Adhesion
Why Does Water Adhere to the Sides of the Xylem Tracheids and Vessels?

Water molecules are attracted electrostatically to areas of charge on polar molecules, and are also attracted to charged groups on a hydrophilic surface such as glass. Consequently, such surfaces are ***wettable,*** in the sense that water spreads over them and binds loosely to them. By contrast, hydrophobic surfaces, such as those of most plastics and waxes, lack surface charge and hence are not wettable; water on them will form isolated droplets, but will not spread out over the surface. The cell wall of xylem tracheids and vessels, being composed of cellulose, are highly polar and hydrophilic, and therefore wettable.

The readiness of water to bind to hydrophilic surfaces explains the phenomenon of ***capillarity*** —the tendency of aqueous liquids to rise in narrow tubes. If the end of a narrow glass tube is inserted below the surface of a volume of water, water will rise in the tube to a level well above the water level outside). The reason is that glass is very hydrophilic, having many charged groups on its surface. The water molecules, electrostatically attracted to the glass, tend to creep upwards along the surface of the tube and to pull other water molecules (linked to them by hydrogen bonds) along with them. The water level stops rising when the pull of gravity just counteracts the electrostatic forces that contribute to capillarity. The larger the diameter of the tube, however, the smaller the percentage of waster molecules in direct contact with the glass and, correspondingly, the smaller the rise in the water in the tube. Even though the relatively few molecules in contact with the glass have a tendency to creep upward, they are held back by their cohesion via the network of hydrogen bonding with the rest of the water in the tube.

The very small diameter of tracheids and vessels contributes to the importance of adhesion in overcoming the pull of gravity. Water will naturally climb up along the walls of these cells by capillarity for a short distance; the narrower the diameter, the farther up the water will climb. This natural phenomenon contributes to the strength of the force of adhesion in the TCAT theory.