Support tube R&D for Final Quad

KEK  Hiroshi Yamaoka

Contents

1. Introduction

2. Prototype support tube
   (1) Configuration
   (2) Vibration Test

4. Conclusion
Support tube R&D

PURPOSE
Evaluate a validity of FEM calculations

(1) 20t x 100w x 695L
Measuring oscillation properties.

(2) 10t x 50w x 1440L

(3) 20t x 100w x 695L

(4) 20t x 100w x 695L
2.5t x 100w x 200L

Done!

(5) 1/10 model
Presented!

Long stroke shaker
Max. Force: 13.6kgf
Max. Velocity: 76cm/s
Max. amplitude: 15.9cm
Size: 21.3x16.8x52.6cm
Weight: 36kg

PREFERENCE
Evaluate a validity of FEM calculations
Result

1st: ~30Hz
2nd: ~190Hz

Input Acc. = 2x10^-4 (cm/s^2)
→ 0.5nm @ 10Hz, 5x10^-3nm @ 100Hz

- Amplitude
- Phase
are not same!!

- Input Acc.
- Stiffness,
are not same!!

It’s hard to set-up with same
- Input Acc.
- Stiffness
Connecting thin plate

\[ I_m = \frac{b}{12} \cdot h_m^3 \]
\[ = \frac{100}{12} \cdot 20^3 \]
\[ = 6.7 \times 10^4 \text{ mm}^4 \]

\[ I_s = \frac{b}{12} \cdot h_s^3 \]
\[ = \frac{100}{12} \cdot 2.5^3 \]
\[ = 130.2 \text{ mm}^4 \]

\[ \frac{I_m}{I_s} = 512 \]

Thin plate is meaningless??

2.5t x 100w x 200L

20t x 100w x 695L

2.5t x 100w

20t x 100w
Result

1: 26Hz

2: 40Hz

3: 161Hz

4: 187Hz

1: 30Hz

2: 43Hz

3: 184Hz

4: 197Hz

Amplitude (nm)

Frequency (Hz)
Test conf-1,2

→ Good agreement with the FEM calculations.

Test conf-3

→ Both structures are vibrated independently.
→ It’s hard to set-up with same stiffness.

Test conf-4

→ 1st, 2nd: Good agreement with the analyses.
→ Structural disagreement can be absorbed.
1/10 prototype support tube

Prototype support tube

Thin Tube

Shaker
Test items

Cantilever
  • Taper flange/Flat flange
    - Measuring oscillation properties
    - Compare to the ANSYS calculation
    - Effects of joining strength

Both-ends supported
  • Taper flange/Flat flange
    - Measuring oscillation properties
    - Compare to the ANSYS calculation
    - Effects of joining strength
    - Thickness of connection tube

Sorry, next time.
Tests (Hammering test)

Input

Output

FFT

FRF Table

FRF (Frequency Response Function)

\[ H_{ij}(f) = \frac{X_i(f)}{F_j(f)} \]

X_i: Output Acc.
F_j: Input force
○ Results

(Taper flange, 12-M6)

A: 57Hz
B: 129Hz
C: 585Hz
D: 1216Hz
E: 1690Hz
F: 2500Hz
Effects of joining strength

![Diagram showing effects of joining strength with data points for different types of bolts: 3-M6, 6-M6, 12-M6. The graph plots Frequency (Hz) against Axial Force (kg). The data points are labeled as 1st-Taper, 2nd-Taper, 3rd-Taper, 4th-Taper, 5th-Taper, 1st-Flat, 2nd-Flat, 3rd-Flat, 4th-Flat, 5th-Flat.](image)
Conclusion

Cantilever type

FEM ⇔ Test results

→ 1\textsuperscript{st}, 2\textsuperscript{nd} mode: Good agreement
⇒ Stiffness of support base is not completely defined to the FEM.

- Taper flange/Flat flange
  - Effects of joining strength
⇒ Taper tube is efficient.

- According to change the number of joining bolts,
  → Resonant frequency is changed.
  ⇒ Stiffness is changed (Flat flange).
    is not so changed (Taper flange).

------------- Further tests -----------------

- Cantilever with mounting heavy load
- Both-ends supported type
- Tests with mounting isolators (Passive).
- Active feedback