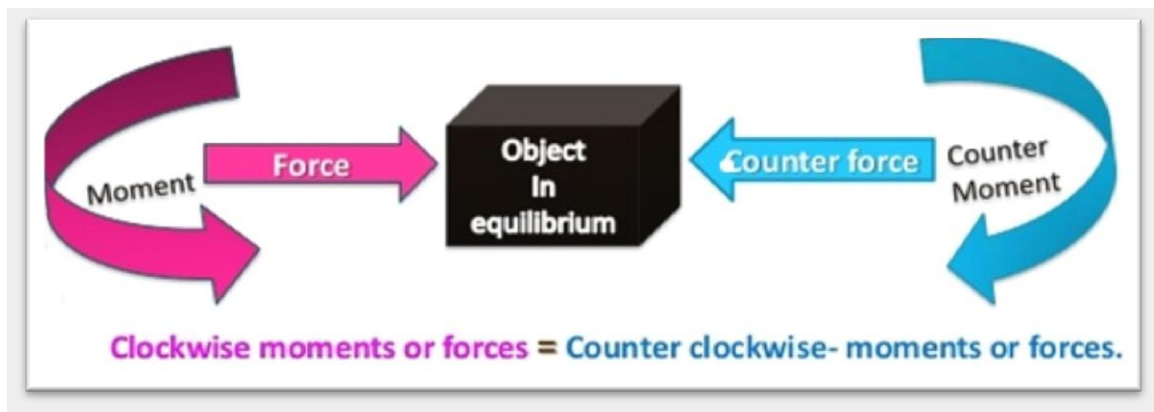


Stability

Equilibrium

Equilibrium is a state of balance in which all forces are equal.

Any rigid object will be in equilibrium when external forces acting on it don't tend to move it or rotate it around an axis, i.e.



There are two conditions of equilibrium those were as

- A. **FIRST CONDITION OF EQUILIBRIUM:** It is called static or transition equilibrium where the sum of forces equal zero.
- Clockwise forces + counter clockwise forces = zero.
- B. **SECOND CONDITION OF EQUILIBRIUM:** It is called dynamic or rotational equilibrium where the sum of moments equal zero.
- Clockwise moments + counterclockwise moments = zero.

Stability

Stability is the ability to maintain one's Balance in both static and dynamic situations without mechanical devices.

Distinguish between Equilibrium, Stability and Balance

Equilibrium

Equilibrium is a state of balance in which all forces are equal.



Stability

Stability is resistance to disruption of equilibrium.



Balance

Balance is the ability to control equilibrium during changing body's positions.

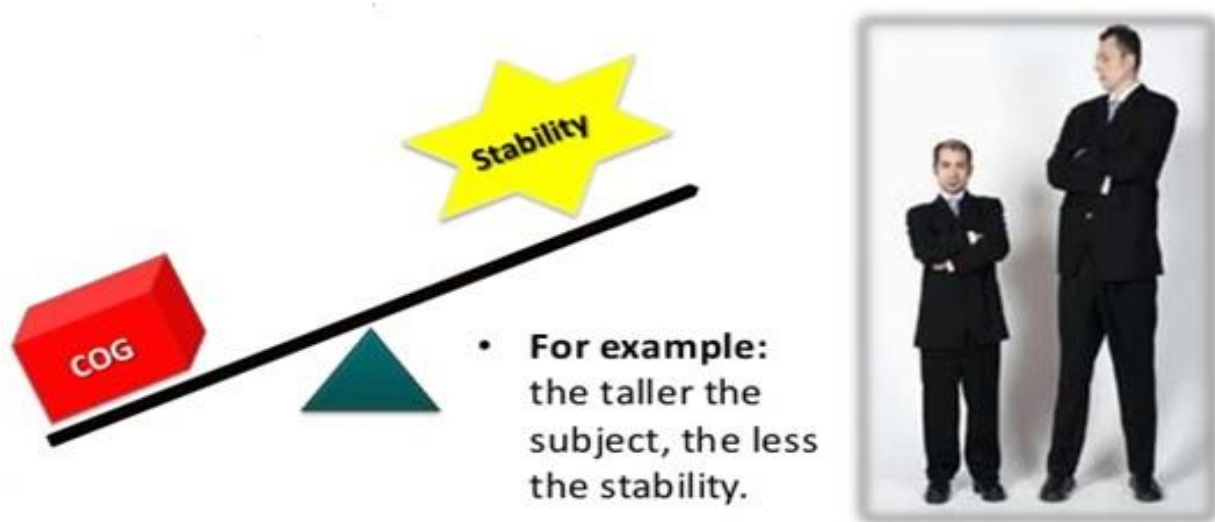


Factors influencing Stability:

- 1) COG height.
- 2) Base of support (BOS).
- 3) Relation of line of gravity to BOS.
- 4) Properties of the supporting surface.
- 5) Segmentation principle.
- 6) Subject vision and emotional state.

➤ COG HEIGHT:

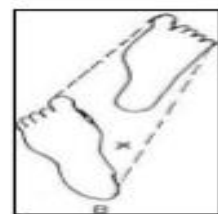
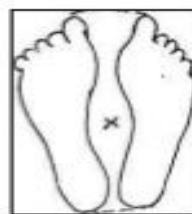
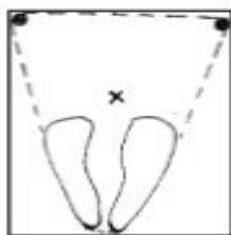
While other things being equal, the lower the Center of Gravity (COG), the greater will be the body's Stability.



➤ BASE OF SUPPORT (BOS):

- 1) BOS is the area formed under the body by connecting with one continuous line all points in contact with the ground.
- 2) BOS is the area between two feet during standing or the area of contact with the floor including two feet.

Example: If a patient walks with sticks or crutches the BOS is the area between the crutches and the feet. Fig (C)



BOS Considerations

1. An increase in the BOS will be associated with an increase in the stability.



2. An increase in the BOS should be in the direction of applied force. So, greater stability will be obtained if the BOS is widened in the direction of applied force.

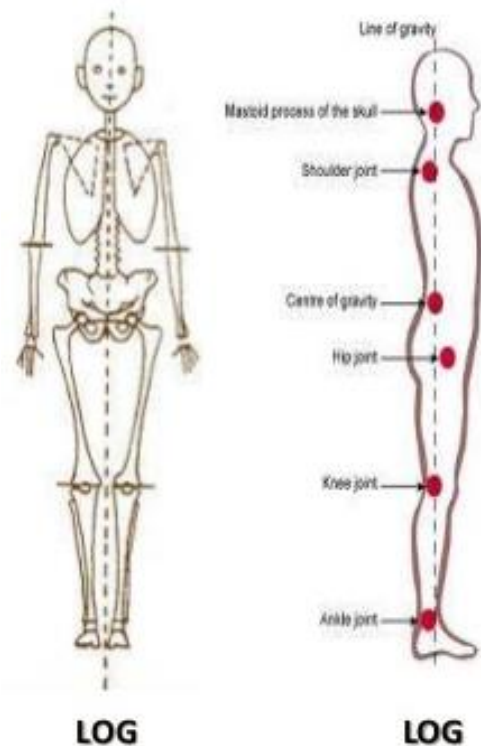


Example, a subject standing inside a bus is preferred to face the road or the front of the bus because when a force is applied by stoppage of the bus suddenly, it will be compensated by increasing the BOS forward (by taking step forward).

➤ RELATION OF LINE OF GRAVITY TO BOS

• Line of Gravity (LOG):

Line of gravity is a vertical line which falls through the COG and within the BOS. When the human body is in the standing position the line of gravity passes from the vertex through the 2nd sacral vertebra to just in front of the ankle joint and between the feet.



- **Line of gravity**



For balance to be maintained, it is essential that the line from LOG should fall within the BOS.

The farther the line of gravity from the center of BOS, the lesser the stability.



The nearer the line of gravity to the center of BOS, the greater the stability.



Examples: In stride standing, LOG lies within BOS. If a subject stands on toes, the LOG will become near to edge of BOS so the stability will decrease so, any push to the subject will disturb standing easier than if LOG is in the middle of BOS.



Close standing



Stride standing



Standing on Toes

➤ **PROPERTIES OF SUPPORTING SURFACE:**

a) Friction:

- Other things being equal, the greater the friction between the supporting surface and the parts of the body which are in contact with it, the more stable the body will be.
- But, this friction should increase up to certain limit then the friction will act as a disturbing factor limiting the movement.

Examples:

- Patients use crutches with rubber ends in order to increase stability via friction.
- Skating decreases stability unless the subject has coordination.
- Basketball player wears rubber-soled shoes to increase friction between his body and the floor so increasing stability.

b) Softness of the supporting surface:

In lifting up exercises, more energy will be wasted in case of using soft mattress. So, hard mattress should be used to increase stability and to conserve energy of the patient.

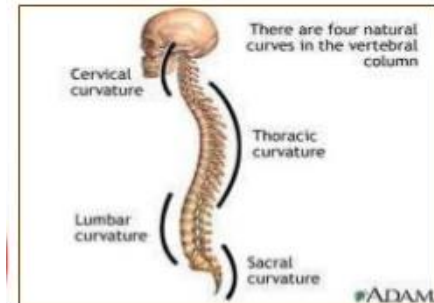
c) Inclination of the supporting surface:

The inclination of the surface is the angle which the supporting surface makes in relation to the body movement. The greater the inclination, the lesser the stability.

➤ SEGMENTATION PRINCIPLE

Segmentation principle stated that If there is deviation of a part of the body to certain direction, there is another compensator deviation of another part of the body to the opposite direction to maintain balance during this position".

For example: Any disturbance in the curvature of the spinal column will be compensated by movement of other segment that leads to change in the alignment of the vertebral column, i.e. cervical lordosis is compensated by dorsal kyphosis and lumbar lordosis is compensated by sacral kyphosis.



Another example: is obvious while holding an object in one direction, another deviation to the opposite side is necessary to gain stability.



➤ THE PERSON HIMSELF

- Mass
- Vision
- Physical and Emotional State
- Pain
- Age

a) **Mass:** Other things being equal, the greater the mass of the body, the greater will be its stability. For example; carrying weight in both hands will increase stability than in case of carrying a weight in one hand.

- b) Vision:** Other things being equal, a person has a greater balance and stability in locomotion under difficult circumstances when he focuses his vision on a stationary object rather than on moving or disturbing stimuli.
- c) Physical and Emotional State:** There is positive relationship between ones physical and emotional state and the ability to maintain balance under difficult circumstances. For example; a diseased person is less stable than healthy one.
- d) Pain:** Pain may decrease stability especially if the pain affects the lower extremities.
- e) Age:** The person will be more stable in adulthood period than in childhood and the stability will also decrease in senile subjects due to the physiological changes occurring as a result of aging process.

Types of Stability

There are two type of stability those are as

- Static stability and
- Dynamic stability

Static Stability:

Static stability means that any small displacement away from a stable equilibrium causes a net force to push it back to the equilibrium point.

Diamagnetic materials are used to provide static stability.

Dynamic stability:

Dynamic stability occurs when the levitation system is able to damp out any vibration-like motion that may occur.

Dynamic stability are provided by eddy current damping (conductive metal influenced by field) and tuned mass dampers in the levitated object.

Guiding Principles for Stability

1. To maintain balance when still, the athlete's center of gravity must remain over the base of support. For example, beginning a free weight lifting movement, such as the squat, requires the lifter to hold a standing position.
2. To regain balance when lost, an athlete can enlarge the base of support and reposition the center of gravity over it. Example: Placing the feet wider to prevent falling after being pushed helps recover balance.
3. When lifting or carrying an object, shift the body weight in order to maintain balance. Example: Lean in the opposite direction when carrying a heavy equipment bag.
4. For greatest stability in all directions, the center of gravity should be over the center of the base of support. Example: Holding a handstand requires the hips to remain toward the center of the base formed by the hands.
5. An athlete can become more stable by lowering the center of gravity. Example: A shotput follow through involves bending the knees to prevent fouling.
6. The greater the friction between the supporting surface and the athlete's body, the greater the ability to maintain balance. Example: Wearing shoes that prevent excessive sliding on a playing surface.
7. Shifting the center of gravity toward an approaching force increases an athlete's ability to maintain balance. Example: A football lineman shifts weight toward the opposing line prior to the snap.
8. An opponent can be forced to lose balance if pushed or pulled in the direction where the center of gravity is closest to the edge of the base of support. Example: Boxers can lose balance when weight is shifted back on the heels.
9. For positions of readiness, the shorter the distance the center of gravity must move to clear the base of support, the more rapidly the body can be put in motion in that direction. Example: Sprinters in the "set" position shift their weight in the direction of the race.