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Deformation pre-compensated optimization design of cam ring for low pulsation hydraulic motors

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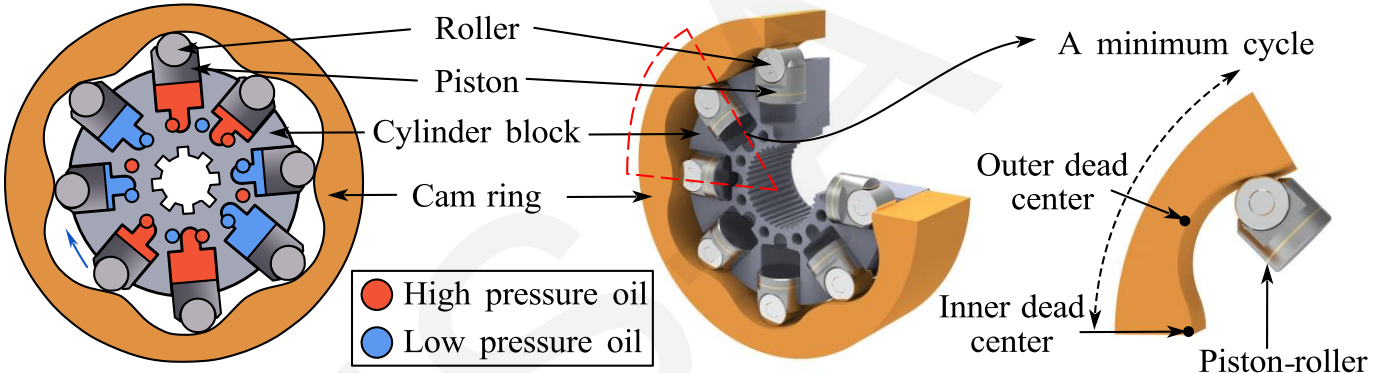
Background and Problem

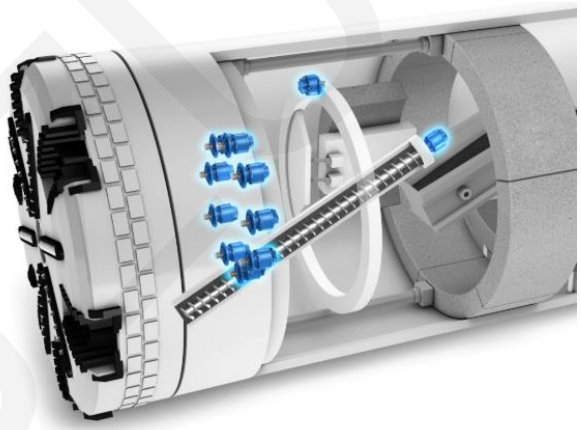


Working Principle

Applications

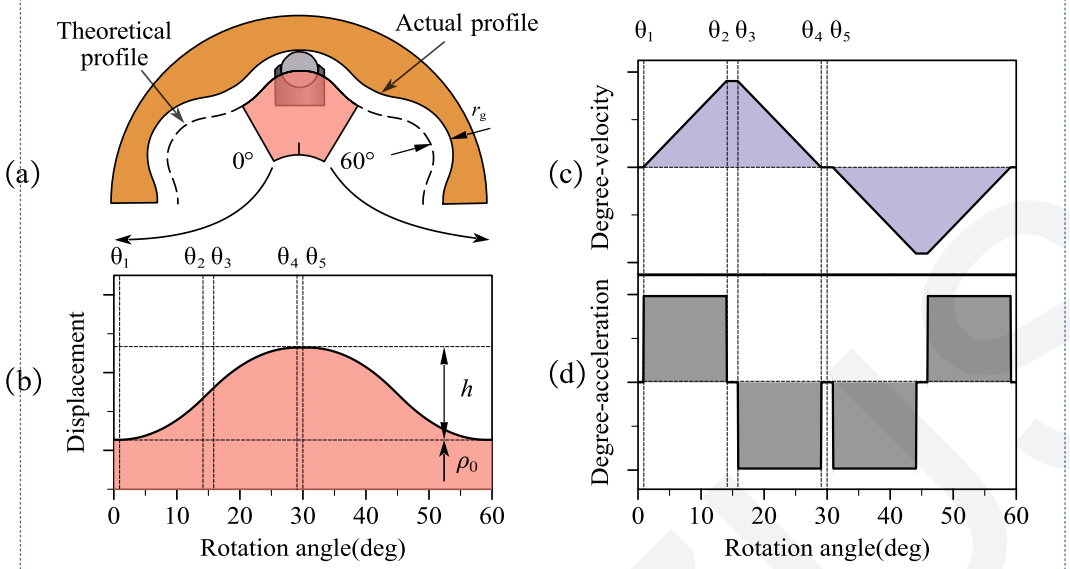
Excellent capability to withstand high loading at low - speed:

For example:



Low speed stability is poor, it is difficult to accurately control the load

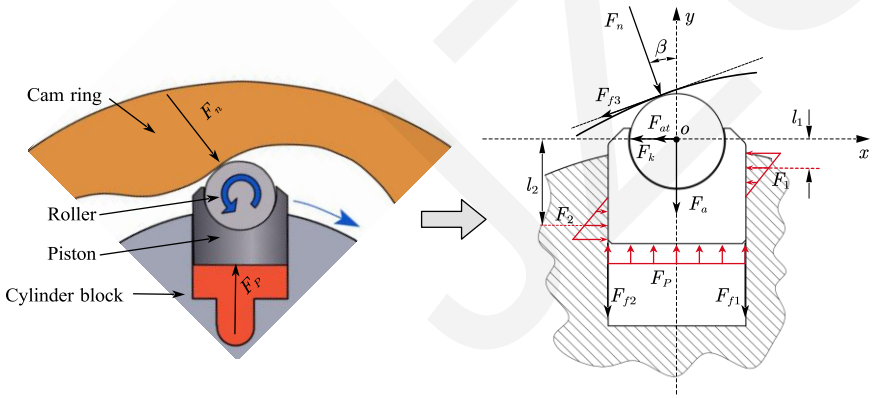
Kinematic and Force Analysis

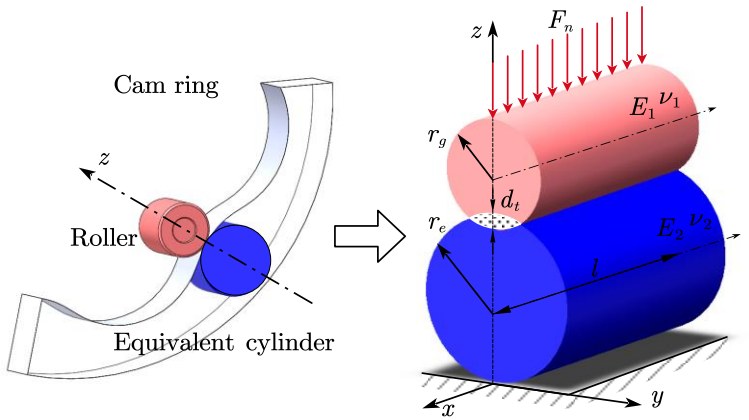


- Combining the actual roller working conditions and Hertzian contact theory, the deformation can be expressed as:

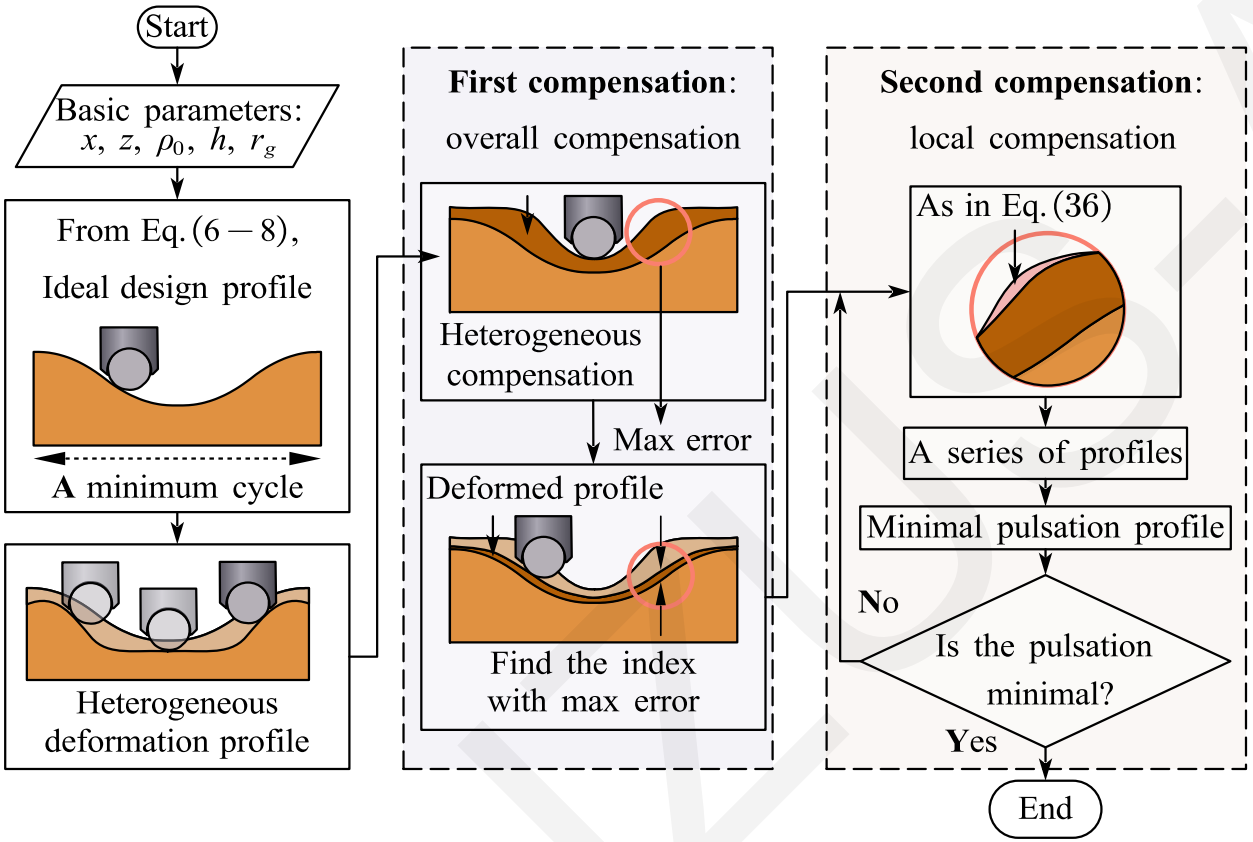
$$F_n(\theta)=\frac{F_P(l_2-l_1)}{\cos(\beta)(l_2-l_1)+\sin(\beta)(l_2 f+f^2 d+l_1 f)},$$

$$d_t=\frac{F_n}{\pi E_* l}\left(\frac{\ln(4\pi E_* R_* l)}{F_n}-1\right),$$





Pre-compensation Optimization



Flow chart of the two-step deformation pre-compensated optimization approach design

Step 1. The theoretical cam ring profile is initially designed with equal acceleration and deceleration profiles with transition zones;

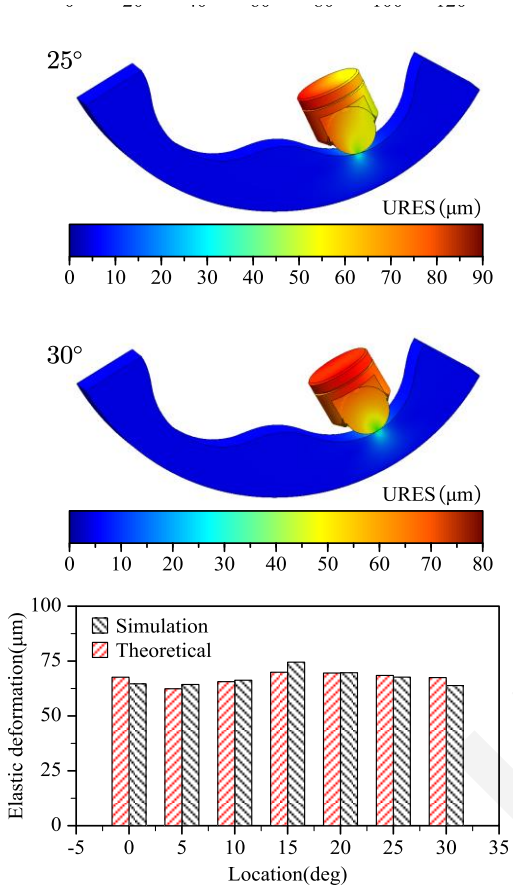
Step 2. The value of the heterogeneous elastic deformation of the cam ring is calculated;

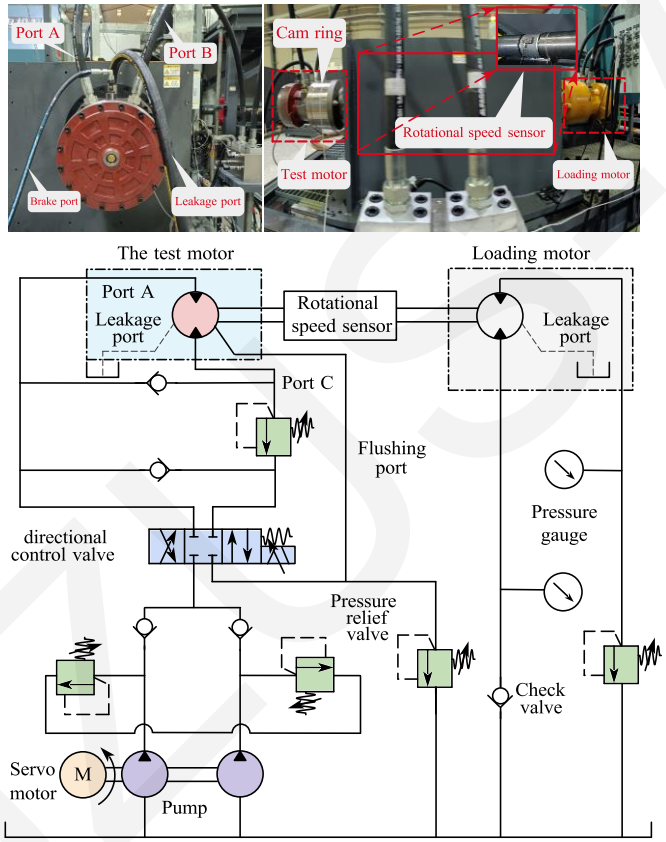
Step 3. The deformation is fitted to a smooth curve and compensated to the overall cam ring profile;

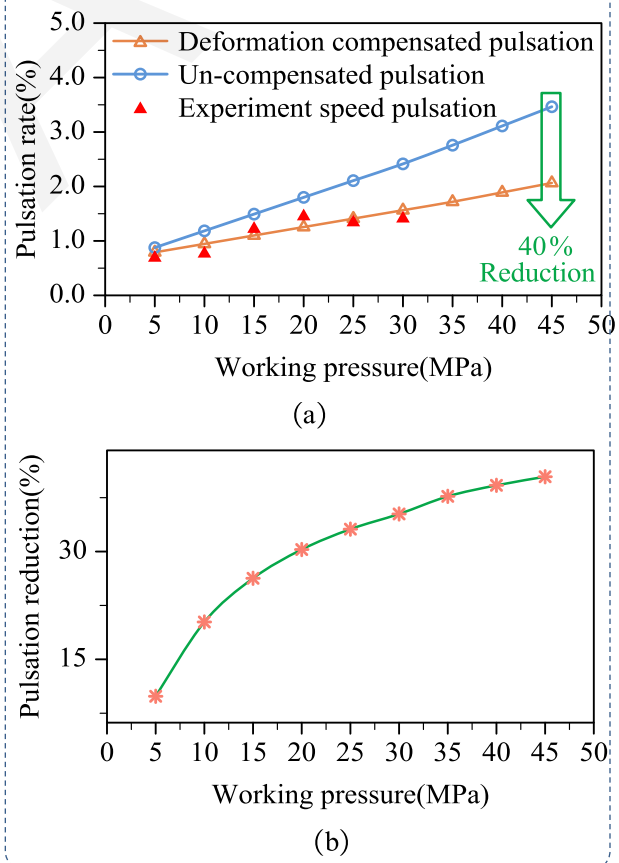
Step 4. The local cam ring profile with the largest error is compensated again, and the profile is fine-tuned within a small range. The loop iterates until the pulsation rate no longer reduces;

Step 5. The optimized cam ring profile is obtained to achieve lower pulsation of the hydraulic motor.

Case Study and Validation







Simulation verification

Test rig and hydraulic system

Experimental results

Conclusions

- **A two-step deformation pre-compensated optimization approach to cam ring design was developed, including an initial overall compensation process and a second local compensation process.**

- **A process for calculation of cam ring deformation was derived based on a detailed kinematic and force analysis of a hydraulic motor, and verified by finite element simulation method in a case study.**

- **The pulsation reduction rate increases as working pressure increases, and a high pulsation reduction rate of 40% can be achieved at a high working pressure of 45 MPa.**