IOT WIRELESS MONITORING IN TUNNEL CONSTRUCTION

1. **Gateway**
   Connected to a load cell to monitor the force in ground anchors

2. **Wireless Tiltmeter installed using a vertical mounting bracket**
   An integrated biaxial inclinometer that serves as a 2-in-1 sensor and node used to measure tilt, building response to tunneling, angular distortion or horizontal displacement

3. **Piconode Analog 1 channel**
   Connected to a crackmeter or displacement sensor (potentiometer) to measure movement across surface cracks and joints and building response to tunneling

4. **Piconode Analog 1 channel**
   Connected to a crackmeter or displacement sensor (vibrating wire) to measure movement across surface cracks and joints and building response to tunneling

5. **Vibrating Wire Node 1 channel**
   Connected to a crackmeter or displacement sensor (vibrating wire) to measure movement across surface cracks and joints and building response to tunneling

6. **Vibrating Wire Node 1 channel**
   Connected to a piezometer (vibrating wire) to measure groundwater level and pore water pressure

7. **Piconode Analog 1 channel**
   Connected to a crackmeter or displacement sensor (potentiometer) to measure movement across surface cracks and joints and building response to tunneling

8. **Vibrating Wire Node 5 channels**
   Connected to strain gauges (vibrating wire) to measure strain and stresses in structural members

9. **Vibrating Wire Node 5 channels**
   Connected to an in-place inclinometer (IP) on a chain in a hole or excavation to measure lateral deformation in diaphragm walls or lateral ground movement to monitor performance of structural members and movement behaviour of soil

10. **Vibrating Wire Node 5 channels**
    Connected to Multipoint Borehole Extensometers or MPBX (vibrating wire) to measure ground movement behind diaphragm wall or vertical deformation at various depths

11. **Wireless Tiltmeter attached to a rigid beam and installed on a chain**
    An integrated biaxial inclinometer that serves as a 2-in-1 sensor and node used to measure tilt, building response to tunneling

12. **Laser Distance Node**
    An integrated laser distance meter node that serves as a 2-in-1 sensor and node used for convergence measurement in the excavation walls