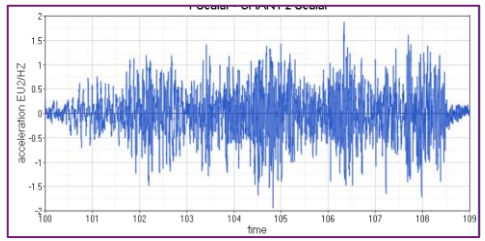
Random Vibration Fatigue Analysis for Bracket of PAB Module with LS-DYNA

Tengteng Wang

Autoliv CTC

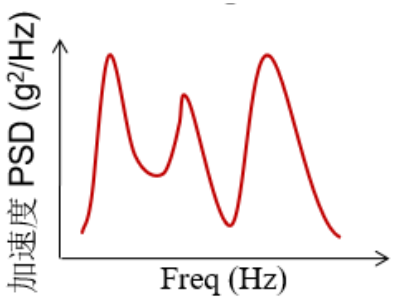
Random Vibration Fatigue Analysis for Bracket of PAB Module with LS-DYNA

Random Vibration & Random Fatigue



Uncertain Loading

Car driving on rough roads

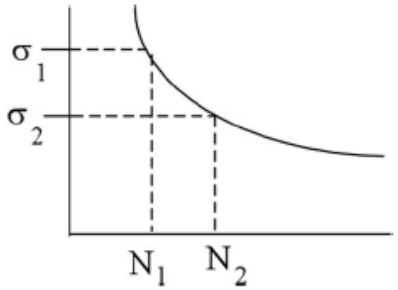


Random Vibration

Input loaded at all frequencies at the same time

Probability Distribution

S-N Fatigue Curve



Typical SN (or Wöhler) curve

Accumulation of Damage

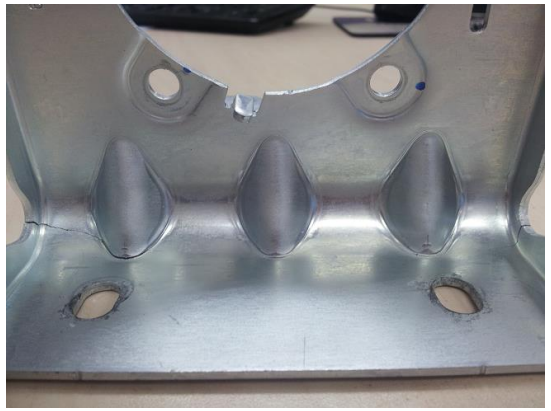
$$R = \sum \left(\frac{n_i}{N_i} \right)$$

Random Fatigue

Random Vibration Fatigue Analysis for Bracket of PAB Module with LS-DYNA

Background(Before)

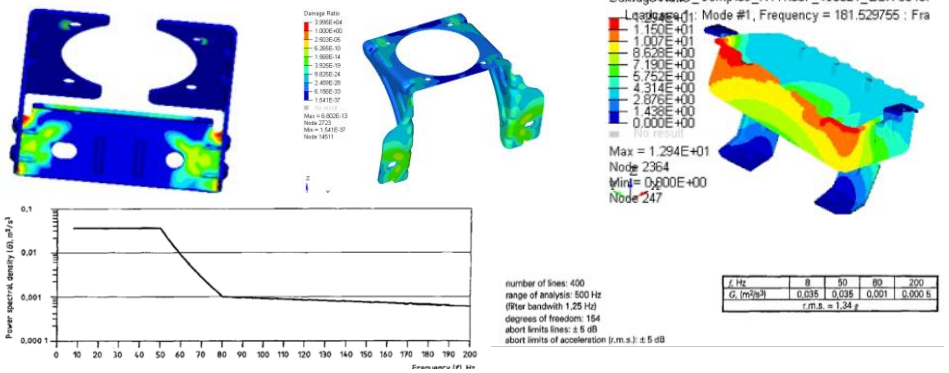
- **CAE PAB bracket fatigue prediction accuracy is not good.**
  - The unreality modeling for assembly model can't get high accuracy result.
  - Once DV failure occurs, delivery delayed and cost added.
  - CAE recalculation + design change + new moulds and sample + environment retest + vibration durability retest



One DV failure cost :
Time cost: **3 months**
Money cost: **20w~50w**
(DV test: 12w, DV samples: 6w, change moulds: 2w ~ 32w)

Achievement(After)

- **Prediction accuracy of the FE model is improved.**
- **25 PAB bracket ESRs are counted, no DV failure occur (Jun 1, 2018- May 31, 2019).**



- **Benefit:**

	Time saving (h)	Cost saving (RMB)
With upper bracket (14)	14*72 = **1008 h**	**10w~50w**
Without upper bracket (11)	11*48 = **528 h**	**5w~25w**
Annual saved	1536 h / 24 = **64 day**	**15w~75w**

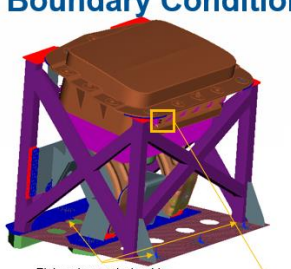
- **Next Step:**

Vibration durability test in DV phase can be partly replaced by CAE after verifying serials projects and database.

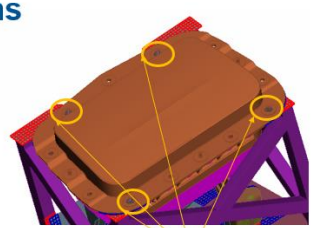
Random Vibration Fatigue Analysis for Bracket of PAB Module with LS-DYNA

Modeling & Result

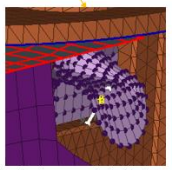
Boundary Conditions



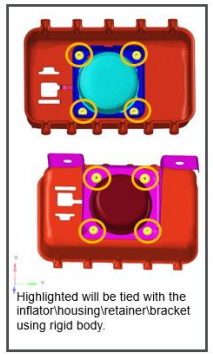
Fixture is constrained in the bolts positions.



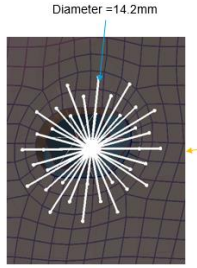
Cover is connected with the fixture using beam element and the pre-tightening force is added in the model. .



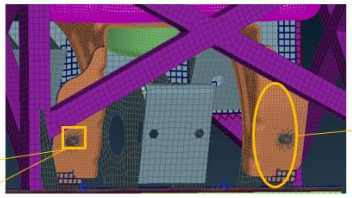
Housing is connected with Cover using element beam.
Beam outer diameter = 0.2mm.

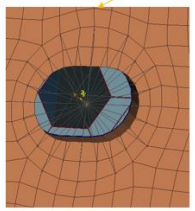


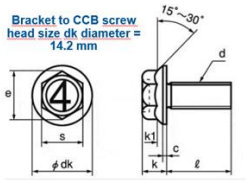
Highlighted will be tied with the inflator\housing\retainer\bracket using rigid body.

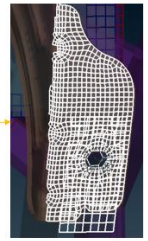


Beam element is used to mimic the bolt connection between bracket and fixture. And the estimated thread pre-tightening force is added in the model.

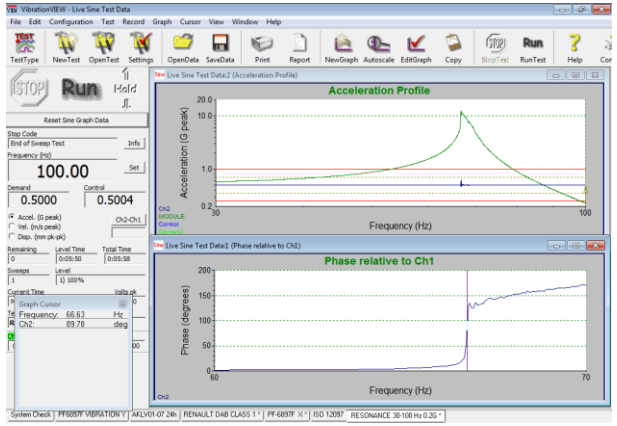


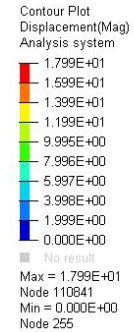


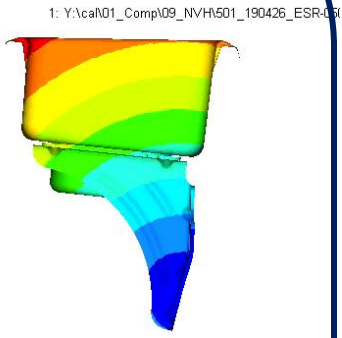




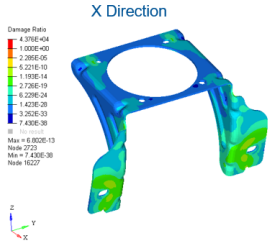
Using contact to mimic the real state.
As the contact is non-linear, using intermittent eigenvalue method to solve the vibration behavior in LS-DYNA.





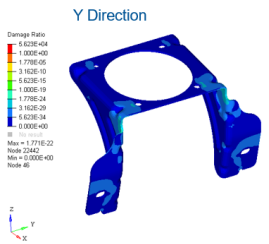


	Test result /Hz	Simulation result /Hz	
Case 1 (without cover and cushion)	66.63	65.2	-2.1%
Case 2 (with cover without cushion)	82.67	84.02	1.6%
Case 3 (with cover and cushion)	70.13	67.58	-3.6%



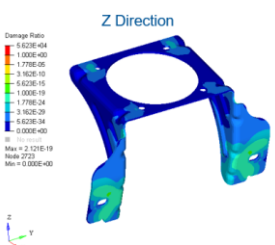
Max. Damage Ratio = 6.802E-13

X(24h): Max damage ratio <1 PASS



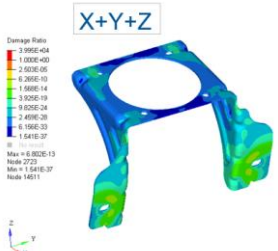
Max. Damage Ratio = 1.771E-22

Y(24h): Max damage ratio <1 PASS



Max. Damage Ratio = 2.121E-19

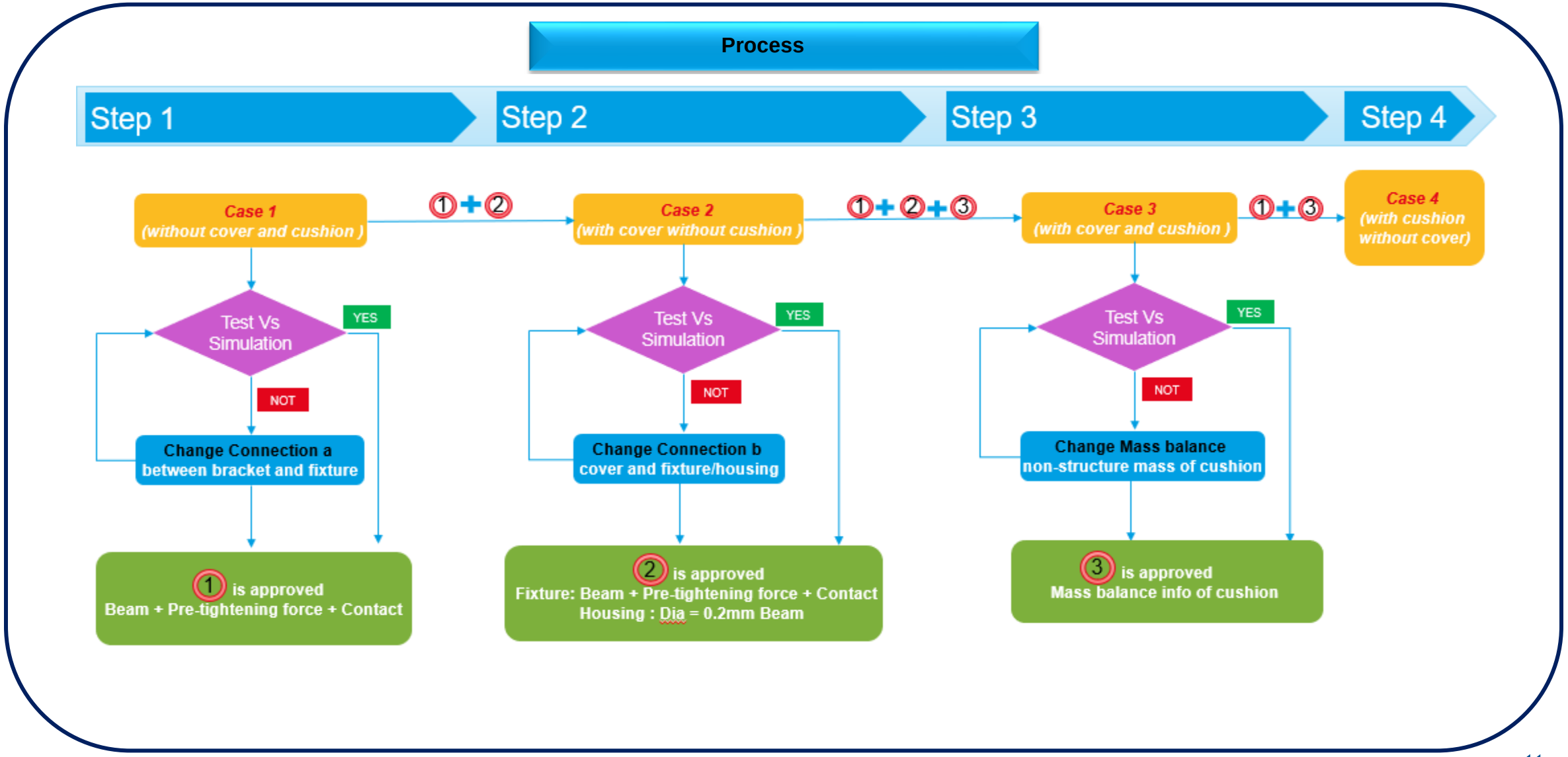
Z(24h): Max damage ratio <1 PASS



Max. Damage Ratio = 6.802E-13

X(24h)+Y(24h)+Z(24h): Max damage ratio <1 PASS

Random Vibration Fatigue Analysis for Bracket of PAB Module with LS-DYNA




Each year, Autoliv's products save over 30,000 lives
autoliv.com
Autoliv