Tech-58: Panel Impact Testing

SSL-Engineering-Testing to AS-1926.1-1993 (Swimming Pool Safety – Fencing for Swimming Pools).

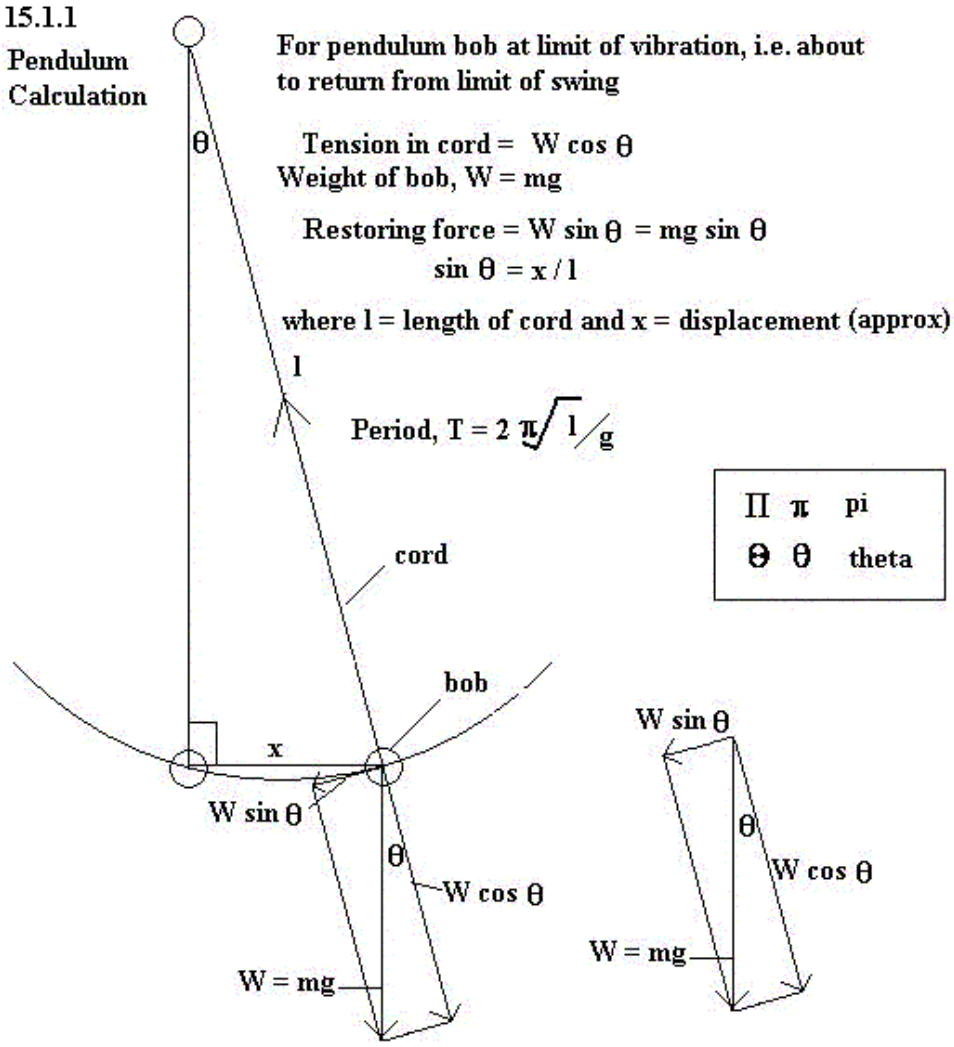
Testing to Appendix-D. Strength Test for Flexible Materials and Components.

Scope:- Impact testing for adequate strength for lattice panels to an impact test standard.

Principle:- Applied dynamic force to lattice panels to inspect for penetration, tearing, breakage and signs of fracture and loosening. Applied at centre point of panel.

9.1kgs on pendulum of various lengths

Energy calculation of impact



Date 21 Jan 06	Test Person: A Turnour (CPE)			Location: Ingham	
Test	Test Criteria 9.1kg weight Ø50mm diam	Pendulum Elevation above impact point	Panel Type	Fastenings Steeltites 10 gauge class-3 alloy	Failure features: Penetration, Breakage, Tearing, Fracture, Other.
Test-1	R = 1450mm @ 37°	292mm	Steel HV-75	Top + Bottom + Sides @ 2 per side = 8 fasteners	2mm dent
Test-2	R = 1850 @ 33°	298	Steel HV-75	Top + Bot + Sides @ 2 per side = 8 fasteners	4mm dent only
Test-3	R = 1850 @33°	298	Steel HV-75	Sides only @ 2 per side = 4 fasteners	4mm dent only
Test-4	R = 1850 @ 60°	920	Steel HV-75	Sides only @ 2 per side = 4 fasteners	8mm dent in 50mm radius area of impact.
Test-5	R = 1850 @ 60°	920	Hardwood 2" gaps Diamond	Sides only @ 2 per side = 4 fasteners	Stipples knocked half out at four slat overlays.
Test-6.	R = 1850 @ 60°	920	Soft CCA Pine 2" gaps Diamond	Sides only @ 2 per side = 4 fasteners	Rear diagonal slat knocked off 10 consecutive staples

In Test-4, If the Potential Energy = mgh = 9.1kg x 9.81 m/s/s x 0.92 m = 82.12 joules (kgm^2/s^2). Per the movie, The string is cut and the pendulum falls (swings) to its lowest point where its PE converts all its energy to Kinetic Energy (motion) becomes maximum. KE = $\frac{1}{2}mv^2$. Thus v^2 = 82.12 kg m^2/s^2 x 2 / 9.1 kg . and v = 4.25 m/s. (= 15.3 kilometers per hour.)

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The value for **g** (the gravitational acceleration of 9.8 m /s/s) can be directly substituted for **a** in the following equations ,

$v = u + at$	$M = m v$
$s = u t + \frac{1}{2} a t^2$	$F = m a$
$v^2 = u^2 + 2 a s$	$E = \frac{1}{2} m v^2$
	$P_d = m a (h_2 - h_1)$

Suppose a zealot with evil intensions stumbled from the gondola of a stationary balloon positioned at an altitude of 5,000 metres (s = 5,000 and h_2 = 5,000) , falling onto a

concrete road at sea level ($h_1 = 0$) . From Newtonian equations above , determine the time taken (t) and impact speed (v) of the falling zealot with mass (m = 75 kg) . The zealot's initial velocity (zero) does not affect on the calculation .

$s = u\,t + ½\,a\,t^2$ $5000 = 0 + ½ \times 9.8 \times t^2$ $5000 / 4.9 = t^2$ $t^2 = 1020.4081$, then **t = 31.944 seconds ***	$v = u + at$ $v = 0 + 9.8 \times 31.944$ v = 313.05 m/s **or 1126.98 Km/h *** and in agreement with --- >	$v^2 = u^2 + 2\,a\,s$ $v^2 = 0 + 2 \times 9.8 \times 5000$ As $v^2 = 98{,}000$, v = 313.05 m/s **or 1,126.98 Km/h ***

Travelling near the speed of sound at impact , determine the zealot's theoretical force (F) , momentum (M) , and energy (E) released at that moment with the concrete road and compare these predictions with the gravitational potential difference , at ***h*** $_2$.

$F = m\,a$ $F = 75 \times 9.8$ **= 735 kg m/s/s**	$M = m\,v$ $M = 75 \times 313.05$ **= 23,478.75 kg m/s ***	$E = ½\,m\,v^2$ $E = ½ \times 75 \times (313.05)^2$ $= ½ \times 7{,}350{,}022.687$ **= 3,675,011.343 kg (m/s) ^{2} ***	$P_d = m\,g\,h$ $P_d = 75 \times 9.8 \times 5{,}000$ **= 3,675,000 kg (m/s) ^{2}**

(***** denotes that these figures cannot be realised on the Earth due to the atmosphere .)
(**Note : The term potential difference P_d , supersedes and replaces the previously maintained description of potential energy**) .
The difference of 11.343 kg (m/s) ^{2} , 0.0003086% of 3,675,000 kg (m/s) ^{2} should be ignored .

These answers suggest that in Newton's instantaneous Universe , the mechanism of impact immediately liberates the total available potential difference as energy . Such a naive belief cannot be taken seriously , because the potential difference depends on separation . As the zealot speeds to the ground , the potential difference progressively decreases until the point of impact where the zealot has the same gravitational potential spread-eagle on the ground ($P_d = 0$) .

Throughout the fall , the potential difference (**$P_d = mgh$**) has no direct influence on the motion of the body , nor the energy released at impact . It does not get involved in any process and may not be fully realised . A potential difference remains as a hypothetical construct without form . For the entire fall , because the gravitational acceleration (g) remains relatively constant along the path , (at 5,000 m , g = 9.793 m/s/s , while at 0 m , g = 9.806 m/s/s), then **F = m a** presents a relative and constant force (as **F = m g**) that remains out of the impact equation .

The **terminal momentum** becomes the critical force-form (as **$F_M = m\,v$**) converted at the final and fatal moment of concrete poisoning (at impact) into various force-and-energy-forms . Therefore , momentum describes a force-form . Through the affect of constant acceleration , the gravitational potential difference of 3,675,000 kg (m/s) ^{2} , calculated between two vertical sites separated by 5,000 metres , should become a momentum of 23,478.75 kg m/s and if fully realised would liberate 3,675,011.343 kg (m/s) ^{2} of energy for a period of time after impact .

In the non-instantaneous universe , the mechanism of impact slowly liberates the abrupt change in momentum . The magnitude of the impact reaction depends on the shape , structure , density , chemical bond strength , contact area , and reactivity . As the first molecules of the zealot's

soft body tissues come into contact with the ground , they suddenly stop moving , however , the molecules above them continue to move to the ground at the impact speed until stopped by the resilience of the chemical structure . A better illustration of this effect would be to re-distribute the zealot's mass into a large hollow ball that compresses and bounces after the impact .

However , as molecules behind these first few layers continue to move towards the contacting surface layers , layer upon layer , a dramatic compression effect produces an effective overburden pressure , reaching energy levels capable of breaking chemical bonds (perhaps nuclear bonds) . When falling head or feet-first , the smaller surface contact point greatly increases the compression effect for a greater period of time immediately after the moment of impact . The human body pancakes and breaking open like an egg , splatters for a longer period of time . A belly first landing would certainly kill , as the heavy skeleton continues to plough through the soft tissues of the body , breaking the backbone , rib cage and pelvis .

It stands to reason that the chances of survival would be improved by **spreading the impact over the greatest surface area ; falling backward to land absolutely flat on the back , on a smooth area of soft ground , effectively stopping the heavier components of the skeleton before stopping the soft tissues and rib cage** .

Owing to increasing air pressure with decreasing altitude , an increasing air resistance soon begins to cancel out gravity's acceleration effect , limiting the drop speed to an almost constant terminal velocity , of around 200 Km/h (55.5 m/s) . Therefore , the theoretical impact velocity predictions of the zealot's body striking the ground do not agree with the actual impact velocity . At this greatly reduced speed , a slim chance exists that with updraught effects , protectors , cushion effects , cupped hands , and the back landing technique , the zealot could actually survive the fall , as have a few very lucky people , falling from buildings , cliffs, bridges , and aircraft . As a fall from any height can kill , falling techniques must be practiced in the appropriate environments with the appropriate supervision and instruction . The differences between the theoretical impact momentum and the terminal velocity impact momentum can be illustrated by comparing the previous table with the table below .

As 1 Newton = 1 kg (m/s)^2

$F = m\ a$ $F = 75 \times 9.8$ **= 735 Newtons**	$F_M = m\ v$ $= 75 \times 55.556$ **= 4,166.7 kg m/s**	$E = ½\ m\ v^2$ $= ½ \times 75 \times (55.556)^2$ $= ½ \times 231,485.1852$ **= 115,742.6 Newtons**	$P_d = m\ g\ h$ $= 75 \times 9.8 \times 5,000$ **= 3,675,000 Newtons**

Depending on drag factors , from the moment of initial acceleration , the atmosphere presents a progressively increasing resistance . After the fourth second , the increasing air resistance and buoyancy begin reducing the rate of acceleration . About 300 metres beneath the drop-off point , some eleven seconds into the fall , the air resistance and buoyancy present an opposing force that decreases the acceleration to an almost constant velocity , after which the terminal momentum begins to reduce . At an altitude of 4,700 metres , the terminal velocity can be substantially greater than the terminal velocity at 500 metres . Consequently , irrespective of the drop height above 350 metres , the same impact or terminal velocity produces the same impact effects .

Based on the sea level **terminal velocity <u>alone</u>** , for a period of time following the moment of impact , only 3.149 % of the full potential difference of the 5,000 metre fall should be realised . This means that during the fall , the atmosphere and zealot should have absorbed , converted , liberated , or rejected about 3,560,000 Newtons , presenting an average resistance close to 710 Newtons per metre . In terms of the 96 seconds drop time , the system removed some 37,000 Newtons per second (about 670 N/m) . These averages should not be taken factually because

they present a hypothetical indication of energy transfer without considering the real situation where the greatest changes to the terminal velocity take place in the lower regions of the atmosphere .

The total energy released by an impact momentum depends on many factors , such as the surface area of impact and the shape of the object . The more concentrated the matter and impact area , the greater the impact effects . A 75 Kg Lead ball dropped from 5,000 metres creates a greater impact event with its terminal momentum being spread over a small area . Rather than splattering on the surface , the lead ball with its much higher terminal velocity penetrates and displaces the surface , resulting in the production of a crater and a greater number of chemical reactions . However , the same mass of lead , when fashioned into a large spherical shell 2 metres across and dropped from the same height experiences greater wind resistance . Having a much lower terminal velocity , as the impact energy spreads over a greater area , it crumples on striking the surface .

Unfortunately , most reference texts and educators confuse the student through the incorrect use of jargon , the terms , standards and examples describing force , work , resistance , drag , pressure , and energy . Often educators use pure physics to describe terrestrial events , negating the other forces in Nature that affect the trajectory . Some use the example of a mortar shell fired into the air , claiming that the shell strikes the ground with the same terminal velocity as the initial velocity , and to insult the intellect, that the shell takes the same length of time to reach its maximum height as it does to fall from that height . Rubbish ! Owing to air resistance , the mortar shell takes longer to fall than it does to rise , striking the ground at its terminal velocity . Many educators deceive by the assumption that because $\mathbf{E = \frac{1}{2} m v^2}$ relates to energy , there must be a direct equivalence between ;

the Newton , 1 kg (m/s) ^{2} , and **the Joule**, $\frac{1 \text{ kg } (\text{ m/s })^2}{\text{ m }}$, one Newton per metre .

The two terms have completely different meanings and definitions , being distinct from other confusing terms such as , pressure (kg / m ^{2}) and the kilogram force , by definition , exactly 9.80665 N (at sea level and at latitude 45° , a 1 kg mass exerts a force of 9.80665 N towards the centre of the Earth) . The Joule being a measure of work and a measure of energy deliberately confuses the issues , because work and energy cannot be directly interchanged . An event said to *consume* a number of Newtons over a distance , with respect to change in position , by definition *consumes* that energy at a rate measured in Newtons per second , or at a rate of Newtons per metre per second . Each measurement being qualified by a specific definition . However , the word *consumes* presents a totally misleading and invalid view . It means , to destroy , eat away , or use up , a wasting of the applied energy-form . Such an inappropriate word should never be used in scientific discussions unless applied correctly . The word **convert** being far more appropriate and accurate description must replace that ill-conceived poorly chosen word .

As general acceptance of *potential* and *kinetic energy* removed the need to give suitable definition and mechanism to matter , force , energy and all energy-forms , development and use of the Kinetic theory prevented the rationalisation and understanding of a system's relativity to the next . Scientific demarcation barriers and the adoption of the three thermodynamic generalisations led to the development of an incorrect theoretical model of matter , that without means or mechanism , convoluted The Sciences . The numerous application dependent definitions of *potential energy* destroyed scientific credibility . Due to the acceptance of incomplete pictures of matter , force , and energy propagation in the terrestrial environment , the cumulative reaction effects (described as positive and negative entropy) extended the assumption of terrestrial truth to the atomic level .