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中文概要

题目: 吸收边界在物质点法动力模拟中的实现

目的: 材料高速冲击结构物的过程中引起应力波往往在材料中向边界逐渐传播,并在传统固定或自由边界处反射回材料内部,造成结构物附件的应力场和接触力数值的扰动。本文旨在在物质点法模拟中实现吸收边界的应用,在模型边界处吸收材料中的应力波,减少其反射及其对中心区域的干扰。

创新点: 1. 对不同条件处的边界分别采用黏壶和阻尼层的吸收边界,能够优化边界处应力波的吸收效果; 2. 建立物质点法分析模型,对吸收边界的效果进行了量化评估。

方法: 1. 在边界网格节点上采用黏壶吸收边界,通过数学推导,确定不同时刻对节点处速度的调整量,以实现对应力波的充分吸收; 2. 在距离边界一定距离的厚度内,设置阻尼层,对材料瞬态速度进行一定程度的调整,使其达到所需的稳态值,即对应力波完成了吸收; 3. 采用物质点法建立一维压缩、海底滑坡冲击管线和管线贯入模型,对吸收边界的使用效果进行了评估,并对两种吸收边界的使用场景进行了分析。

结论: 1. 黏壶吸收边界通过对波动方程的推导,在自由边界处使用更灵活; 2. 阻尼层吸收边界需要在计算区域外侧设置一定厚度的阻尼层,且阻尼值不宜过大; 3. 一定条件下,两种吸收边界可以组合使用,能够优化对应力波的吸收。

关键词: 物质点法; 吸收边界; 海底滑坡; 冲击