立姿人體與垂向振動環境下之生物動態響應研究

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摘 要

人體經常以立姿暴露於垂向振動環境，垂向振動一般可分為簡 諧振動與瞬間衝擊振動，其中簡諧振動包含步行運動、跑步運動、 跳繩運動與站立於載具上等，瞬間衝擊振動包括跳傘、跳躍與體操 運動等。若振動與瞬間衝擊過於激烈時，將造成人體骨骼、肌肉、 關節及韌帶的損傷，若振動頻率和人體內臟器官的自然頻率相接近 時，則會引起人體共振而造成內臟器官的損傷。故本論文乃以立姿 人體於垂向振動環境下之生物動態響應為研究重點，運用質量－彈 簧－阻尼系統模型進行分析研究，並配合Mathematica 數值運算軟 體進行運算。首先進行Griffin 兩個自由度模型、Kim 三個自由度 模型、Nigg 四個自由度模型、Maryam 八個自由度模型與Qassem 十五個自由度模型等，不同自由度之立姿人體數學模型，並配合相 關實驗數據相互比較後，選定Maryam 八個自由度模型與Qassem 十五個自由度模型應用於簡諧運動與瞬間衝擊運動之分析，其中 Maryam 八個自由度模型用於步行、跑步、跳繩、跳躍、體操與跳 傘等運動分析；Qassem 十五個自由度模型應用於跳繩、跳躍、體 操與跳傘分析，將分析結果配合相關人體損傷判據探討損傷之情 形。簡諧運動研究結果顯示，步行、跑步與跳繩運動並未對人體造 成損傷，且以跳繩運動之人體動態響應最為強烈；而當跑步運動之 步頻加快時，人體部位之動態響應將隨之增加，因此將增加受傷之 機率。於瞬間衝擊運動研究結果顯示，跳傘運動研究中，因T-10 降落傘著地速度較高，因此，著地瞬間之衝擊力將對跳傘者造成傷 害；於體操運動研究中，著地瞬間之衝擊力，將造成頸椎、胸椎、 - vi - 腰椎及小腿等部位之損傷。立姿人體於垂向振動或衝擊運動，除了 造成下肢部位的傷害外，亦容易引起脊椎之損傷，因此於不同運動 時，除注意下肢部位的損傷防護之外，亦須加強對於脊椎損傷之防 護。

關鍵詞 : 立姿，動態響應，垂向振動，質量－彈簧－阻尼系統模型， 簡諧運動，瞬間衝擊運動

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