The effect of additional masses on the dynamic buckling of a like-beam structure

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In industrial safety, dynamic buckling is one of the most important considerations to design structures subjected to sudden loadings. For instance, spacer grids in nuclear fuel assembly should have sufficient buckling strength in case of major accidents as earthquakes. Several studies using finite elements models with experimental validation for static buckling and post-buckling of spacer grids were conducted [1]. In literature, most studies focus only on inner characteristics of the spacer grid components without a fully dynamic analysis of the fuel rods movements [2]. Dynamic buckling of structural elements (columns, plates, shells...) under impulsive axial loading has been studied using different approaches. It has been widely investigated for imperfection-sensitive structures with neglected axial inertia forces [3]. For nearly perfect structures, other studies have shown that the axial inertia forces must be considered, particularly in the case of high impact velocities [4].

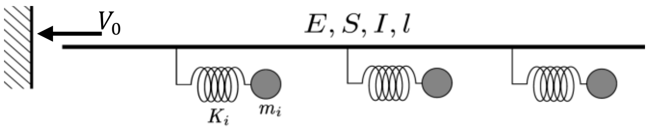

Fig. 1: Model of beam with additional masses

We propose a simplified beam model to reproduce the effect of fuel rods, as lumped masses, on the dynamic buckling of the spacer grid. In the present study, we conduct a stability analysis based on eigenvalues evolution for the system shown in figure 1. The occurrence of buckling and its characteristics (time to buckling, eigen values, modes) are affected by additional masses due to axial stress waves. This effect is illustrated using the impact response of the system with an initial velocity for different configurations. Each configuration is defined by a specific distribution of mass-spring systems and by their frequencies.

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