SCIENCE BEHIND REVERSE SWING

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Pune

Cricketing Nations

Australia

England

India

Pakistan

New Zealand

South Africa

West Indies

Sri Lanka

Zimbabwe

Bangladesh

BACKGROUND INFORMATION

- Swing bowling is a skill in cricket that bowlers use to get a batsmen out.
- It involves bowling a ball in such a way that it curves or ‘swings’ in the air.
- The process that causes this ball to swing can be explained through aerodynamics.

Dynamics is the study of the cause of the motion and changes in motion
Aerodynamics is a branch of Dynamics which studies the motion of air particularly when it interacts with a moving object

There are basically four factors that govern swing of the cricket ball:

Seam

Asymmetry in ball due to uneven tear

Speed

Bowling Action

Seam of cricket ball

Asymmetry in ball due to uneven tear

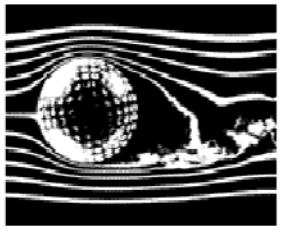
Cricket ball is made from a core of cork, which is layered with tightly wound string, and covered by a leather case with a slightly raised sewn seam
Dimensions- Weight: 155.9 and 163.0 g
224 and 229 mm in circumference

Speed

Fast bowler between 130 to 160 KPH

THE BOUNDARY LAYER

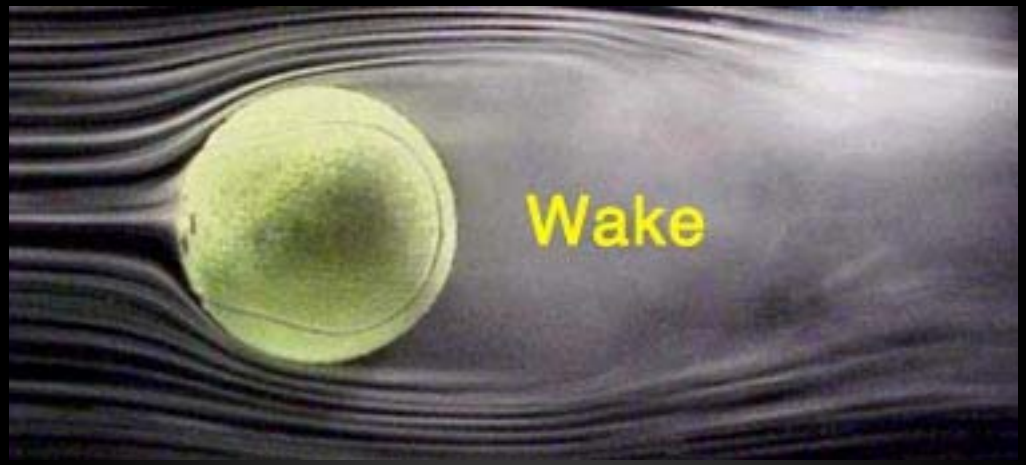
- When a sphere travels through air, the air will be forced to negotiate a path around the ball
- The Boundary Layer is defined as the small layer of air that is in contact with the surface of a projectile as it moves through the air
- Initially the air that hits the front of the ball will stick to the ball and accelerate in order to obtain the balls velocity.
- In doing so it applies pressure (Force) in the opposite direction to the balls velocity by NIII Law, this is known as a Drag Force.
- As this boundary layer moves around the sphere, it loses velocity as it is essentially ‘slipping off’ of the sphere and the sphere can no longer apply a force on the boundary layer to keep it at the spheres velocity
- As the boundary layer ‘slips’ off of the sphere, it approaches zero velocity in which the boundary layer no longer has any effect on the ball.
- At this point the air will separate from the ball, This is known as the boundary separation point



Wind Tunnel Smoke Flow
(Picture F.N.M. Brown)

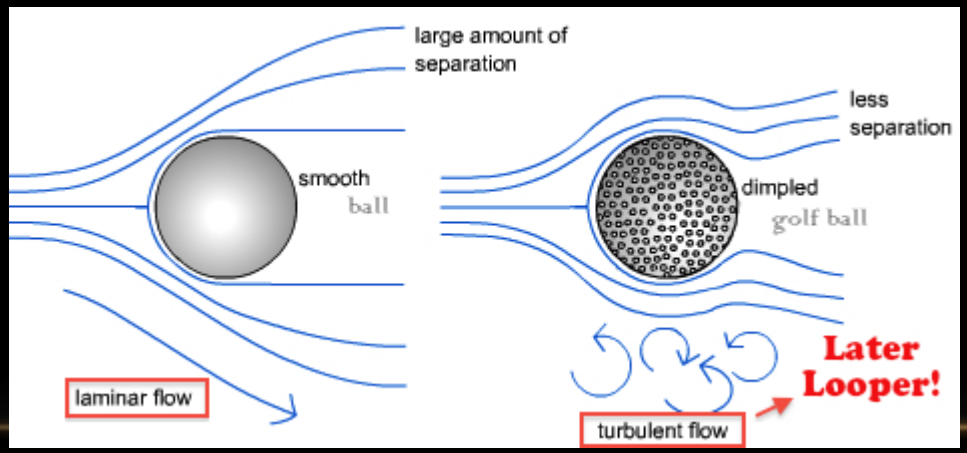
BOUNDARY LAYER SEPARATION

- As the boundary layer separates from a sphere, it forms a wake.
- A wake is an area of low pressure that appears directly after the separation point of the boundary layer
- This wake is created by the separating boundary layer as it is accelerated off the surface of the sphere. By Newton's Third Law, the wake will then cause an equal and opposite force on the sphere.



LAMINAR/TURBULENT AIR FLOW

- *The boundary layer spoken about previously can adopt two methods of flow around a sphere, either turbulent or laminar flow.*
- *Laminar flow refers to the smooth airflow around a sphere, in which the layers of air do not interact and disturb each other.*
- *Turbulent airflow refers to the rough flow of air around an object in which many layers of air mix together in a chaotic manner*
- *Because many layers of air are involved, turbulent airflow will reach zero velocity and have a separation point at a later spot on the ball. It reaches zero velocity at a later spot as its velocity is constantly replenished by the mixing air layers*



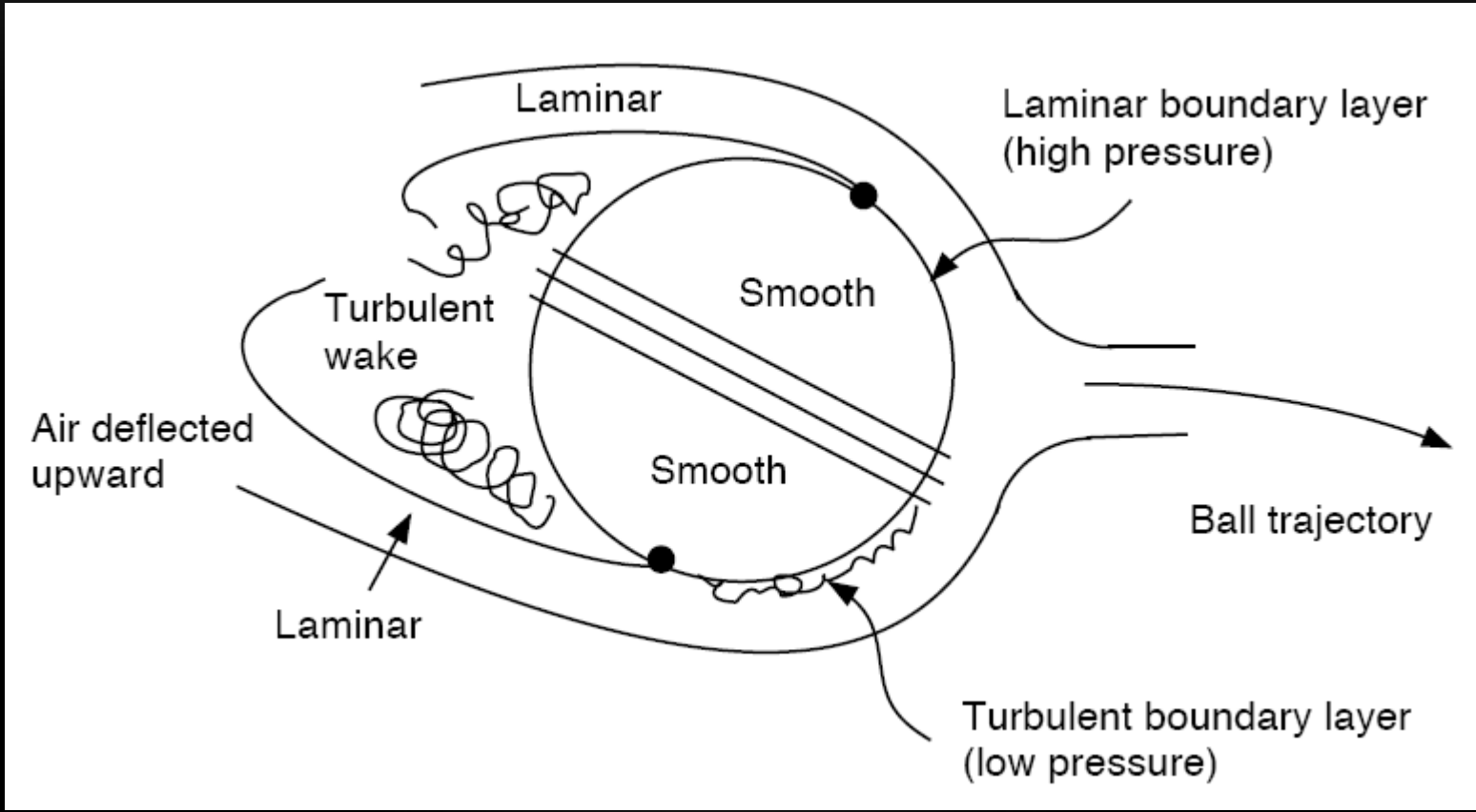
REYNOLDS NUMBER

- The Reynolds number is a number that can be used to determine whether or not the flow around an object will be turbulent or laminar.
- It can be calculated by the equation Re = Ud/v. where U is the speed of the projectile, d is the diameter of the sphere and v is the viscosity of the medium .
- Generally, a Reynolds number of greater than 200 000 will cause turbulent airflow around a sphere.

APPLICATIONS IN CRICKET

- Conventional swing bowling involves bowling a new cricket ball with the seam upright at a slight angle in the direction you wish the ball to swing.
- As the ball moves through the air in this manner, the seam trips one side of the airflow into turbulence, whilst on the other side of the ball the airflow remains laminar (due to smooth surface of cricket ball)
- Laminar airflow will reach zero velocity much quicker than turbulent airflow, resulting in an asymmetry in the position of the separation points
- This ultimately causes the wake to be skewed towards the side of the laminar airstream.
- By Newton's Third law, this wake applies an equal and opposite force on the cricket ball, causing the ball to 'swing' in the direction the seam is pointing, this is shown aside

Swing bowling with new ball (both sides smooth)



Outswinger (Right hand batsman)

Inswinger (Right hand batsman)

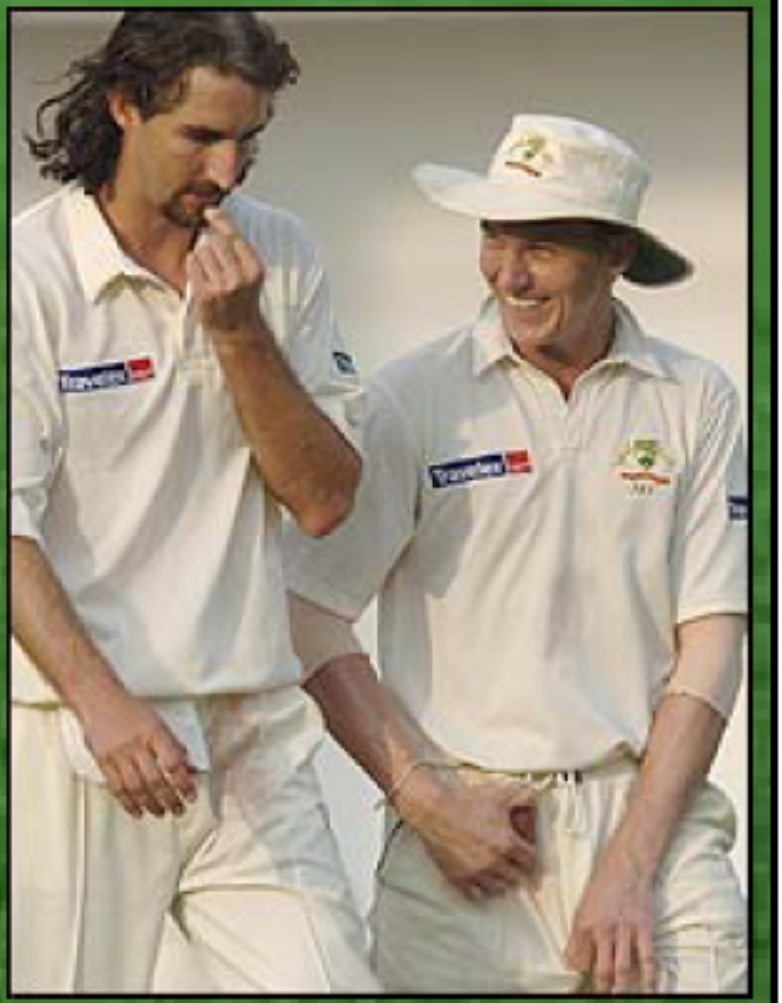
THE BALL

You will often see fielders constantly shining one side of a ball by rubbing it on their trousers.

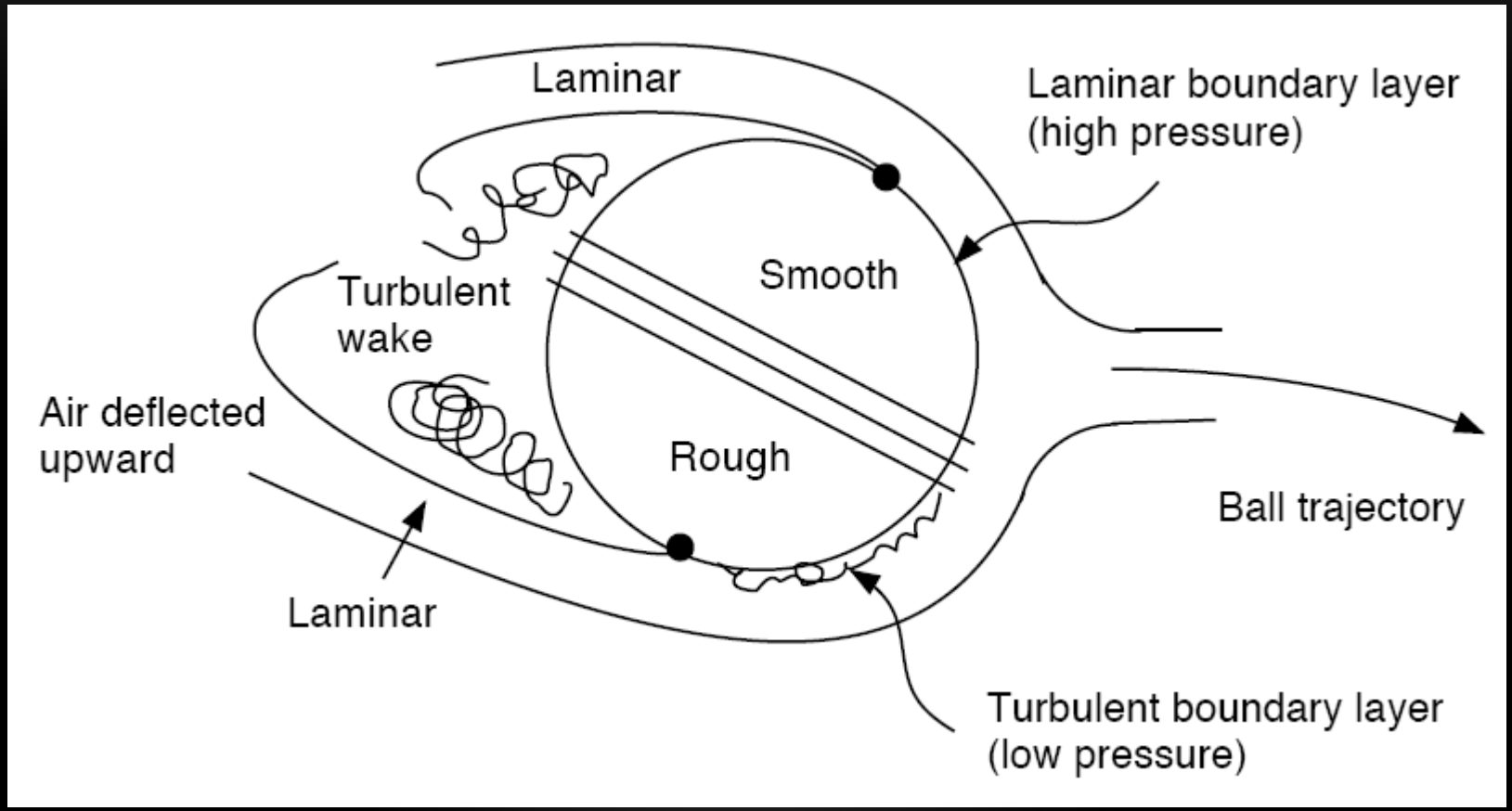
The rubbing helps to maintain a smooth, shiny side while the opposite is left to deteriorate through normal wear and tear.

In simple terms, the aerodynamics of bowling means the shiny side travels faster through the air, while the rough side acts as a brake, pushing the ball in that direction.

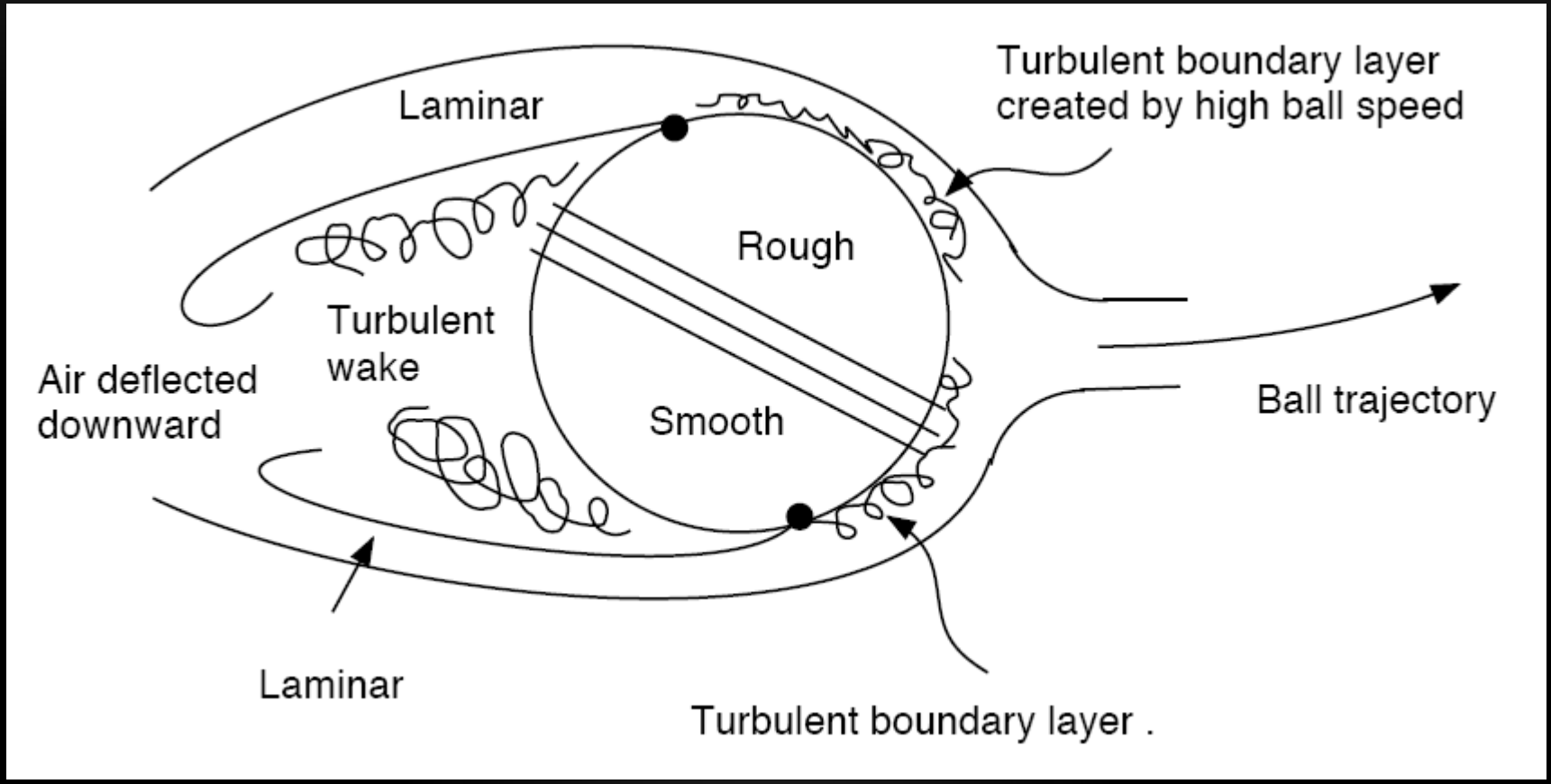
But other factors also play a part too.



Swing bowling with new ball (one side smooth and other side rough)

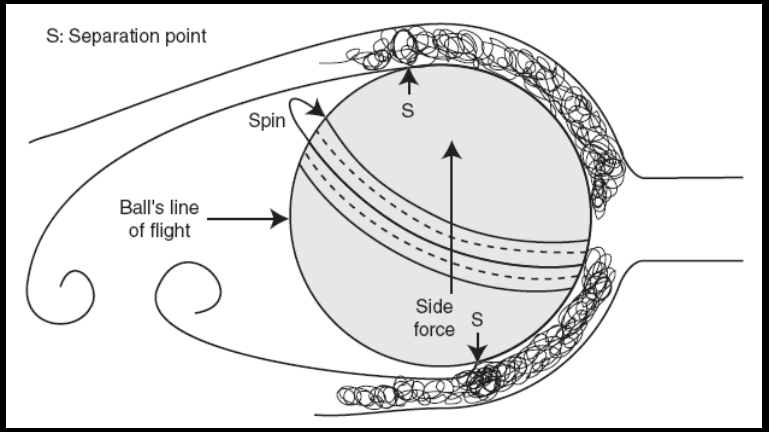


Reverse swing (one side smooth)



REVERSE SWING

- Reverse swing requires very high speeds and the ball to be rough. Unlike conventional swing, reverse swing will swing in the direction the seam is NOT pointing
- The ball is delivered in the very same method as conventional swing.
- As the ball travels through the air, the airflow around the ball on both sides become turbulent due to the roughness and high speeds. Now, as the turbulent flow goes over the seam of the ball, it gets ‘tripped’ again so to speak, into a very thick turbulent layer
- This thick turbulent layer will separate earlier than the regular turbulent layer on the other side of the ball, resulting in a wake that is skewed in the direction of the thick turbulent flow
- This results in a net force on the ball in the direction the seam is not pointing in, causing the ball to swing in this direction.



OTHER FACTORS OF SWING BOWLING

- Speed plays a major part in the art of swing bowling.
- As seen in the Reynolds Equation Re = Ud/v, Velocity is directly proportional to the Reynolds Number (for a constant diameter and viscosity)
- If the ball is travelling too fast or slow, the net result will be a consistent air flow (laminar or turbulent) all around the ball which will cause no sideways net force to be acting on the ball.
- There is an optimal speed in which swing bowling is most effective, this is between 112-135km/h for conventional swing bowling, and 140-150km/h for reverse swing bowling

- Seam Position also affects the amount of swing.
- The seam position affects when the airflow around a ball becomes turbulent, and thus directly affects the amount of sideways force on the ball, as it controls where the separation point will be.
- The ideal seam angle is 45 degrees from the motion of the ball

ADVANTAGES/DISADVANTAGES TO THIS PHYSICS

- With this knowledge in hand, bowlers can now bowl in certain ways that maximize the amount of swing they get, such as bowling at a certain speed range or a certain seam angle.
- Coaches can now look for bowlers that naturally bowl in ways that cause the ball to swing.

- Now the cause of swing is known, people may manipulate the ball in order to get more swing. This could include ‘pinching’ the seam with fingernails in order to make it more prominent, causing the airflow to be more turbulent over it. This is unethical and is a concern in the game of cricket.
- As bowlers now know how swing bowling works, it will lead to more bowlers using it and ultimately lower scoring cricket games. This is a negative as low scoring games will attract less people to the game.

OPINION AND CONCLUSION

- Swing bowling is a vital aspect of cricket that takes extreme skill to master. Watching a good swing bowler is just as exciting as watching any other part of the game, because of this I believe that this knowledge will lead to more exciting and skillful cricket; as more cricketers adopt swing bowling techniques. A basic understanding of aerodynamics could lead to cricketers developing new methods of swinging the ball, other than conventional and reverse swing. This would further increase the skill level of the game.

- Swing bowling is a unique art that can be explained through aerodynamics. The swing of the cricket ball is ultimately caused by asymmetrical air flow over either side of the ball which causes a net side wards force to act on the ball. The asymmetry of the airflow can be enhanced by increasing the speed of the ball, the roughness of the ball and the seam position of the ball.

Cricket is a gentleman's game
Play the game in right fairness and sportsmanship

Thank You