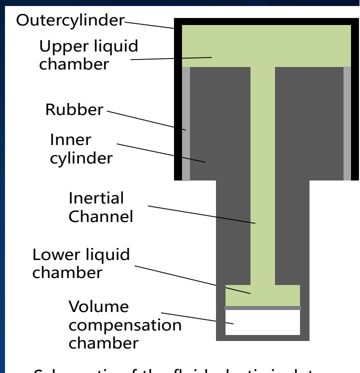
AMMCS 2022
应用数学，建模与计算机仿真国际学术会议
Applied Mathematics, Modeling and Computer Simulation

No. CS426

Investigation of the displacement transfer characteristic and Parameter optimization design of fluid-elastic isolator

INTRODUCTION

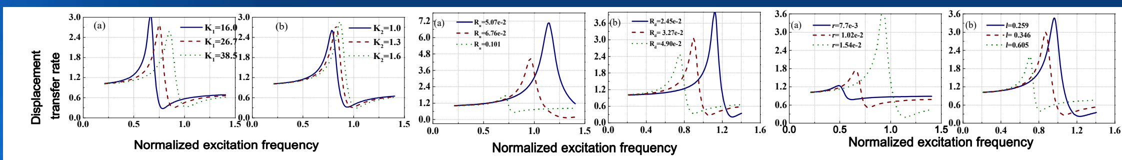
The main parameters of the fluid-elastic isolator are studied and optimized. The effects of the six parameters on the displacement transfer rate are analyzed. Parameter optimization design is conducted by employing the genetic algorithm (GA) for a civil helicopter. Aiming at the minimum displacement transfer rate, the criterion for parameter optimization design is proposed. Design parameters with a high vibration isolation rate and low weight are obtained. Results reveal that the fluid elastic isolator possesses a higher vibration isolation rate and lower weight cost than the experimental result in the literature. And it will be helpful for the parameter design of the fluid elastic isolator.



Schematic of the fluid-elastic isolator

PARAMETER ANALYSIS

The influence of K_1, K_2, R_u, R_d, r and l on the transfer characteristics of the vibration isolator is analyzed. the main parameters would change the anti-resonance point. The optimal displacement transfer rate is negatively related to R_u, R_d, and l. A single parameter would cause complex influence on the transfer rate, therefore the overall effects of different parameters should be taken into consideration when conducting parameter optimization.



The change of transfer rate T_d with different parameters

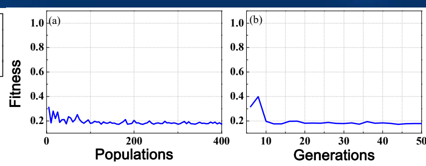
GA OPTIMIZATION

According to the value range of the material property and the structural size, parameter optimization design is carried out, and the displacement transfer rate T_d is set as the fitness index. The parameter optimization design criteria suitable for the fluid-elastic vibration isolator is then proposed.

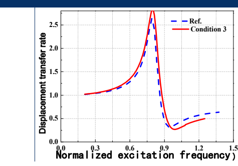
$$T_d = \min\left[\frac{K_1R_2^2 + K_2R_1^2 - m\omega^2R_2^2R_1(R_1-1) + i\left(c\omega R_1^2R_2^2 + \eta R_2^2\right)}{K_1R_2^2 + K_2R_1^2 - M_2\omega^2R_2^2 - m\omega^2R_2^2(R_1-1)^2 + i\left(c\omega R_1^2R_2^2 + \eta R_2^2\right)}\right]$$

$$F_n = W_tT_d + (1 - W_t)m_{fe}$$

Eq.(1): Displacement transfer rate; Eq.(2): Optimization design criteria



Transfer rate with different (a) populations; (b) generations



Comparison of GA result with the Ref.

CONCLUSIONS

Employing the genetic algorithm, the displacement transfer rate is far lower (cond. 1). Based on the material property (cond. 2), the optimized displacement transfer rate is still lower. Applying the design criteria Fn, the parameters in are optimized (cond. 3). Compared with the literature, the obtained fluid-elastic vibration isolator has a lower displacement transfer rate and also lower weight cost(m_{fe}).

Cond.	T_d	m_{fe}	F_n
1	17.1%	0.516	0.346
2	20.5%	0.700	0.454
3	27.1%	0.156	0.214
Ref.	30.0%	0.221	0.261