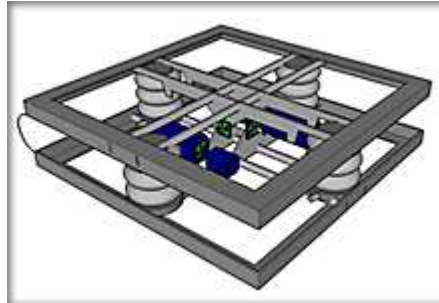


Quasi-Motion Tipper Platform Application Note

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11/7/2008



Keywords: Quasi-Motion, tipper platform, bellows, universal joint, hydraulics

Abstract: A tipper platform creates bank and pitch movement which is useful in simulators. This application note provides a procedure for creating a Quasi-Motion tipper platform and describes design considerations.

Introduction

The Quasi-Motion tipper platform allows users to experience bank and pitch motion for simulation applications. The platform uses servo controlled electric pumps to distribute hydraulic fluid between bellows, both on the x- and y-axis. The electric pumps are controlled by the simulation software. The universal joint in the center allows motion in both directions. Together, the bellows and universal joint can support a great amount of weight.

Objective

The purpose of this note is to describe how the tipper platform works, how to create a Quasi-Motion tipper platform, and design considerations.

Use of Hydraulics

The motion of the tipper platform is created using hydraulics. The servo controlled electric pumps receive an input from the simulation software. Based on the desired motion, the pumps are used to transfer hydraulic fluid between the bellows. The bellows on the x-axis are connected to each other through the hydraulic system so that when one side is filled to the maximum level, the other side is at the minimum level. The same is true for the y-axis. Because of the use of the incompressible, hydraulic fluid, this platform can support a great deal of weight while still creating motion.

Procedure for Creating Tipper Platform

The first step in building a tipper platform is to create a frame for the top and bottom. Steel tubing is often used in the frame because it is strong, inexpensive and easy to weld. Steel tube supports are attached inside the outer frame in order to distribute the load being placed on the bellows and universal joint. Flat plates are attached to these supports, which are then attached to the bellows and the bellows and universal joint are attached between the top and bottom frame. Once the base is constructed, the hydraulic oil is added to the bellows and hydraulic tubing is attached between the bellows and the electric pumps using a crimping machine.

Design Specifications

First, the user must specify how much weight will be placed upon the platform. The spacing of the bellows can be determined in order to support the maximum allowable torque. Based on the pressure and diameter specifications of the bellows being used, the supported torque can be found using the equation

$$\tau = [(P_{\text{bellow}} * \frac{\pi d_{\text{bellow}}^2}{4}) - F_{\text{opp}}] * r$$

where F_{opp} is the estimated opposing force and r is the distance from the bellow to the pivot point in the center. Next, based on the desired maximum angular velocity and angular displacement, and the distribution of weight upon the platform, the theoretical moment of inertia can be found using

$$\tau_{\text{theo}} = [\theta * (2\omega\pi)^2] * I_{\text{total}}$$

where I_{total} is the total moment of inertia of the components on the platform. The design must allow the theoretical torque to be less than the maximum allowable torque.

Conclusions and Recommendations

A hydraulic tipper platform is a very effective piece of equipment that can be used in simulation applications. Since the bellows use an incompressible fluid, they can support a large load while still effectively creating bank and pitch motions.

When creating a tipper platform there are several factors to consider. One thing to keep in mind is that while spacing the bellows farther can reduce the theoretical torque, it will also limit the motion of the motion of the platform. Because of this, it is important to define how much angular displacement is necessary to create a realistic experience.

Another thing to consider is that it is optimal to place the bellows upside-down so that the tubing is coming out of the top. This will make it easier to bleed the air out of the bellows which will reduce the cavitations in the hydraulic system and cause it to work more efficiently.

Depending on the user's safety requirements, it may be necessary to add plastic to the sides of the platform. This will prevent a pinch point in case something is in between the top and bottom frames of the platform.

References

<http://piengineering.com/custom/quasimotion.php>