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MULTI-OBJECTIVE CONTROL PROBLEMS FOR OPTIMAL ISOLATION OF ELASTIC STRUCTURES FROM VIBRATION

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Abstract: The problems of designing devices that provide effective protection of complex structures, instruments, equipment, and the man himself from the harmful effects of vibrations, and at the same time possessing limited sizes, continue to attract attention of scientists and engineers. In engineering practice, such devices are called vibration isolators. It is known that the vibration isolation problem is conveniently considered as a control problem in which the regulator acts as a vibration isolator. The main performance indices characterizing an efficiency of vibration isolators usually involve the value determining the maximal course of this device and the maximal deformations or stresses that arise in the elastic object to be protected. The reasonable choice of a suitable vibration isolating device is, as a rule, a search for a some trade-off between these two important indices: the less the maximal course of the vibration isolator, the more maximal deformations and vice versa. Taking into account this circumstance, it may be expedient to set a two-objective problem of synthesizing the control or, in other words, to choose an appropriate vibration isolator minimizing these performance objectives in Pareto sense. If several vibration isolation devices are involved into the process of protection, there is possibility to consider a multi-objective control problem instead of the two-objective one. In this paper, a general approach to multi-objective vibration protection is proposed. By using a scalar multi-objective cost function in the form of Germeyer convolution we derive necessary conditions for Pareto optimality and characterize Pareto optimal controllers in terms of linear matrix inequalities (LMIs) as optimal solutions for this function. As an example, the two-objective problem of seismic protection of twenty-story building is discussed in detail. The performance objectives are the maximum of the maximal intersectional deformations and the maximal displacement of the building relative to the foundation. The problem under consideration is complicated by the fact that the external seismic disturbances is unknown in advance, so the synthesis of vibration isolation device is carried out on the "worst-case", i.e. for the most dangerous excitation from a some class of disturbances.