SAND2018-3109C

NEW CAPABILITIES FOR SIERRA STRUCTURAL DYNAMICS VERSION 4.48

Sierra Structural Dynamics Team

ALL-TO-ALL (DASH) CONTACT

Motivation:

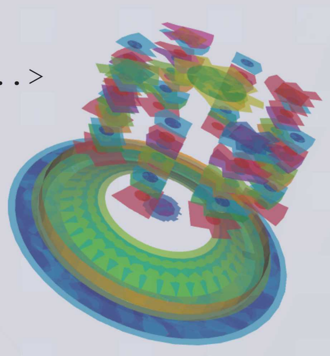
- More powerful and easier to use contact syntax (block skinning, automated search tolerances, general interaction definition, contact on nodesets)
- Consistent syntax and behavior between Sierra SM and SD
- Common contact code for sustainability.

ALL-TO-ALL CONTACT: USABILITY

Existing 'ACME' Tied Data Syntax Requires:

- Definition of 34 extra sidesets in cubit
- 175 lines of input deck syntax to pairs these sidesets
- Manually set search tolerances

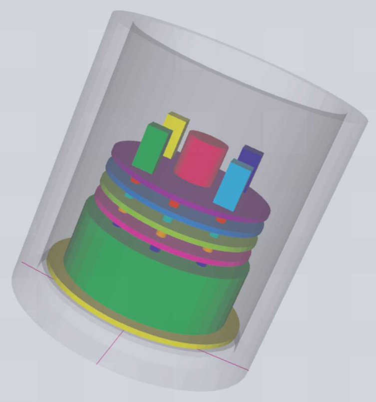
```
tied data
  surface   40002,30002
  search tolerance = 0.05
  gap removal = off
End
<..repeated for ~30 other pairs..>
```



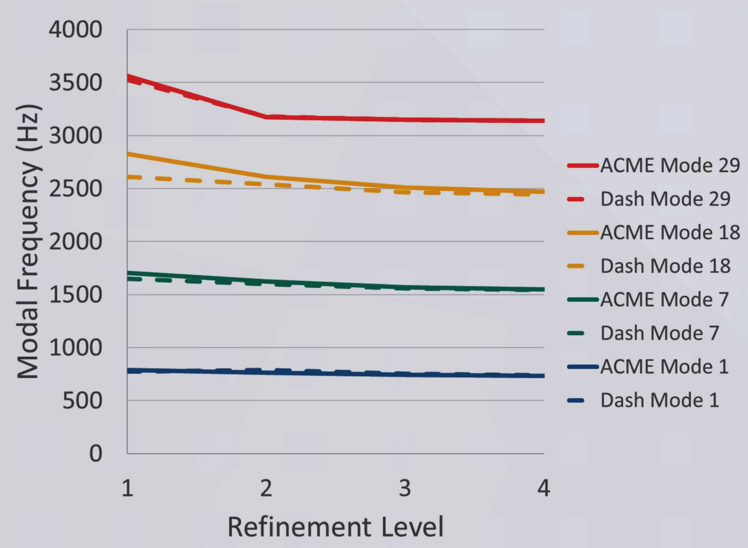
New 'Dash' Contact Syntax Requires:

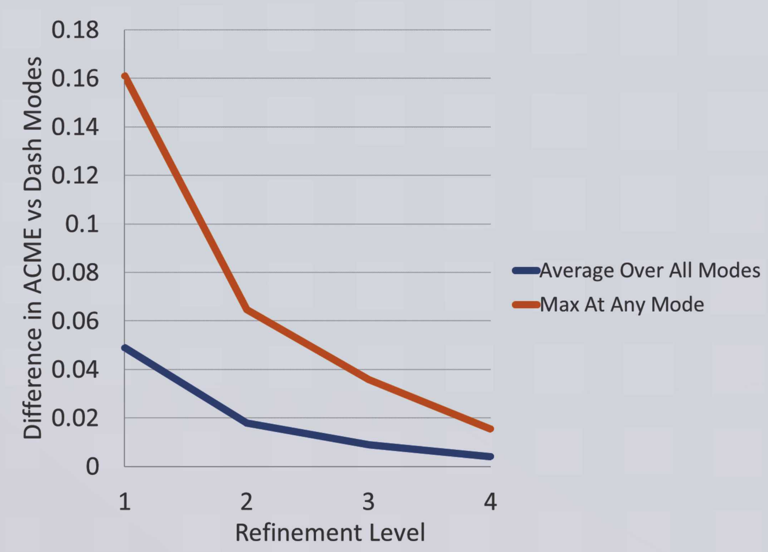
- 7 input lines

```
Begin-contact-definition
  skin all blocks = on
  gap removal = off
  begin-interaction-defaults
    general contact = on
  end-interaction-defaults
end
```



ALL-TO-ALL CONTACT: ACCURACY

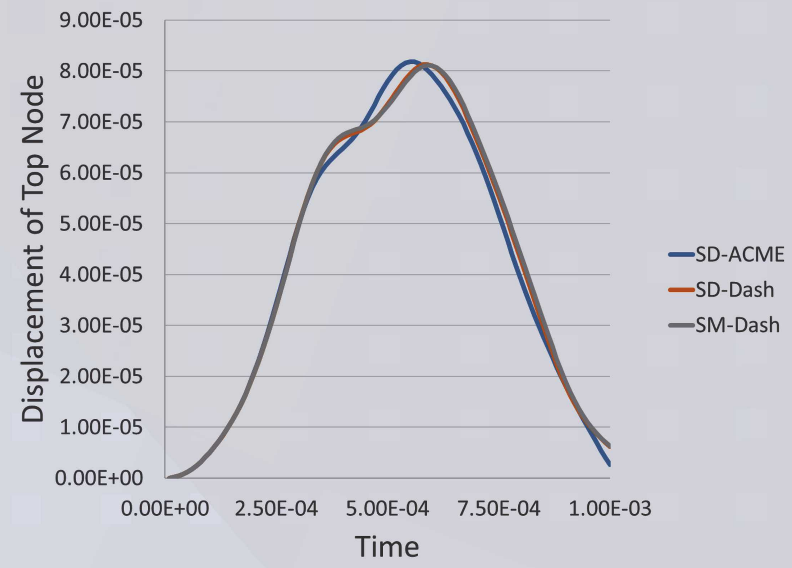


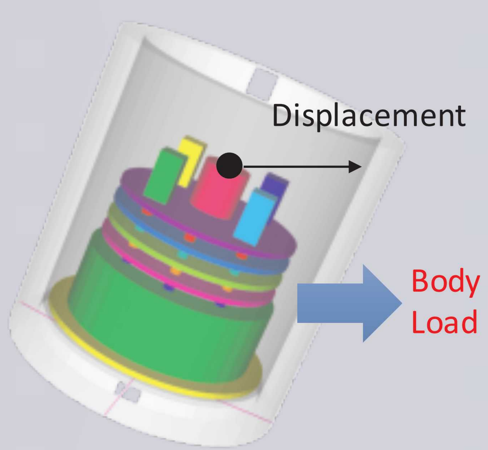


Solution convergence:

- Choice of master/slave constraint pairing becomes less important as mesh is refined. ACME & Dash converge to same results
- Notice that mesh refinement has far more affect on frequency than ACME/Dash

ALL-TO-ALL CONTACT: CONSISTENCY





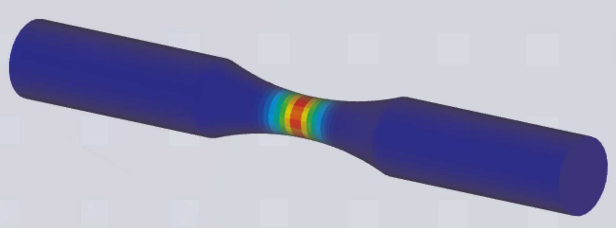
New SD contact capability has identical syntax to SM contact. Greatly improves usability and accuracy of SM/SD preload, handoff, or model conversion

Confirmed SD/Dash and SM/Dash give the same constraints with same syntax if

- Using node/face constraints
- Tied contact only
- Constraint gap removal off

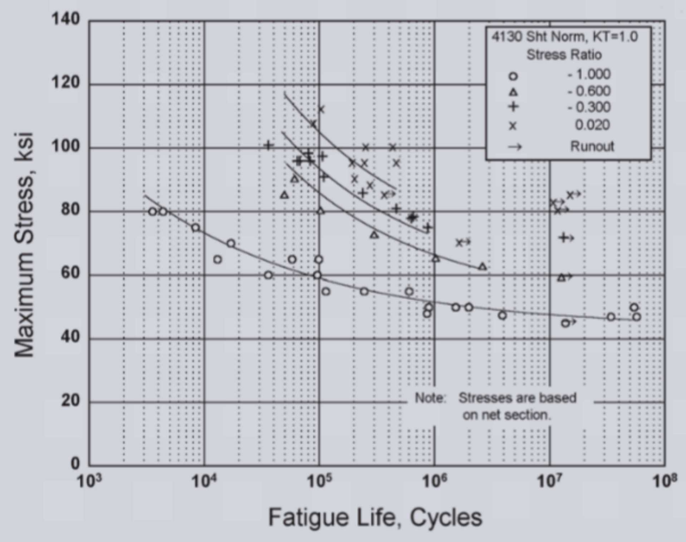
Using the same constraints greatly improves consistency of SD vs. SM results

HIGH CYCLE FATIGUE ESTIMATION



Motivation:

- Provide a convenient estimation of high cycle fatigue life based on modal random vibration result



Computes the following:

- Zero Crossing Rate

$$\nu_o^+ = V_{RMS2}/(2\pi \cdot V_{RMS})$$

- Peak Crossing Rate

$$\nu_p = \sqrt{M_4/M_2}$$

- Narrow Band Damage Rate

$$D_{NB} = \frac{\nu_o^+ \tau}{A}(2\sqrt{2}\sigma_s F_{SS})^m \Gamma\left(\frac{m}{2}+1\right)$$

- Damage Rate (Wirshing-Light method)

$$D = \lambda D_{NB}$$

HIGH CYCLE FATIGUE: USAGE

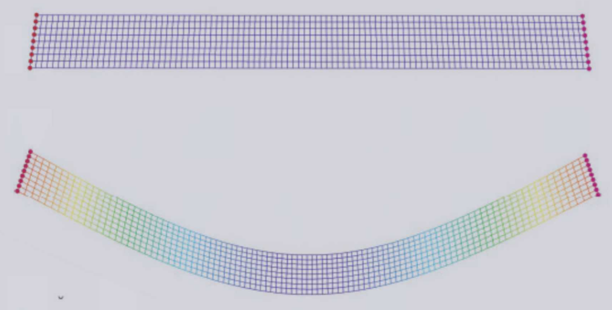
```
SOLUTION
case eig
 eigen nmodes=150
 shift=-1e5
case rand
 modalranvib
 lfcutoff = 10
 nosvd
case damage
 fatigue
 method=wirsching
 duration = 1.0e+6
END
≈
```

```
MATERIAL  AISI4140
  E=29.0e6
  nu=0.32
  density=0.283
  Fatigue_A1 31.6
  Fatigue_A2 -14.0845
  Fatigue_A3 0.80
  Fatigue_stress_scale 1.0e-3
END

OUTPUTS
  vrms
END

ECHO
  fatigue
END
```

Material Handbook Properties



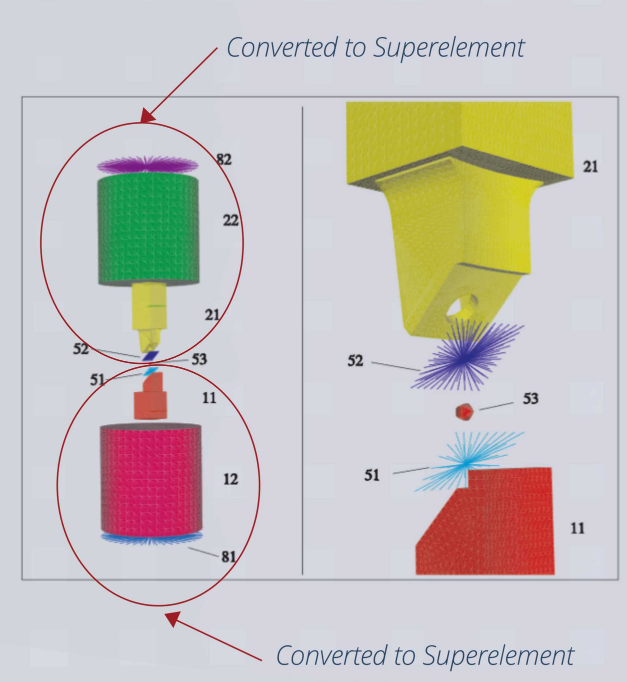
Accumulated 'DAMAGE' output for pinned plate

Fatigue damage is a non-dimensional metric where 0.0 is pristine and 1.0 is fatigue failure

SUPERELEMENTS: NASTRAN COMPATIBLE OUTPUT

Motivation:

- Enable sharing SD models with other agencies and contractors



Nastran with Salinas/SE

Mode	MSC Nastran 2016 (Salinas based DMIG) Natural Frequency [Hz]	MSC Nastran 2016 (Nastran based DMIG) Natural Frequency [Hz]
1	528	528
2	931	927
3	2,916	2,892
4	4,675	4,630
5	6,144	6,078
6	6,499	6,446
7	8,292	8,119
8	13,209	12,864
9	14,972	14,427
10	17,796	17,681

Salinas with Salinas SE

Mode	Full Model	4-Mode ROM	0-Mode ROM
1	532.065	532.066	551.163
2	937.066	937.066	1107.19
3	2956.37	2956.87	3758.39
4	4733.4	4734.76	6022.09

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