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OPTIMIZATION TECHNIQUE AND FUZZY LOGIC CONCEPTS USED IN VIBRATION & SHOCK ISOLATION SYSTEM DESIGN.

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ABSTRACT

This is an industry oriented presentation on the physical and mathematical aspects of design and selection of optimized vibration isolator for minimizing the effect of high 'g' shock focusing the marine and aerospace related on board instruments and modules. The introduction starts with the shock event and steady state motion in the Quantum universe. Different type of vibrations and shocks associated with transportation and power plant machineries briefed. The sensitivity and perception of vibration for a human body and the effect of exposure to road vibration also touched upon. The mathematical design aspects are described using spring mass model. Fuzzy and generic logic concepts in design are highlighted The earlier design concepts for bridges and structures are compared to the present age technology. The design and selection aspects of vibration isolation systems for Optical and Laser interferometer set ups, Holographic recording, Optical interferometers and fabricating machineries are detailed. The Space optics, Surface finishing by Diamond Tooling Machines (DTM), Atomic Force Microscope (AFM), Micro Electro-Mechanical Systems (MEMS) and NEMS, microelectronic component - fabrications etc. are related to micro and nanometer level dimensional accuracy. With reference to application for high aperture imaging devices like camera, spectrometers and telescopes etc. and nano metrology set ups the disturbing force transmission from the supporting structure is to be restricted to a near ZERO gravity or microgravity (μg) order. Application of air spring based isolation systems for ground testing of equipments related to aerospace engineering will be focused.

The dynamic forces inducing vibrations and micro -shocks & vibration transmitted through the ground or supporting structure will be reviewed. The molecular forces built up inside the isolator under loaded condition and its effect on response will be briefed. The present state of art of designing isolated work platform using low natural frequency air spring systems with fn < 1Hz. leading to micro-gravity and micro-seismic isolation included. With Negative stiffness control (K technology) natural frequency ~ 0.5 is achievable. A comparison of isolation efficiency achievable with different isolators explained. The validation between the computerized mathematical design results and the actual isolation efficiency measurement after installations were found to be within an acceptable tolerance limit of +/- 10 % for plant machineries. Glimpses of installation applications presented in conclusion.

Keywords: Vibration, Shock, Isolation efficiency, Shock spectra, Spring-viscous dampers, micro-seismic shock, Air spring systems and negative stiffness (K concept)