Estimation of Back Compressive Force

A representation of the model by Donald S. Bloswick at the University of Utah.

Job	Analyst
Task	Date

Measure			Symbol	Value
Body Weight [lb]			BW	[lb]
Load [lb]			L	[lb]
Horizontal Distance [in] (Hands to Lower Back {L5-S1 Joint})			HB	[in]
Back Posture (Angle from Vertical)	Θ [°]	sin Θ	Θ	[°]
Vertical	0	0.0		
Bent 1/4 of the way	23	0.4	sin Θ	[--]
Bent 1/2 of the way	45	0.7		
Bent 3/4 of the way	67	0.9		
Horizontal	90	1.0		

Contributor	Computation	Value
Back Posture A = 3(BW) sin Θ	3 * ( ) * ( )	
Load Moment B = 0.5(L * HB)	0.5 * ( ) * ( )	
Direct Compression C = 0.8[(BW)/2 + L]	0.8 * {( ) / 2 + ( )}	
Estimated Compressive Force F_c = A + B + C	Sum computed values in last column. Comparison Value: 700 lb	

If the estimated compressive forces exceeds 700 lb, consider a more detailed analysis or make changes. Note: This is just an estimate and its accuracy varies with posture, especially as the hands move forward of the shoulders.

Bloswick, D. S. and Villnave, T. “Ergonomics (Chap 54)”. In Harris, R. E. (ed), *Patty's Industrial Hygiene and Toxicology*, 5th ed. Vol. 4, New York: John Wiley and Sons, 2000.

v1.1 2/17/02 © 2002 Thomas E. Bernard

**Estimation of Stresses Associated with Manual Material Handling Tasks:
Back Compressive Force**

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The following material was taken from material supplied by Dr. Bloswick and the Patty's reference, and edited by Thomas E. Bernard (but he accepts no responsibility). Bloswick, D. S. and Villnave, T. "Ergonomics (Chap 54)". In Harris, R. E. (ed), *Patty's Industrial Hygiene and Toxicology*, 5th ed. Vol. 4, New York: John Wiley and Sons, 2000.

This package provides guidance for a relatively simple method to estimate the back compressive force associated with manual material handling tasks. The analytical tool presented is not intended to be used as the sole measure of these stresses but as indicators of potential stress areas which may deserve more detailed analysis. It is suggested that if precise estimates of biomechanical or metabolic stress are needed that more sophisticated computerized models be used.

Five major factors associated with the risk of musculoskeletal injury of the lower back are load, posture, frequency, duration and static positions. One technique to assess risk in manual material handling tasks is the compressive loading on the lower back, which includes the factors of load and posture.

Compressive force is developed directly by the load and body weight as the force component that is directed through the lower back and through the muscle force required to balance moments. This package provides a method to estimate back compressive force based on some simplifying assumptions through the use of load weight, body weight, torso angle, and the distance that the load is held out from the body. A worksheet was provided on the first page and a figure illustrating the measures is provided on page 3.

The estimated back compressive force is then compared to a generally accepted limit. For instance, the National Institute for Occupational Safety and Health (NIOSH) uses a back compressive force limit of 770 lb among other factors in its lifting analysis. A 700 lb limit is suggested here because of the approximation method.

In this method, the estimated compressive force is the sum of three terms. The largest of the terms A, B, or C contributes most to the lifting hazard so task redesign priorities may be established by comparing the relative values of these three terms. Term A is the back muscle force reacting to upper body weight (to lower this, lower the upper body angle from the vertical). Term B is the back muscle force reacting to load moment (to lower this, change the magnitude of the load or the distance that the load is held out from the body). Term C is the direct compressive component of upper body weight and load (to lower this, change the magnitude of the load). In practice, Terms A and B are most

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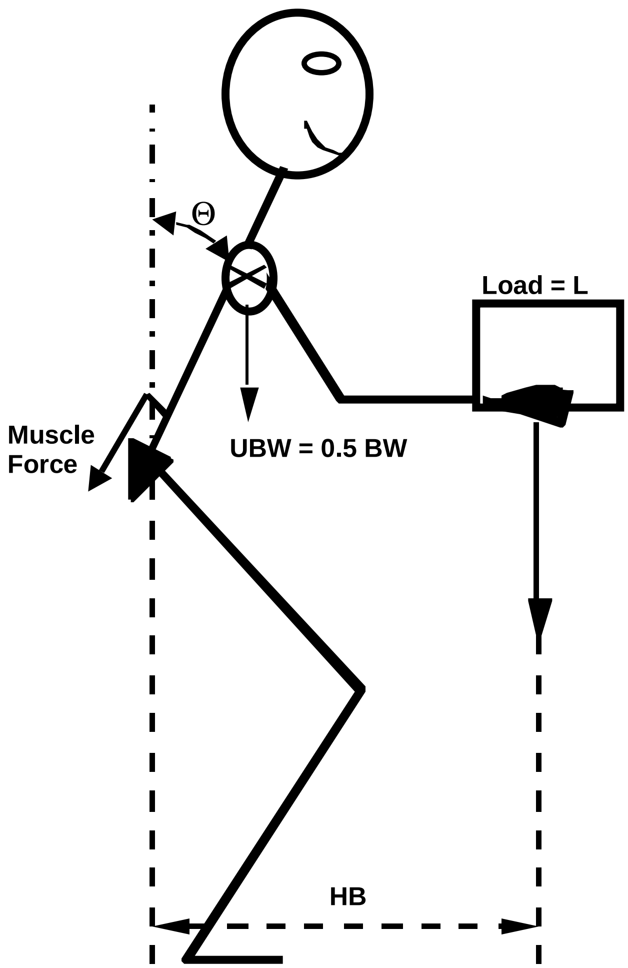
dependent on task. Term C is not likely to be the largest term, and when it is the largest the back compressive force will be low.

It must be emphasized that this is just an estimate and its accuracy varies depending on posture, especially as the hands move out in front of the body. If more precise compressive force data are required, a more sophisticated model should be used.

Reference for Biomechanical Analyses

Chaffin, D. B., Andersson, G., B., J. and Martin, B. J., *Occupational Biomechanics*, 3rd Ed., John Wiley and Sons, New York (1999)



$$F_c = 3(BW) \sin \Theta + 0.5(L * HB) + 0.8((BW)/2 + L))$$

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