface area
	A_{net}	3752.5 mm ² Friction area net of grooves

