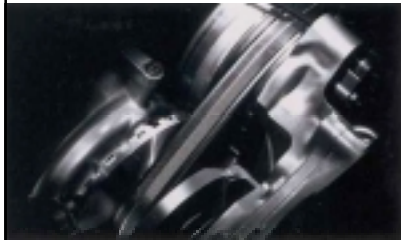


Simulation of Metal Pushing Type V-belt for CVT



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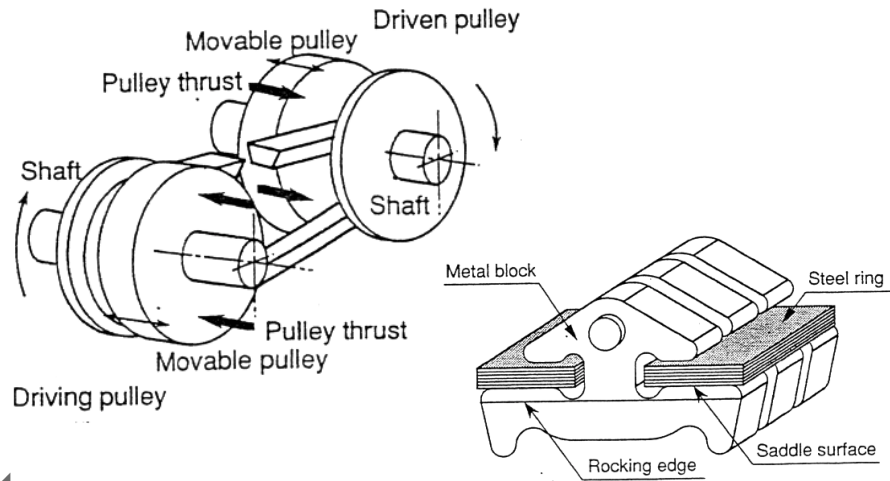
15th ADAMS European User Conference Nov. 15 - 16 , 2000, Rome, Italy

Contents

- General topics about CVT
- Background of simulation
- Simulation method with ADAMS
- Analysis result
- Summary



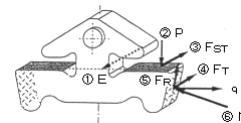
Configuration of Metal Pushing type V-belt for CVT



Requirement for development of belt CVT

- Required function of CVT
 - ◆ Smooth torque transfer between pulley and belt
 - ◆ Smooth speed change
 - ◆ High durability
- Required information
 - ◆ Friction characteristic
 - ◆ Belt behavior
 - ◆ Force balance between components
 - ◆ Mechanism of variable speed
 - ◆ Ring, block and pulley deformation
 - ◆ Influence of deformation to torque transfer

- Evaluation items
 - ◆ Block compression force
 - ◆ Friction forces between block & ring
 - ◆ Forces between block & pulley
 - ◆ Ring tension force
 - ◆ Pulley deformation
 - ◆ Speed ratio
 - ◆ Torque ratio
 - ◆ Slip ratio etc.

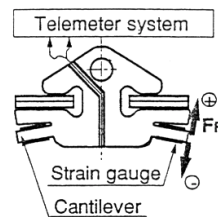


Background of project



■ Why ?

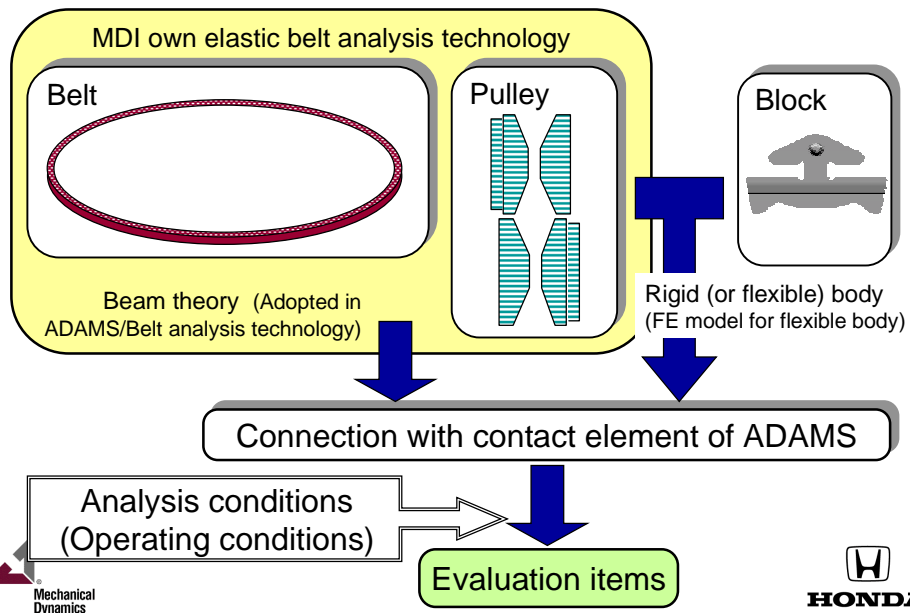
- ◆ Physical test experiences have done for many years.
- ◆ Measurement is difficult.
 - Need machine work to put sensor
 - Cannot be measured in high speed
- ◆ Difference between test and simulation. (Which is correct ?)
- ◆ To get knowledge of torque transfer by CVT

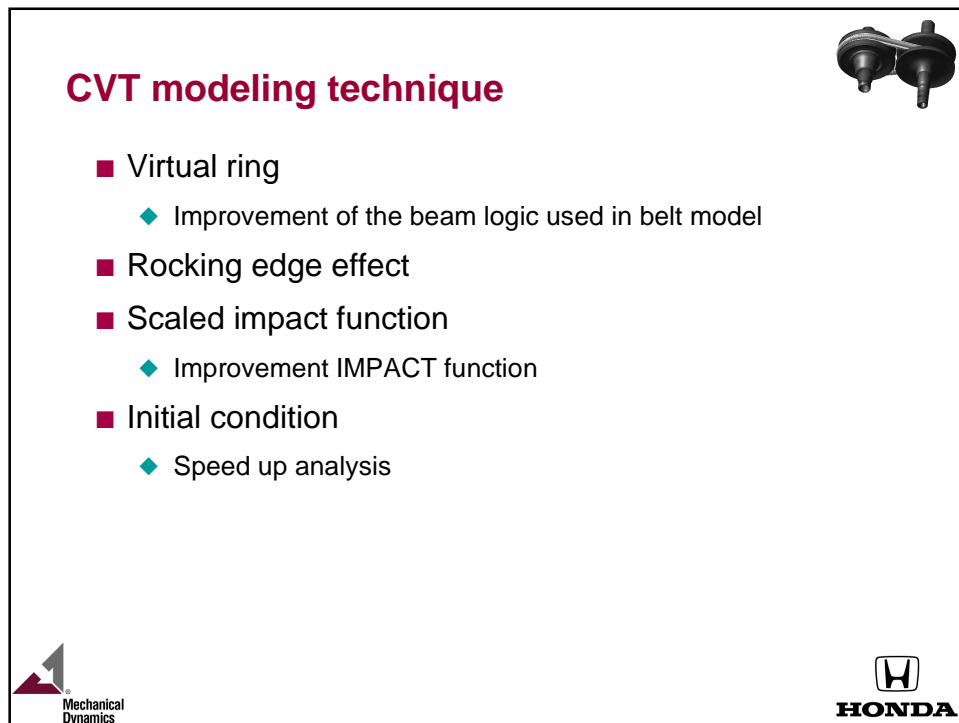
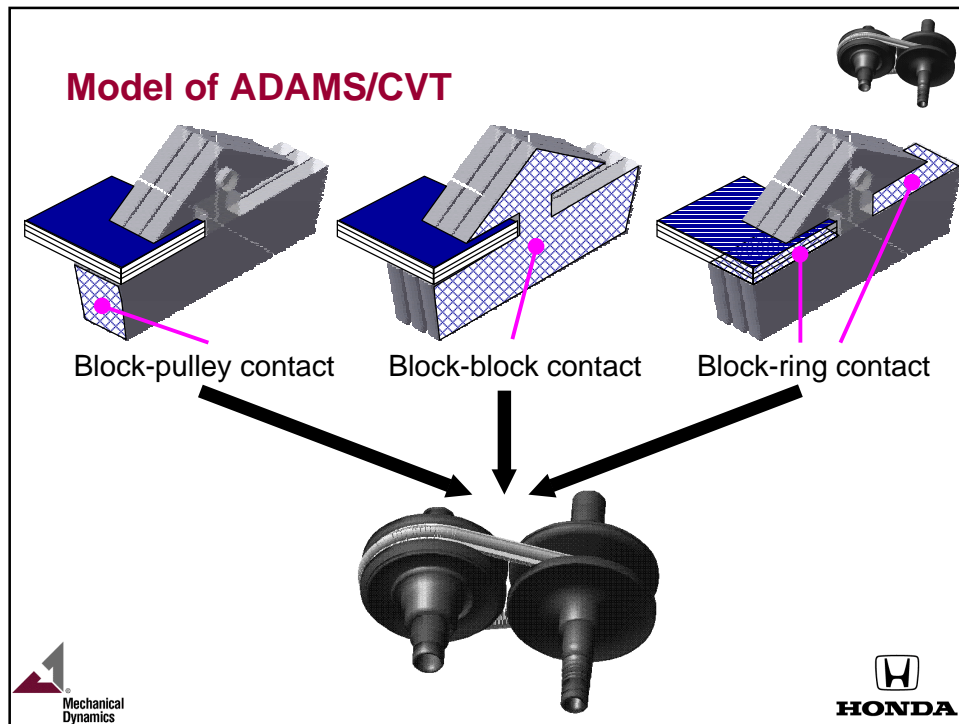


Radial frictional force sensor

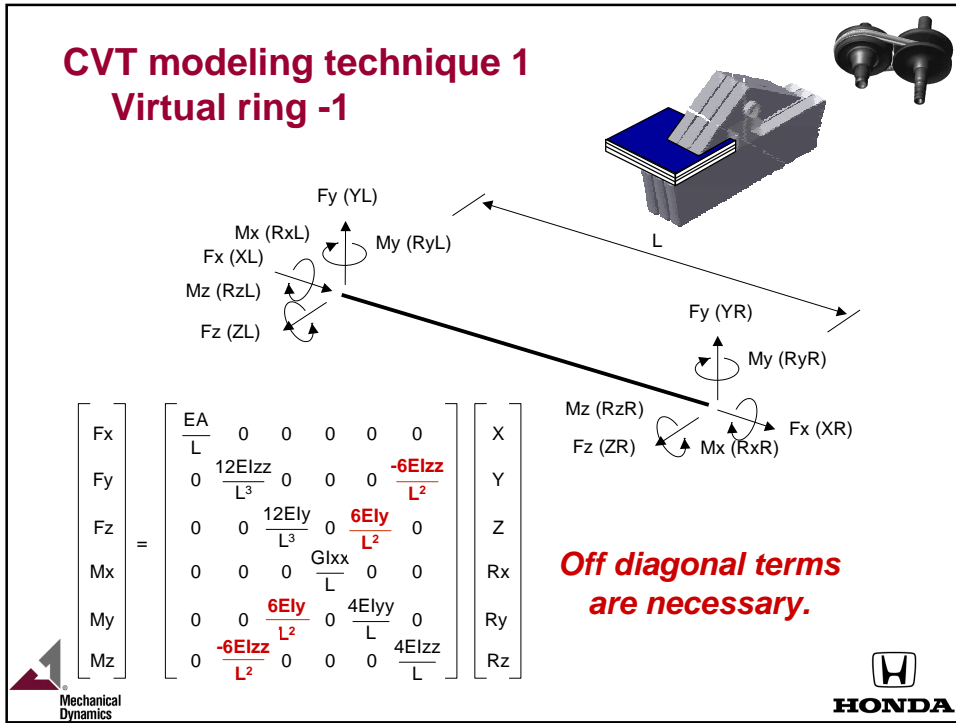


Approach of CVT behavior analysis

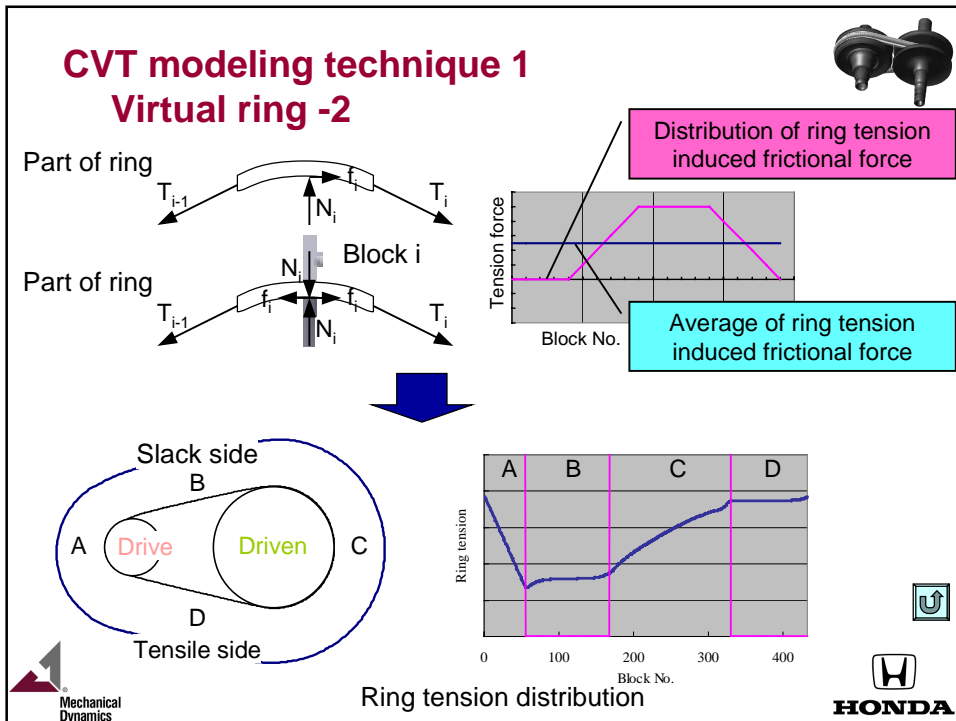




CVT modeling technique 1 Virtual ring -1



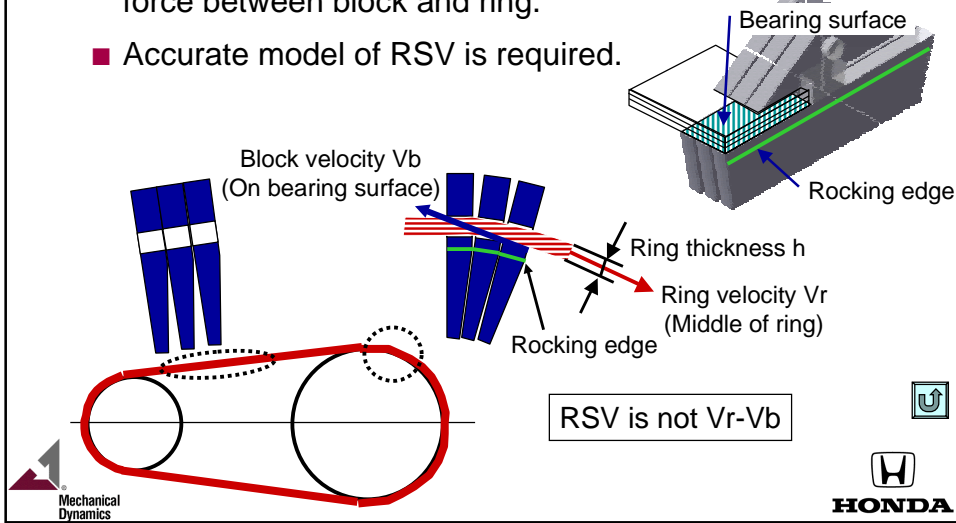
CVT modeling technique 1 Virtual ring -2



CVT modeling technique 2 Rocking edge effect



- Relative surface velocity (RSV) effects the traction force between block and ring.
- Accurate model of RSV is required.

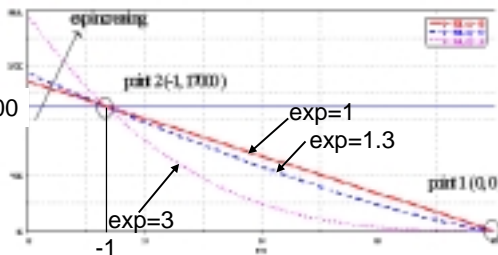


CVT modeling technique 3 Scaled impact function



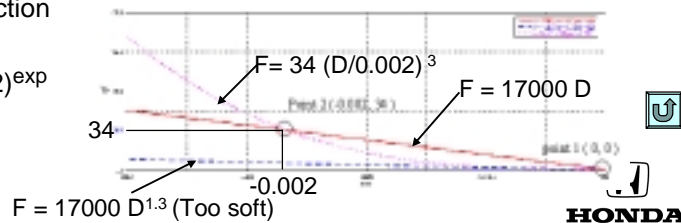
Standard IMPACT function

$$F = 17000 D^{\text{exp}}$$



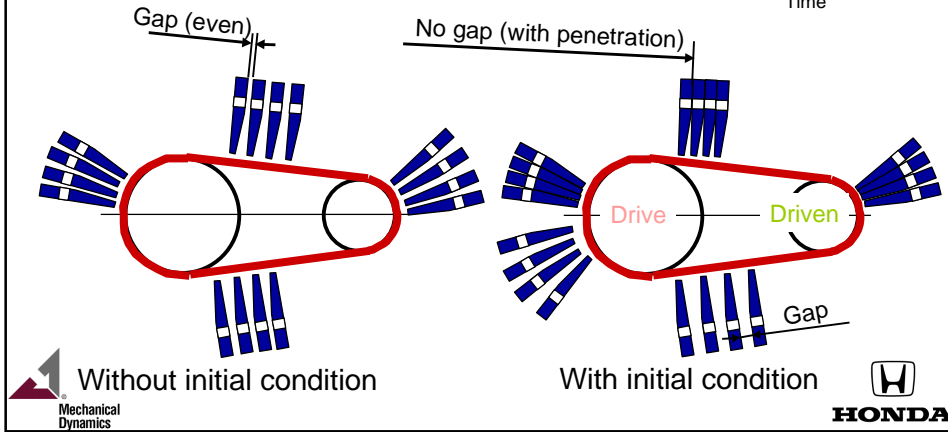
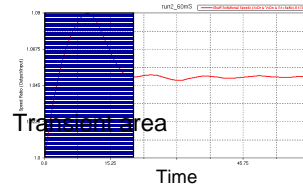
Scaled impact function

$$F = 34 (D/0.002)^{\text{exp}}$$

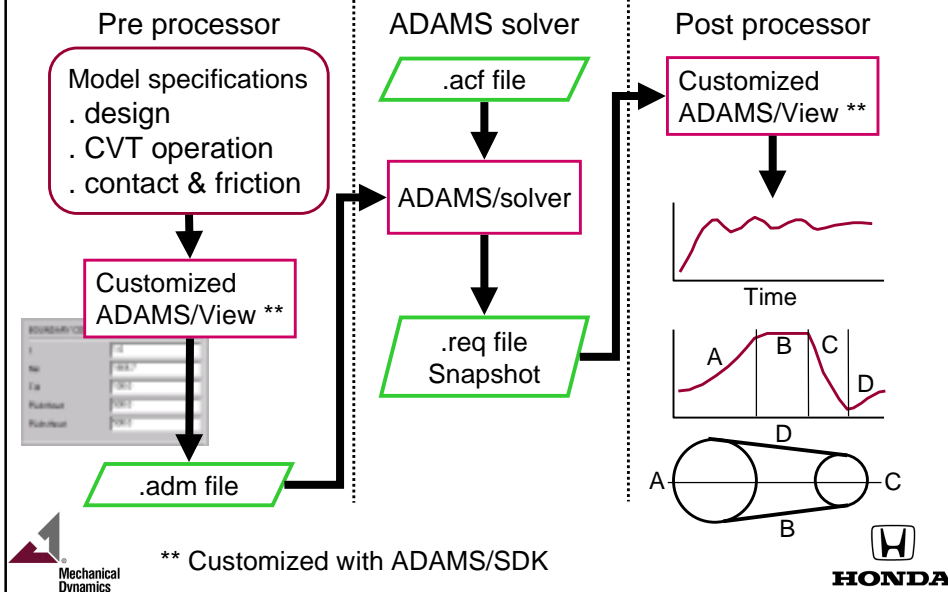


CVT modeling technique 4 Initial condition

- To reduce time to get steady state.



Outline of ADAMS/CVT system



ADAMS model of Pushing type CVT



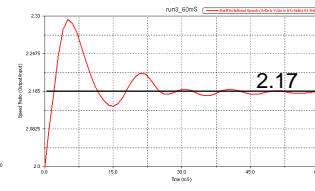
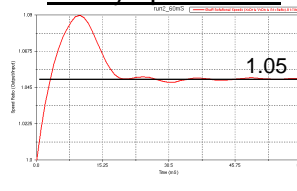
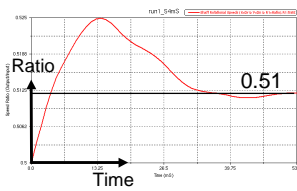
(Demonstration)



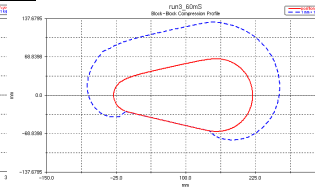
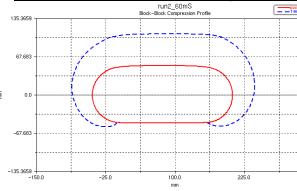
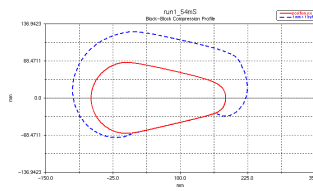
Simulation results



Pulley speed ratio



Block-block compression



Speed ratio 0.5

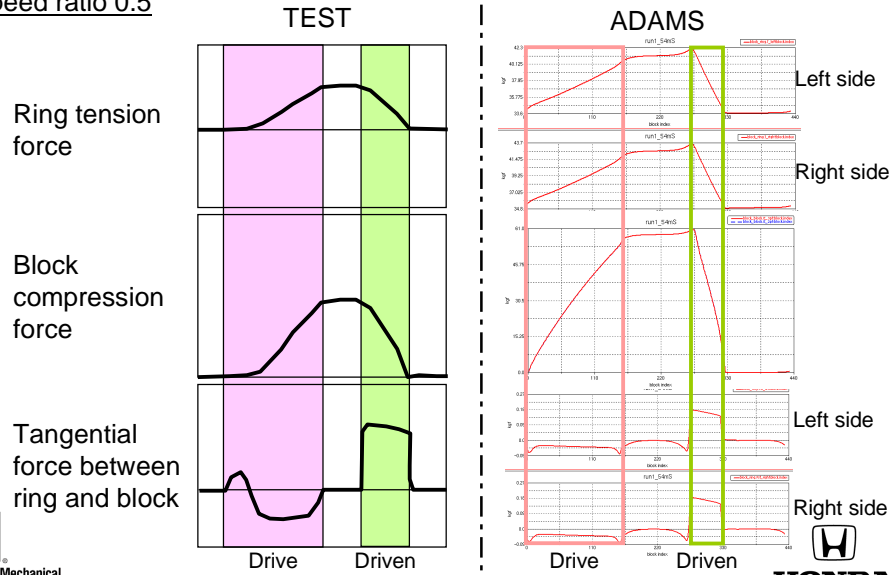
Speed ratio 1.0

Speed ratio 2.0



Comparison of results

Speed ratio 0.5



Summary

- Basic technology for CVT simulation is established.
 - ◆ Similar results as physical test.
 - ◆ Virtual ring method is available to CVT system
 - ◆ Parametric study can be done easily using Pre-processor