



Transportation Engineering II: Highway Design & Railways

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Permanent Way

- Permanent way = The railway track
- Typical components
 - Rails
 - Sleepers (or ties)
 - Fasteners
 - Ballast (or slab track)
 - Subgrade

Permanent Way



A typical twin track

Components



Rails



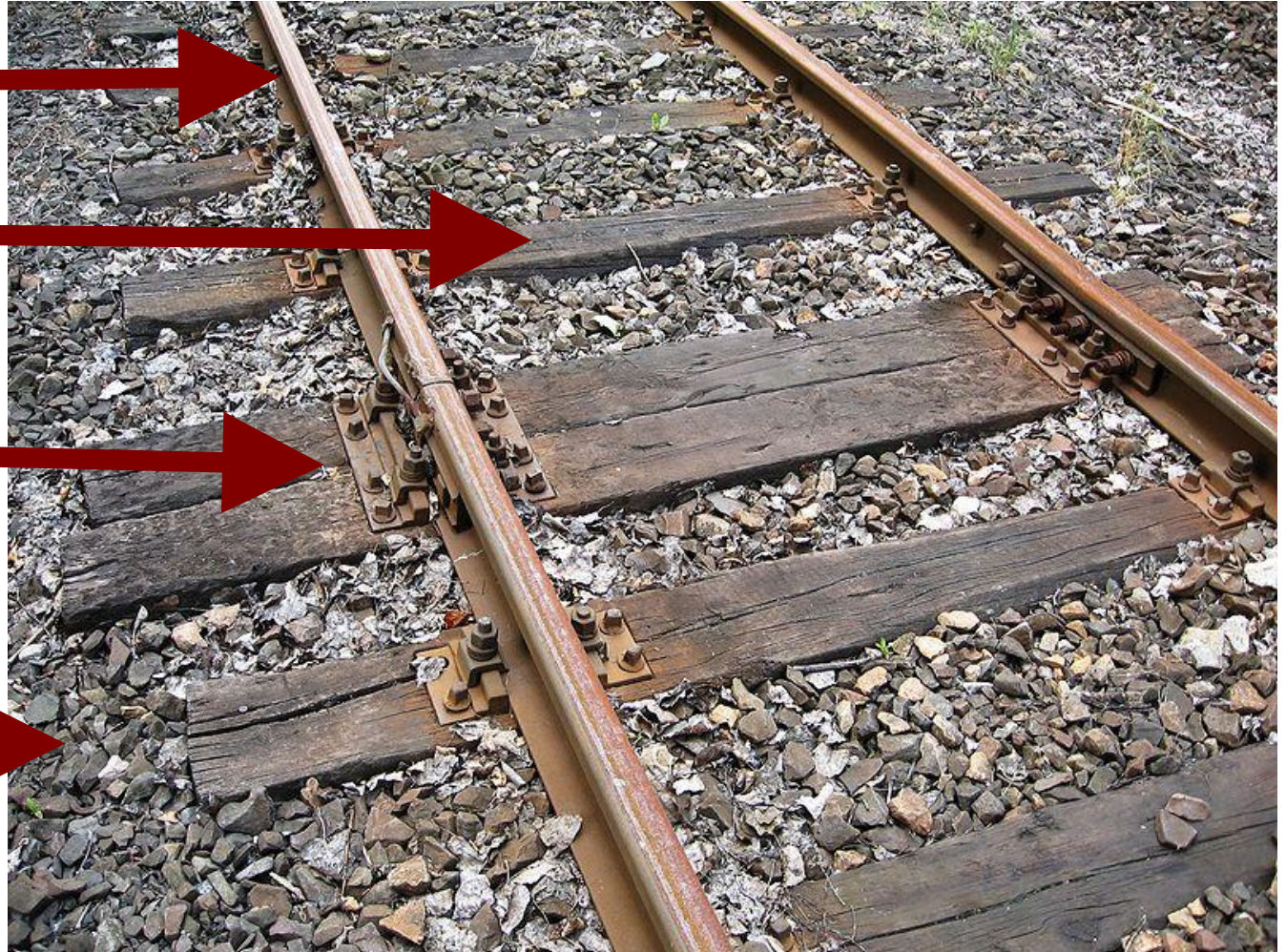
Sleepers



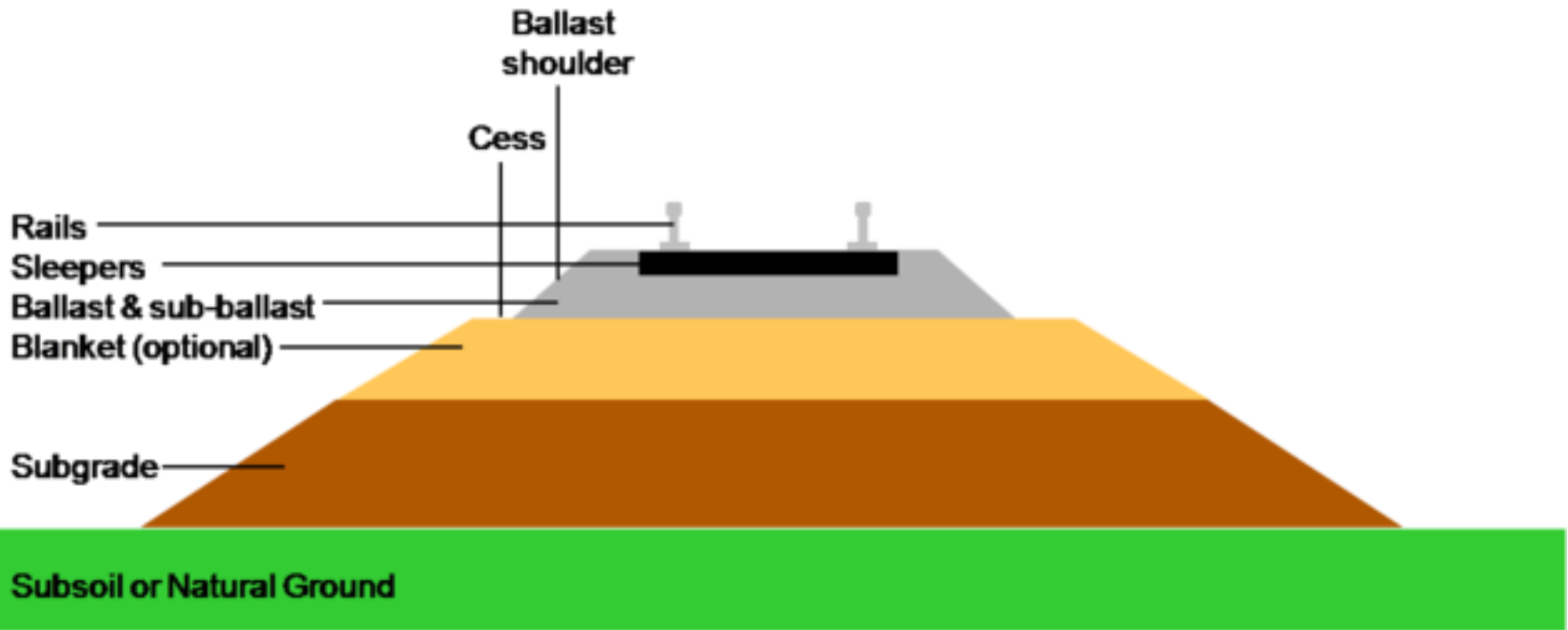
Fasteners



Ballast



Components



Functions of Components



Rails: Provide a continuous and level surface for train movement, provide lateral guidance to the train wheels, bear the wheel load

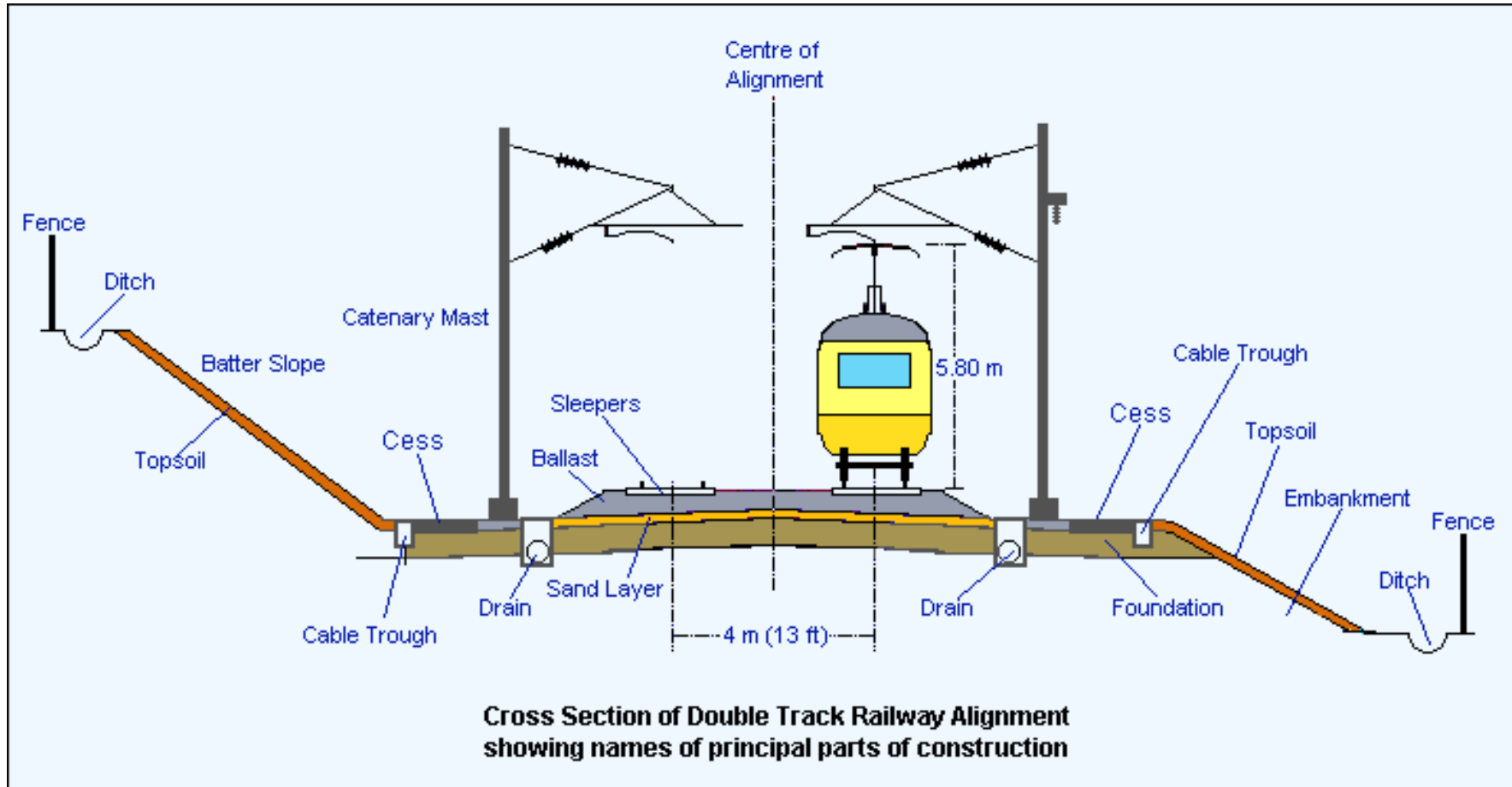
Sleepers: Hold rails in correct alignment and spacing, provide firm and even support to rails and transfer load to a wider area of the ballast

Fasteners: Fix rails to sleepers

Ballast : Transfer and distribute loads to the subgrade, help drainage

Subgrade: Transfers and distributes loads to soil (stabilized) layer

Principal Components



Source: <http://www.railway-technical.com/track.shtml>

Variations: Stabilized Ballast



High speed rail, Japan: Mats have been added to stabilize the ballast

Variations: Ballastless Track



High Speed Rail, China: Ballastless tracks

Alignment of Railway



- Alignment = direction and position given to the **of** the railway track on the ground in horizontal and vertical planes
 - Horizontal: straight and horizontal curvature
 - Vertical: level track, gradient, vertical curve
- Importance:
 - Ensure safety and speed
 - Changing alignment later can be very costly

Requirements of Ideal Alignment



- Basic purpose of construction should be served
 - Strategic considerations
 - Developing backward areas, connecting new trade centers, shortening existing rail distances
 - Political considerations
- Should be integrated with development
 - Land-use plan and other development activities

Requirements of Ideal Alignment



- Should be as economic as possible
 - Shortest route
 - Construction and maintenance
 - C: Balanced cut and fill, minimum rock cutting, drainage along watershed line
 - M: Avoid steep gradients and sharp curves (-> minimize wear and tear of rails and rolling stock)
 - Operational:
 - Provide easy gradient, avoid sharp curves, adopt direct route

Requirements of Ideal Alignment



- Ensure safety and comfort
 - Transition curve, safe gradients (typical gradient 1 in 80)
 - The *steepest railway gradient* is the Leas Cliff Railway, found in Folkestone England, where two gravity powered trains travel up and down a slope of gradient 1:1.64. What makes this even more WOW-worthy is the fact the railway is 123 years old, and the trains are powered by water!
- Aesthetic considerations
 - Journey should be visually pleasing
 - Avoid borrow pits, garbage disposal grounds etc.



Leas Cliff Railway