A Parametric Shock Analysis of Spade-Less, Lightweight, Wheeled, Military Vehicles Subjected To Cannon Firing Impact: A Feasibility Study of Spade Removal

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Tracked military vehicles are being replaced by their lightweight wheeled counterparts in many armies around the world. However, mounting high calibre artillery guns on lightweight, wheeled vehicles may bring about problems such as crew discomfort, vehicle slide, lift-off, turnover, and etc. To avoid these problems, spades are used to connect the vehicle to the ground which in turn reduces the vehicle mobility. Furthermore, the optimum spade design for different vehicles and soils is a difficult if not impossible task to accomplish. In this paper, a spade-less, four-wheeled vehicle with a mounted mortar is modelled, and the effects of the firing impact amplitude, duration, and elevation angle on vehicle response are investigated. It is found that all of the likely problems can be avoided if appropriate precautions are taken, except for firing inaccuracy at very high bomb charges. Therefore, for many cases, it is feasible to remove the spades.

NOMENCLATURE

F_r	Recoil force
m_r	Recoil mass
m_{tr}	Rear unsprung mass
m_{tf}	Front unsprung mass
m_c	Mortar-chassis mass
m_{ch}	Chassis mass
m_{mor}	Mortar mass
I_c	Mortar-chassis mass moment of inertia
I_{ch}	Chassis mass moment of inertia
I_{mor}	Mortar mass moment of inertia
k_r	Recoil stiffness
k_{cr}	Rear suspension stiffness
k_{cf}	Front suspension stiffness
k_{tr}	Rear tire stiffness
k_{tf}	Front tire stiffness
k_{hr}	Rear horizontal stiffness of chassis
k_{hf}	Front horizontal stiffness of chassis
c_r	Recoil damping coefficient
c_{cr}	Rear suspension damping coefficient
c_{cf}	Front suspension damping coefficient
c_{tr}	Rear tire damping coefficient
c_{tf}	Front tire damping coefficient
c_{hr}	Rear horizontal damping coefficient of chassis
c_{hf}	Front horizontal damping coefficient of chassis
L	Vehicle wheelbase
a	Distance from mortar-chassis centre of gravity to front of the car
b	Distance from mortar-chassis centre of gravity to rear of the car
c	Horizontal distance from mortar-chassis centre of gravity to mortar connection point to chassis
f	Distance from mortar centre of gravity to its connection point to chassis
e	Distance from chassis centre of gravity to rear of the car
d	Distance from chassis centre of gravity to front of the car
h	Horizontal distance from chassis centre of gravity to mortar connection point to chassis
α	Mortar elevation angle from horizon
h_c	Vertical distance from mortar-chassis centre of gravity to mortar connection point to chassis
h_r	Vertical distance from mortar-chassis centre of gravity to rear suspension
h_f	Vertical distance from mortar-chassis centre of gravity to front suspension