GAIT KINEMATICS ON AN ELEVATED INCLINED SURAFCE

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INTRODUCTION

Fatal and non-fatal falls from elevation have been documented to be a significant issue in today's workforce. According to the Bureau of Labor Statistics (BLS) in 2003 falls from elevations were reported to be the second-leading cause of fatalities in industry, second only to workplace transportation fatalities, specifically falls from elevation accounted for 13% of all workplace fatalities, with a reported 691 fatalities for the year [1].

In industrial settings, elevated surfaces are typically associated with altered support surfaces (i.e. inclined). While previous research has suggested changes in elevation [2], and exposure to inclined surfaces [3], are risk factors for falls; research is sparse on gait kinematics while exposed to elevation and inclined surfaces simultaneously. Therefore, the purpose of this study was to investigate gait kinematics during exposure to an elevated inclined surface.

METHODS

Twenty subjects, 10 male college students (inexperienced) and 10 male roofers (experienced) between the ages of 19 to 50 years old, participated in this study. The testing protocol was explained prior to providing informed consent consistent with the Auburn University Office of Human Subjects Institutional Review Board (IRB) standards. Exclusionary criteria included a history of neurological, orthopedic, cardiovascular and pulmonary abnormalities as well as any other difficulties hindering normal gait.

Subjects walked (ascending & descending) on an elevated inclined surface (10 to 16 feet from ground level), measuring 16x14 feet at a 6/12 (26°) pitch (Figure 1). A week later, subjects walked on the same inclined surface at ground level. While subjects walked, an 8-camera Peak Performance (Peak 5.0) Motion Analysis System acquired 3D motion data at 120 Hz from markers placed bilaterally on anatomical landmarks to configure the whole body model. Subjects were required to use fall protection that prevented rapid descents if a fall were to occur. Dependent measures included stride length (SL), stride width (SW), step period (SP), and walking velocity (V). A significance level of $\alpha = .05$ was applied.

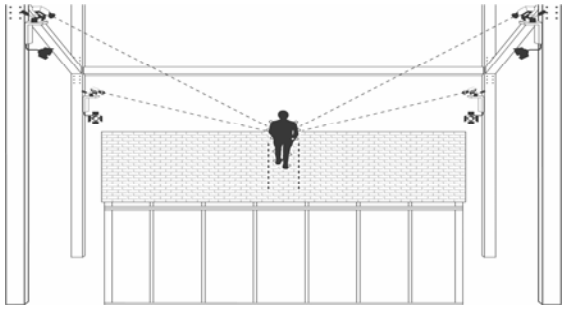

Figure 1. Artist rendering of the elevated inclined surface

RESULTS AND DISCUSSION

Statistical analysis revealed a significant within subject's and between group difference(s) in step length, step width, step period, and walking velocity between the two height conditions and walking directions. Mean values (±SD) for each group, height, and direction are presented in Table 1.

CONCLUSION

An analysis of the kinematics of gait while operating on an elevated inclined surface is important in understanding the effects of elevation on the potential for falls due to slips or loss of balance. While previous research has indicated that step length, width, period, and velocity are correlated to changes in postural stability; it is interesting to note the significant effect of experience at elevation between individuals. This difference may be an underlying factor in fall incidents. Inexperienced individuals demonstrated gait kinematics suggesting a perceived increase in the frictional demands, adjusting their behavior to reduce the risk of a slip or loss of balance. Experienced individuals demonstrated gait characteristics related to postural stability with insensitivity to height. These suggested underestimations of the frictional demands may be a contributing factor related to a loss of balance, resulting in a fall.

REFERENCES

1. Bureau of Labor Statistics: Census of Occupational Injury, 2004.
2. Paulus, W.M., et al. *Brain* **107**, 1143-63, 1984.
3. Redfern, M.S., et al. *Gait & Posture* **6**, 119-25, 1997.

Table 1. Stride length, stride width, step period, and walking velocity, normalized by height, for each direction, height, and group.

	Descending				Ascending			
	Elevation		Ground		Elevation		Ground	
	InEx	Ex	InEx	Ex	InEx	Ex	InEx	Ex
SL(m/ht)	.37±.02	0.46±.01	.41±.02	.49±.01	.44±.01	.53±.01	.47±.02	.55±.01
SW(cm)	11.5±.31	9.6±.25	11.2±.32	8.1±.44	12.4±.27	10.5±.18	12.3±.32	9.1±.44
SP(s)	.39±.01	.57±.02	.47±.01	.63±.02	.47±.01	.64±.01	.53±.01	.69±.01
V(SL/SP)	.71±.02	.83±.02	.8±.02	1.0±.07	.67±.02	.79±.02	.75±.02	1.0±.07