The development of a vibration absorber for vibrating screens

by

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Summary

High levels of vibration are essential for the proper operation of vibrating screens. However, this motion imparts high dynamic loads on their support structures leading to premature failure or costly construction. Various methods exist for the attenuation of these forces, but they require undesirable addition of weight to the screen assembly, which can be as much as 130% of the screen mass. More appropriate methods are pendulum, hydraulic and liquid inertia vibration absorbers. These devices can provide similar isolation at only a fraction of the weight increase of current screen isolation methods. The liquid inertia vibration absorber's unique properties make it ideal for the attenuation of screen forces, as this study will show.

A mathematical model describing the motion for the vibration absorber was derived. This led to an equation describing the force transmissibility, which was used to show which parameters influence the absorber's performance. The model was extended to take into account the effect of conical port inlets/outlets, which were used to reduce the viscous damping. The effect of viscous damping was quantified using computational fluid dynamics. The mathematical model was used to show how an optimal set of parameters could be found.

Two design procedures were developed for the vibration absorber and were then used to design an experimental absorber. The experimental absorber was used to validate the mathematical model. Several practical considerations for the design were discussed and solutions suggested. The stiffness of the absorber was estimated using finite element modelling. Two elastomeric springs of different hardnesses were fitted to the absorber. The softer spring achieved a transmissibility of 16% by 42 Hz. The main stumbling block in reducing the transmissibility even further is the reduction of the damping.

The experience gained from the experimental absorber was used to suggest how an absorber could be applied to a screen. An absorber isolating at 12.5 Hz was designed for this purpose. A theoretical design study investigated two possible configurations of absorber fitment. When the absorber was fitted directly to the screen the force transmitted was reduced 7.2 times. Fitting the absorber to the sub-frame gave similar transmissibility results to that of a screen fitted with a sub-frame only, but the mass ratio was only 15%.

The outcome of this study is a thorough understanding of liquid inertia vibration absorbers as well as a procedure for their optimal design.

Keywords: Vibration absorber, vibrating screen, elastomer mechanical properties, sub-frame, transmissibility, isolation frequency, liquid inertia.

Die ontwikkeling van 'n vibrasie-absorbeerder vir vibrerende siwwe

deur

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Opsomming

Hoë vlakke van vibrasie is belangrik vir die werking van vibrerende siwwe. Hierdie vibrasie veroorsaak egter hoë dinamiese kragte wat na die fondasie van die sif oorgedra word. Die kragte kan vroegtydige faling of hoë aanvanklike konstruksiekoste tot gevolg hê. Verskeie metodes bestaan wat gebruik kan word om die kragte te verminder, maar dit vereis dat groot hoeveelhede massa by die struktuur gevoeg word. Die massa kan tot 130% van die sifmassa beloop. Meer toepaslike metodes is die gebruik van pendulum, hidrouliese en vloeistof traagheid vibrasie-absorbeerders. Hierdie toestelle kan soorgelyke isolasie verskaf teen 'n fraksie van die massaverhoging van huidige metodes. Hierdie studie toon dat die vloeistof traagheid vibrasie-absorbeerder unieke eienskappe het wat dit idiaal maak vir die attenuasie van sifkragte.

'n Wiskundige model wat die beweging van die sif beskryf is opgestel. Dit het gelei tot die afleiding van die krag transmissie vergelyking, wat gebruik is om aan te toon watter veranderlikes die gedrag van die absorbeerder sal beïnvloed. Die model is uitgebrei om ook die invloed van koniese poort inlate/uitlate in ag te neem. Hierdie inlate is gebruik om die viskeuse demping van die absorbeerder te verminder. Die effek van die viskeuse demping is bepaal deur van berekeningsvloeidinamika gebruik te maak. Die wiskundige model is gebruik om aan te toon hoe die optimale stel parameters bepaal kan word.

Twee ontwerpmetodes is ontwikkel wat gebruik is om 'n eksperimentele absorbeerder te ontwerp. Die absorbeerder is gebruik om die wiskundige model te verifieer. Verskeie praktiese probleme met die ontwerp is bespreek en oplossings is voorgestel. Die styfheid van die veer is bepaal deur gebruik te maak van 'n eindige-element model. Twee poliuretaan vere van verskillende hardhede is in die absorbeerder gegiet. Die sagter veer het 'n krag

transmissie van 16% by 42 Hz getoon. Die krag transmissie kan verder verminder word deur die demping te verlaag.

Die ondervinding wat opgedoen is met die eksperimentele absorbeerder is gebruik om voor te stel hoe 'n absorbeerder op 'n sif gebruik kan word. 'n Absorbeerder wat by 12.5 Hz isoleer is vir die doel ontwerp. 'n Teoretiese ontwerp studie van twee absorbeerder en sif konfigurasies is aan die hand gedoen. Wanneer die absorbeerder direk op die sif geïnstalleer word kan die krag wat na die fondasie oorgedra word met 7.2 keer verminder word. Wanneer die absorbeerder onder 'n subraam geïnstalleer word kan dieselfde resultate as vir 'n sif met net 'n subraam verwag word, maar dan teen net 'n 15% verhoging in massa.

Die resultaat van die studie is 'n deeglike analise van vloeistof traagheid vibrasie absorbeerders en 'n metode vir hul optimale ontwerp.

Sleutelwoorde: Vibrasie-absorbeerder, vibrerende sif, meganiese eienskappe van poliuretaan, subraam, krag transmissie, isolasie frekwensie, vloeistof traagheid.

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Table of contents