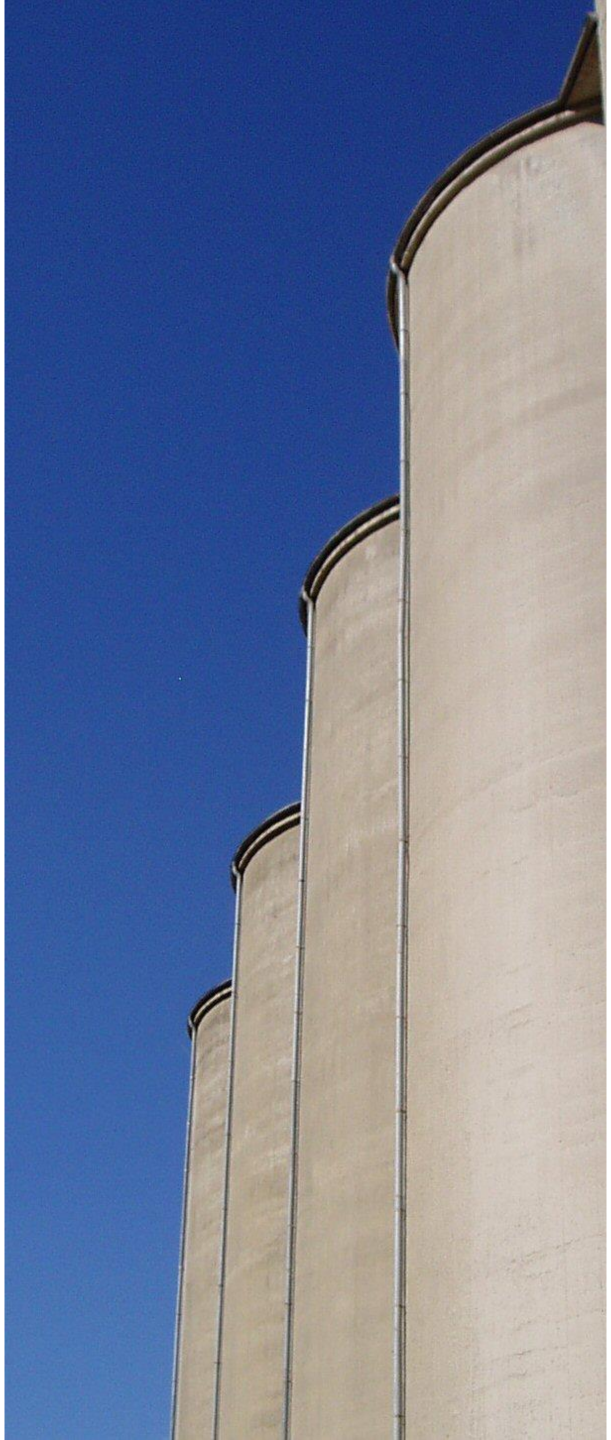
UNIVERSITY of GREENWICH

The Wolfson Centre
for Bulk Solids Handling Technology

Shore-side transport

Choice of Equipment



Shore-side conveying

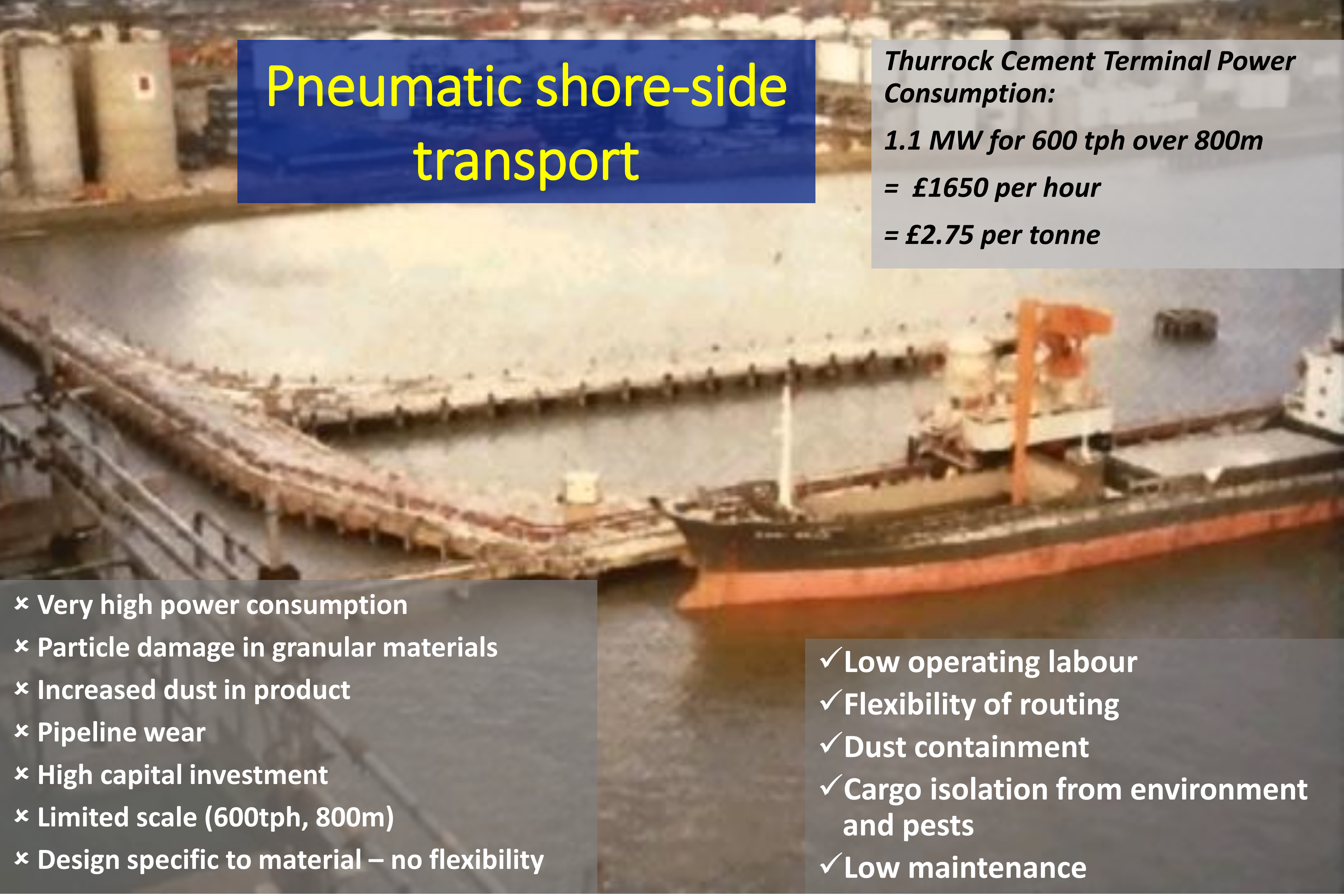
Main technologies:

- Mobile plant
- Pneumatic handling
- Belt handling

Continuous or non-continuous Shiploading

Continuous or non-continuous Shipunloading

Storage



Pneumatic shore-side transport

Thurrock Cement Terminal Power Consumption:

1.1 MW for 600 tph over 800m

= £1650 per hour

= £2.75 per tonne

- × Very high power consumption
- × Particle damage in granular materials
- × Increased dust in product
- × Pipeline wear
- × High capital investment
- × Limited scale (600tph, 800m)
- × Design specific to material – no flexibility

- ✓ Low operating labour
- ✓ Flexibility of routing
- ✓ Dust containment
- ✓ Cargo isolation from environment and pests
- ✓ Low maintenance

Belt shore-side transport

- ×Containment from poor to fair
- ×Poor cargo isolation from environment and pests
- ×Direction changes costly
- ×Limited flexibility of materials
- ×High capital investment

- ✓Very low power consumption
- ✓Low operating labour
- ✓Fairly gentle to granular materials
- ✓Low maintenance
- ✓Wide range of scales (10,000tph, 30km)

Mobile plant for shore-side transport

- ✓Flexibility of routing
- ✓Flexibility of material
- ✓Can deal with difficult materials
- ✓Available on lease
- ✓Low or no capital investment

- ×High operating labour
- ×Very high maintenance
- ×Poor to no dust containment
- ×High particle damage
- ×Limited rates (600tph, 800m)
- ×No cargo isolation from environment and pests
- ×Poor operator safety

Shore-side conveying

- Choice of technology based on:
- Material handling properties
- Sensitivity of material to environment and pests
- Sensitivity of environment to material
- Time horizon of investment
- Labour, capital and maintenance costs

Also to consider:

- Weighing systems, accuracy and purpose
- Sampling (see separate presentation)

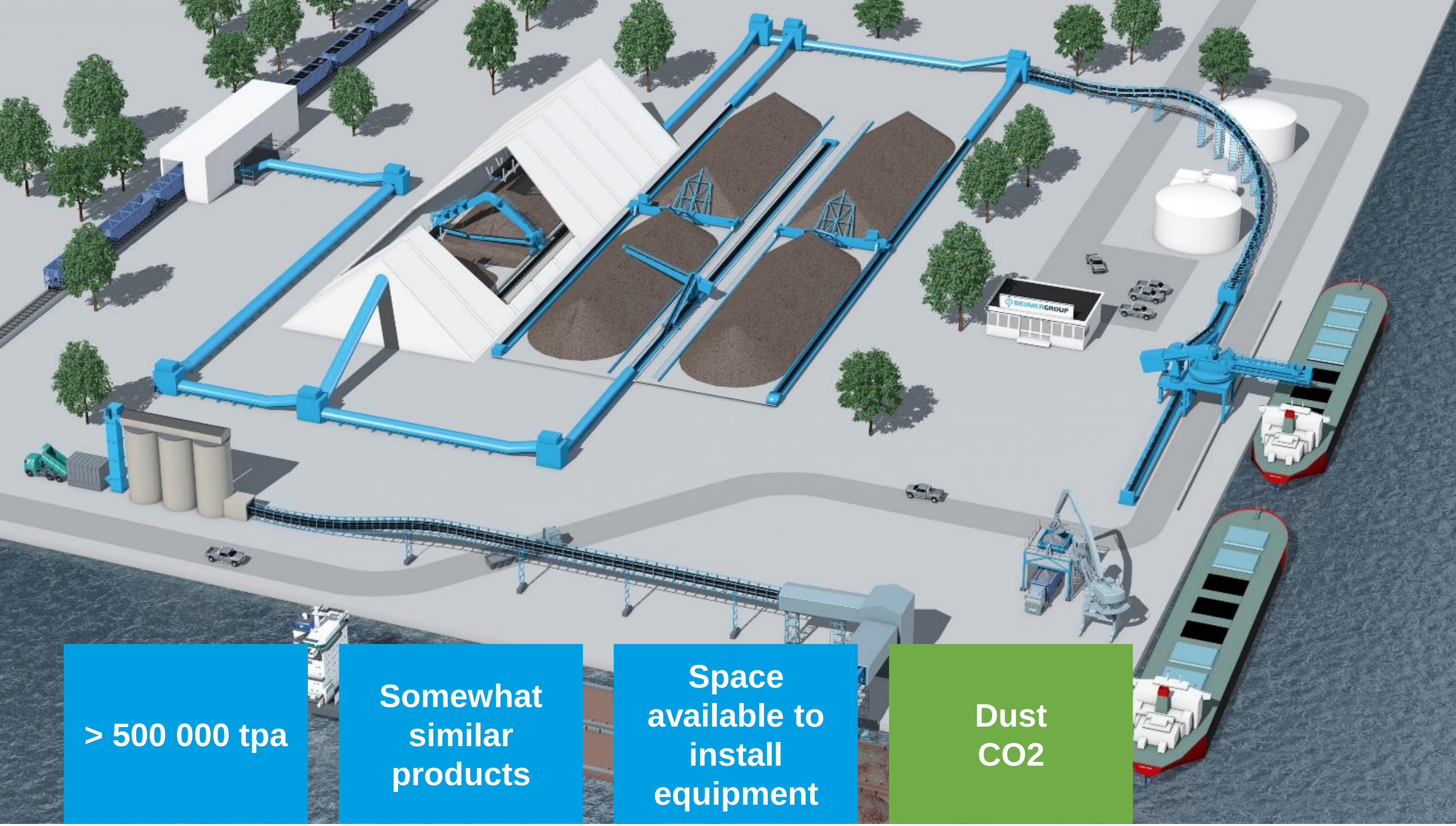
Shore-side conveying

Mobile Plant
(Non-Continuous)
- High Flexibility
- Low capital investment
- Leasing → cost/t only
- High overall cost/t
- Dust, traffic etc.
- Material quality and contamination

Pneumatic Conveying
(Continuous)
- High Flexibility in Routing
- High power consumption
- High abrasion
- Particle breakage for granular materials

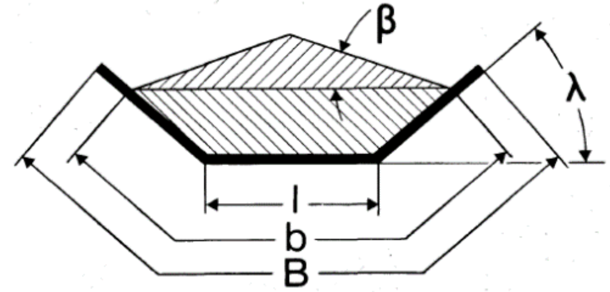
Belt Conveying
(Continuous)
- Low overall cost/t, low power consumption
- Material Handled w/ Care
- High CAPEX
- Installed equipment → blocks roads etc.

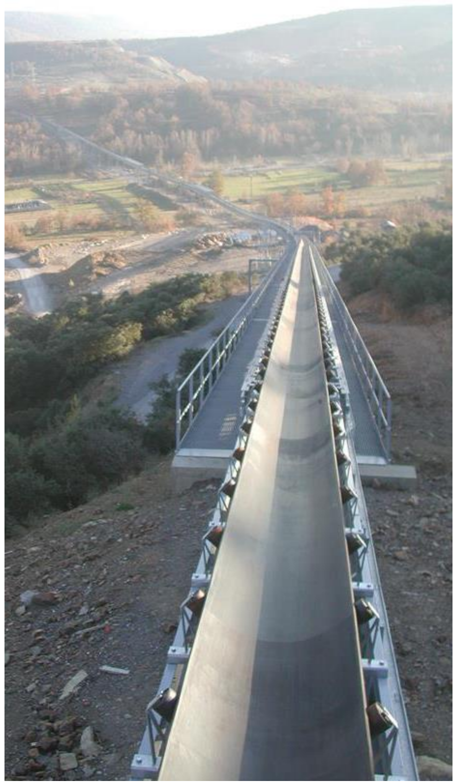
Belt conveyor variations

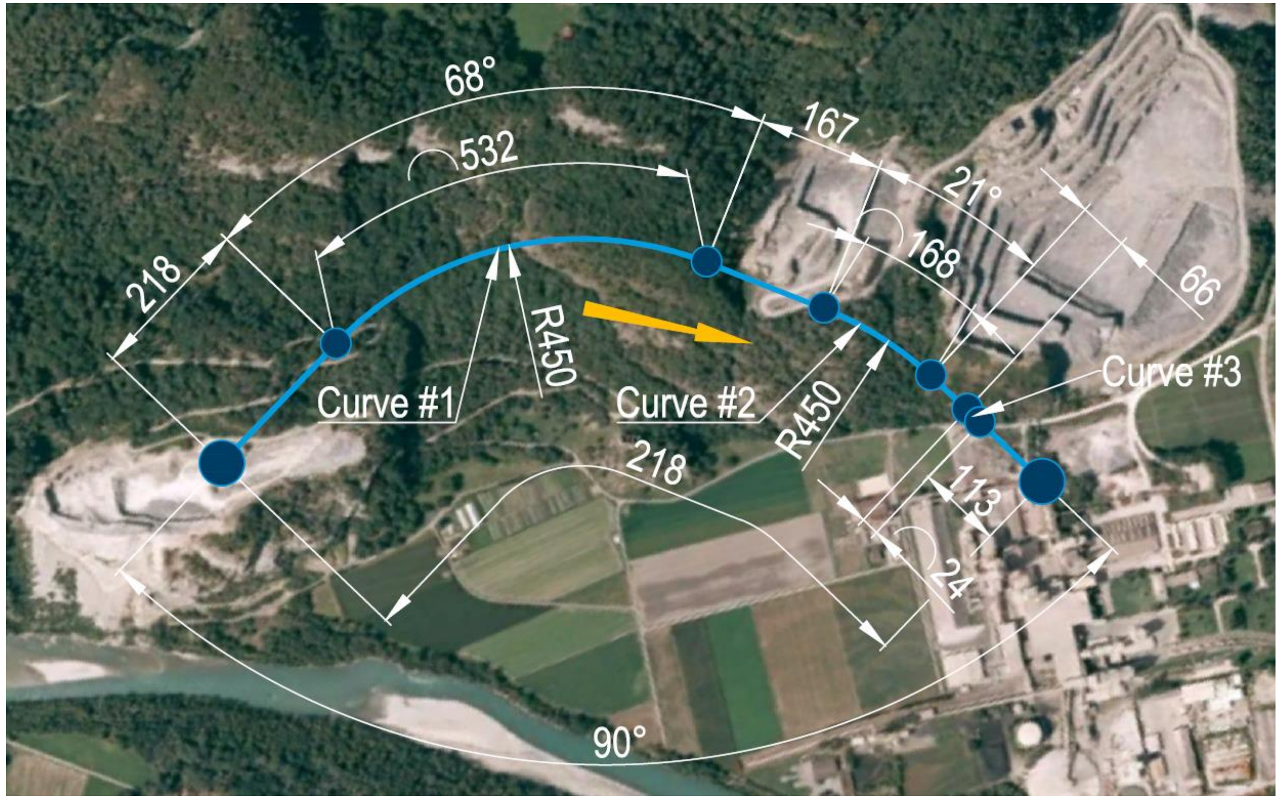

> 500 000 tpa
Somewhat similar products
Space available to install equipment
Dust
CO2

Changes of direction

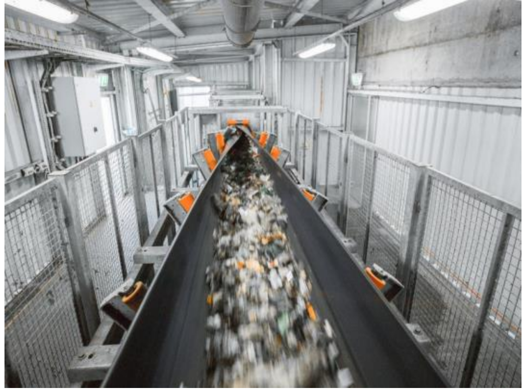
Trough Belt Conveyor w/ Horizontal Curves



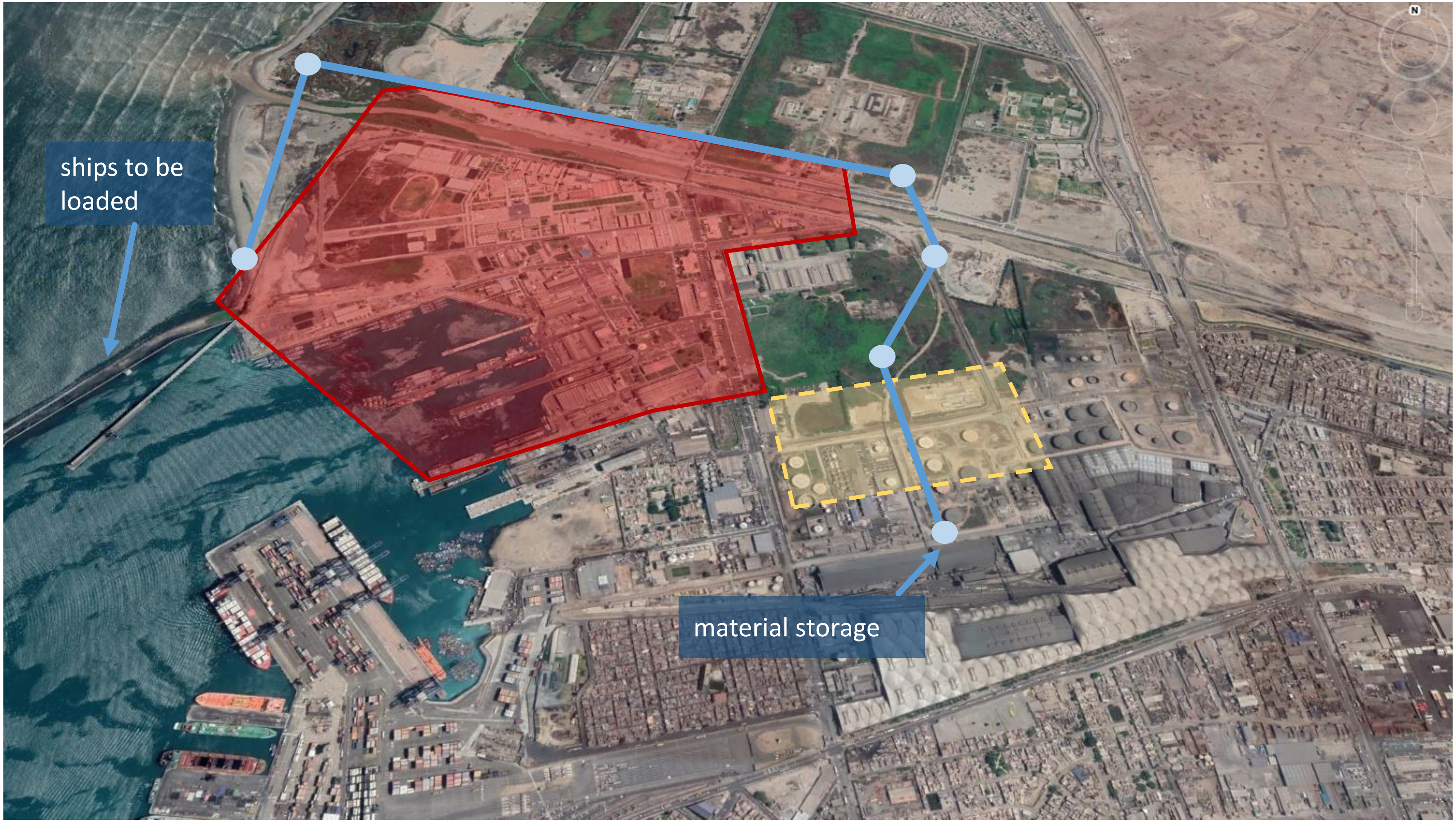




Tube Belt Conveyor (Pipe Conveyor)

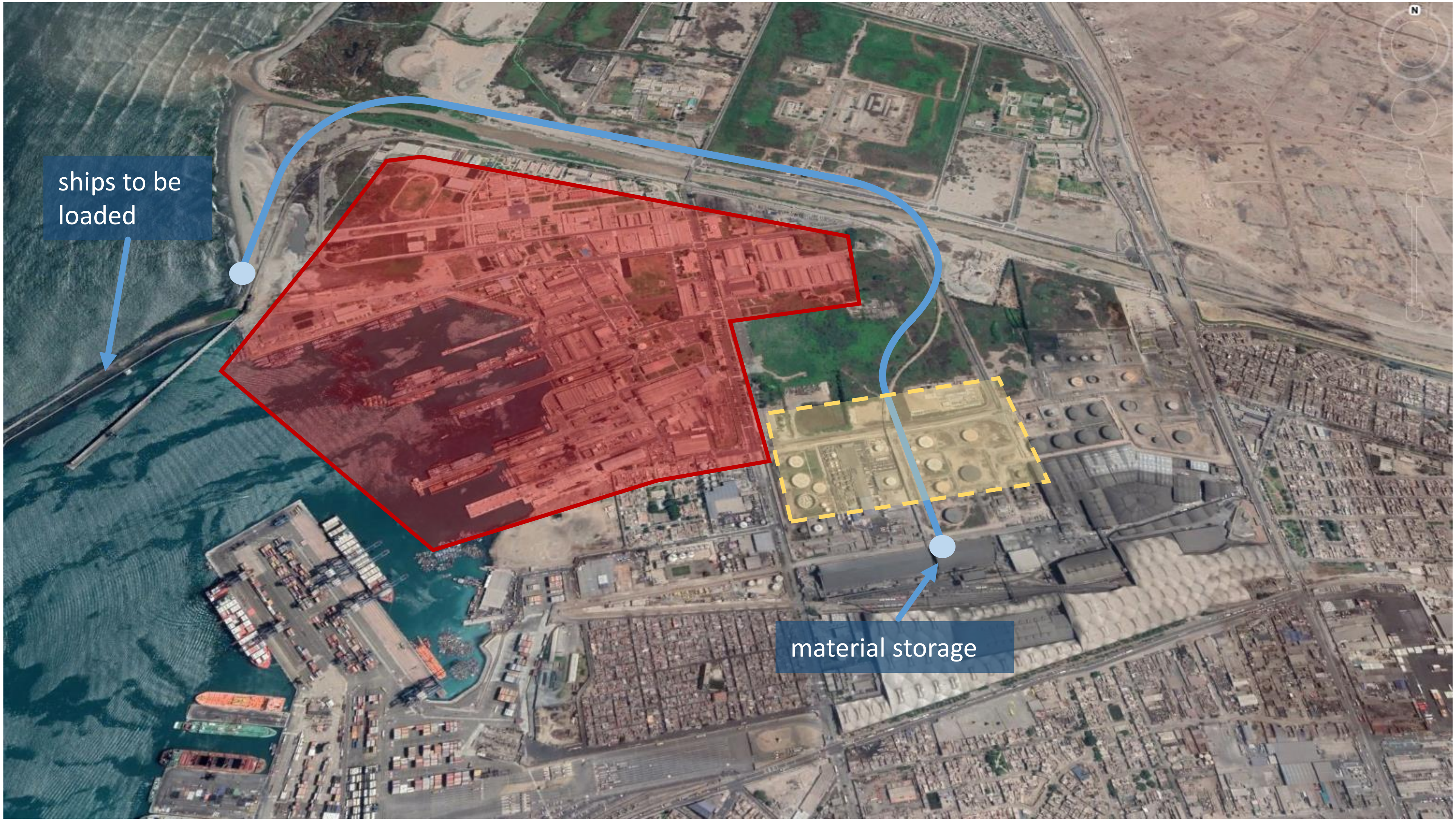


Troughed belt conveyor



- Multiple transfer points
- Each adds cost, drives, dust emission, maintenance . . .

Tube belt conveyor



- Fewer transfer points
- Structure larger and heavier

Tube belt conveyor - advantages

Pipe Conveyor

- Up to 10km and longer
- Tight horizontal curves
- Capacity >6.000t/h
- Belt speed up to 6,5m/s
- Inclination up to 30°

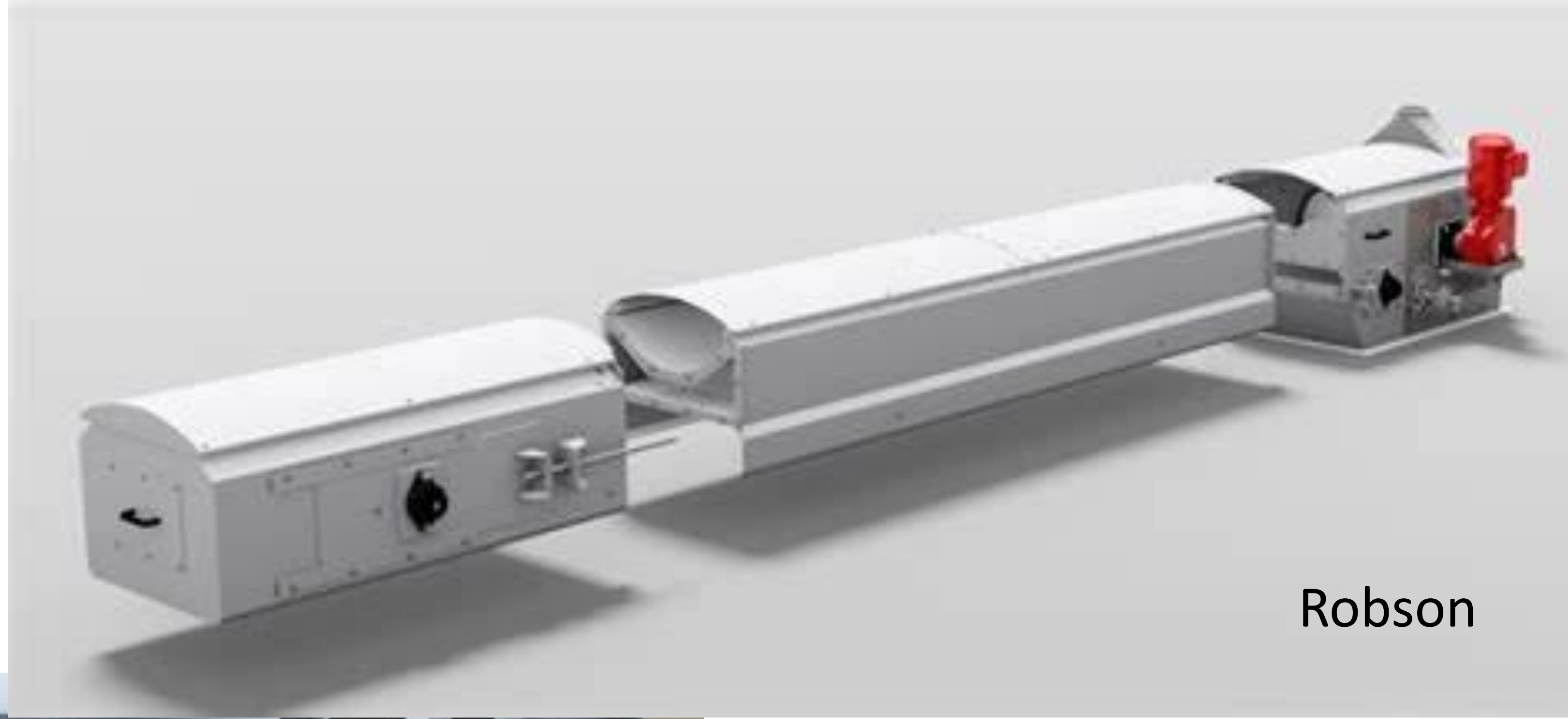
Troughed Belt Conveyor

- Up to 20km and longer
- Horizontal radii >400m
- Capacity >10.000t/h
- Belt speed up to 6,5m/s
- Inclination up to 15°

- **Protection of Material**
- **Protection of Environment**
- **Adaptation to topographic/space requirements**
  - Horizontal curves possible
  - Steeper inclinations (Pipe Conveyor)
  - Narrow Cross Section
- **Eliminating Transfer Towers**
  - Material Transfer
  - Steel
  - Power Supply / Controls Point
- **High availability**

- But:
- Larger section for same throughput
- Cost advantage depends on layout

Air-supported conveyor



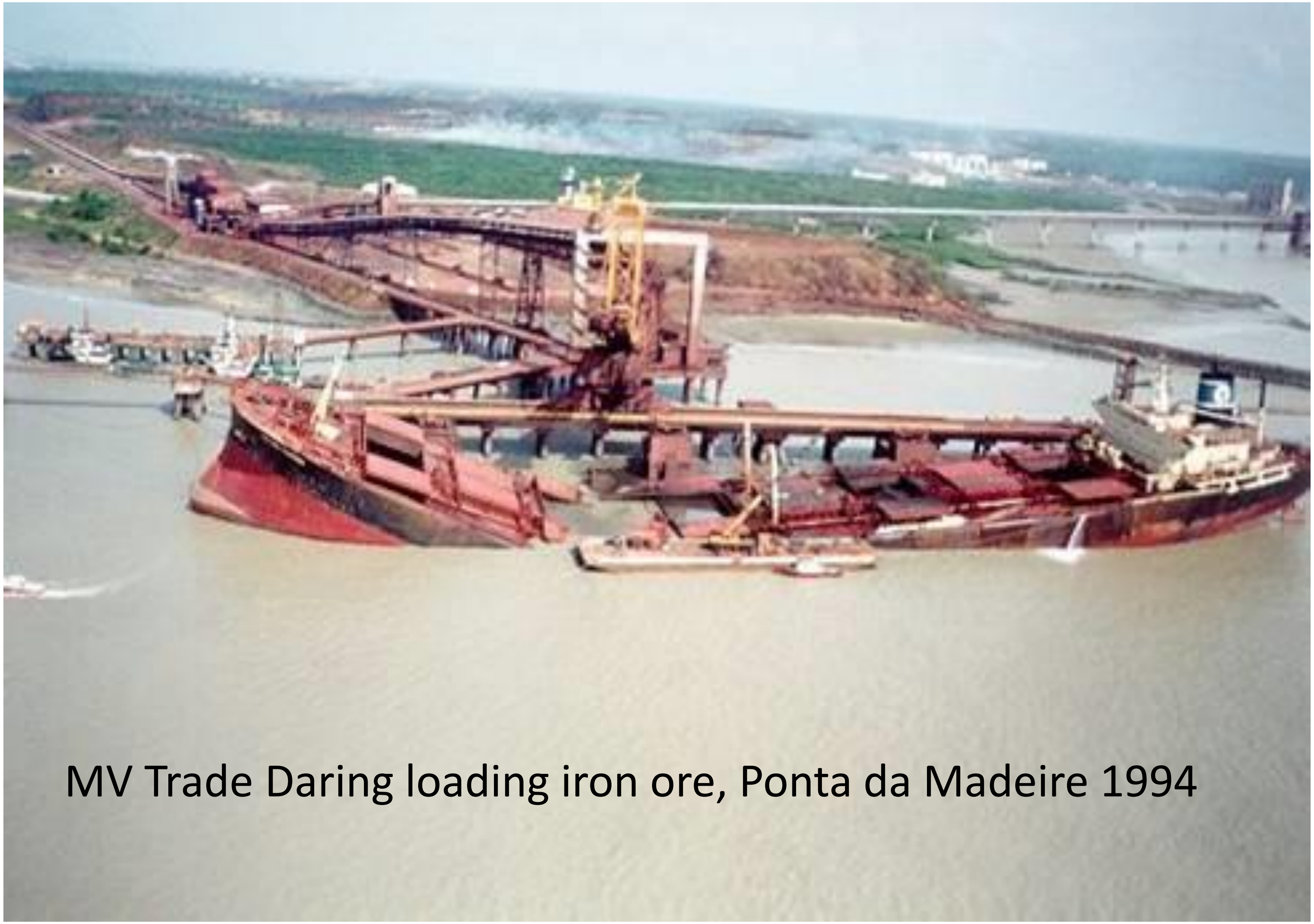
Robson

Robson

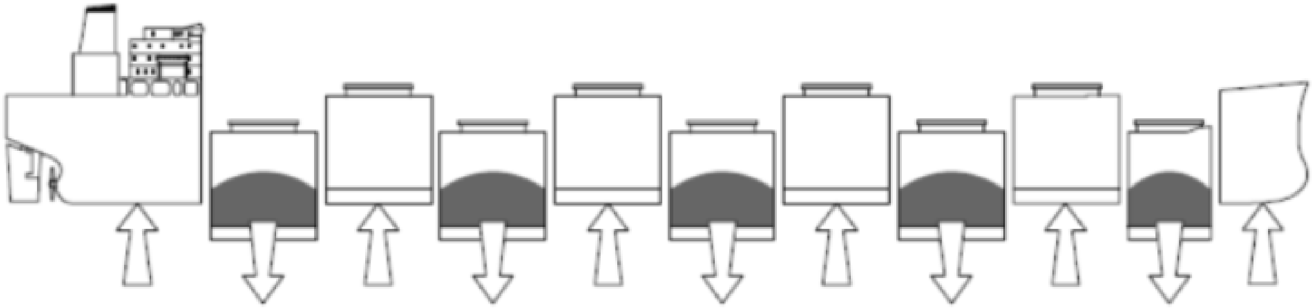
- Fully enclosed – low dust emission
- Belt rides on layer of air from fan
- Filtered vents needed
- Low energy and noise
- Easy to keep clean
- Few moving parts
- Steeper angle achievable
- Reduced explosion hazard

Weighing

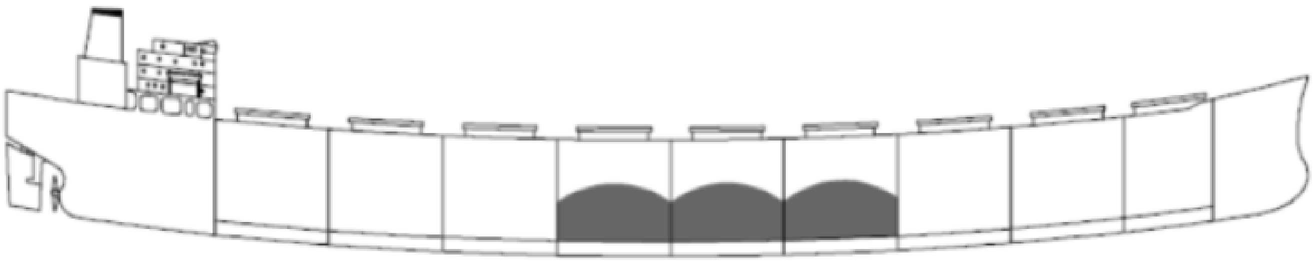
Care in loading and loading



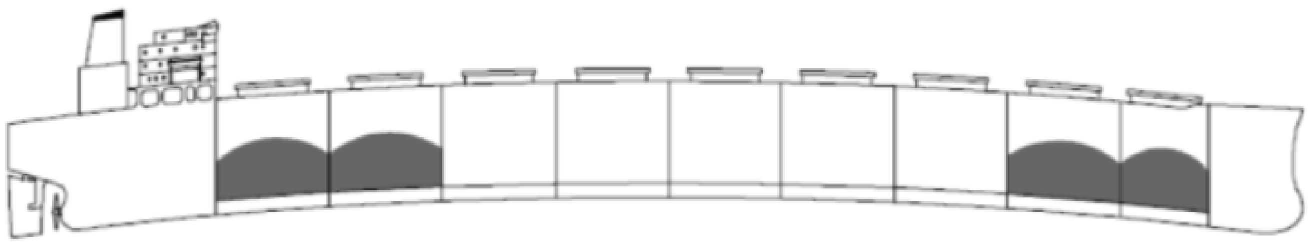
MV Trade Daring loading iron ore, Ponta da Madeire 1994



Shearing Action of the Hull Girder in Still Water



Bending Action of the Hull Girder "Sagging" in Still Water
(Exaggerated Condition - Illustration Purposes Only)



Bending Action of the Hull Girder "Hogging" in Still Water
(Exaggerated Condition - Illustration Purposes Only)

Shearing and bending in a bulk carrier due to unequal hold contents

The Shipyard Blog

Loading and unloading sequence

- Bulk carriers highly susceptible to structural damage from bending
  - ***150 seafarers every year lost in BCs****
  - Primary cause is structural failure
  - Many claims for damage during loading/unloading

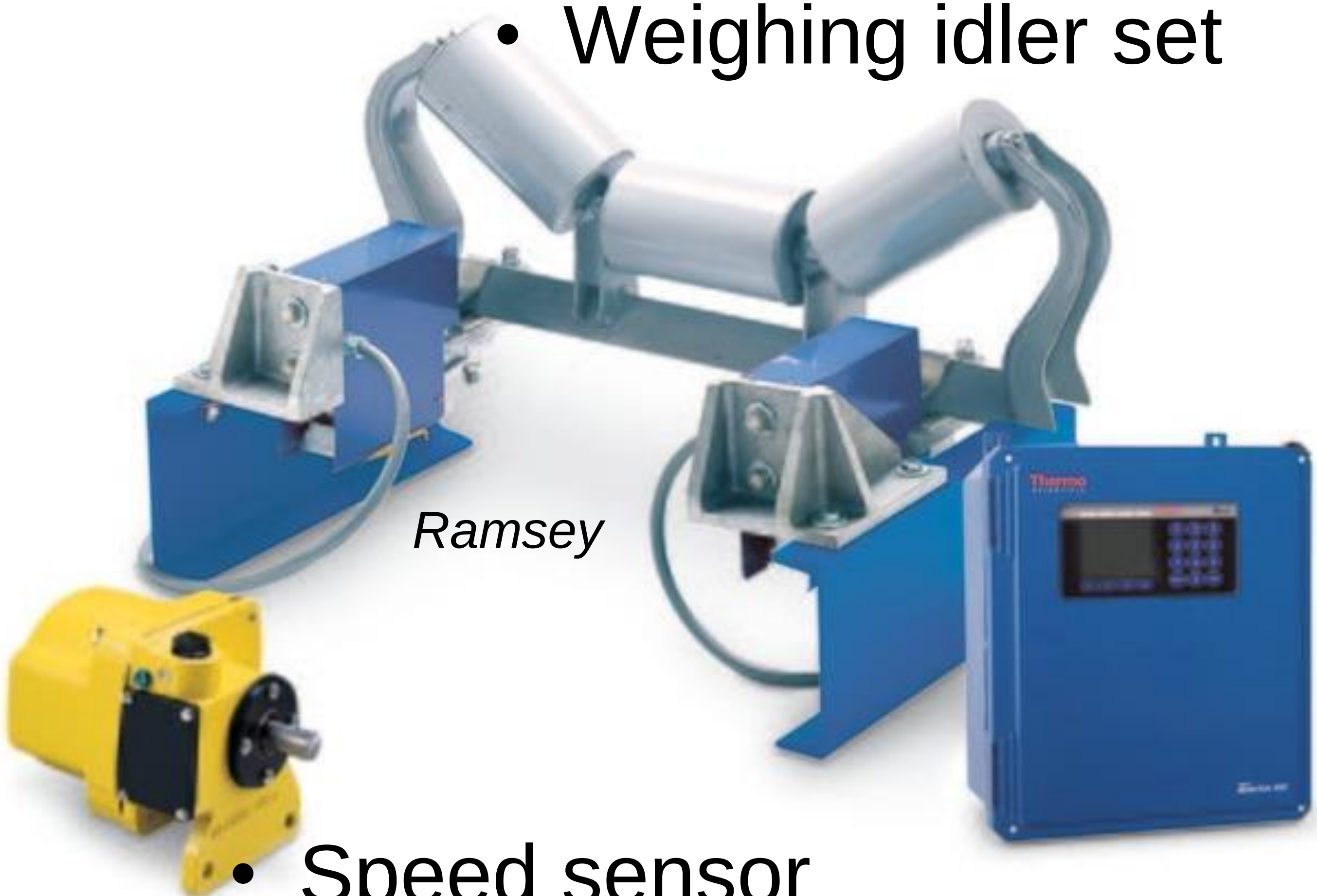
* *Structural Failures of Bulk Carriers,* J Jubb Proceedings of the Institution of Mechanical Engineers, Part E: Journal of Process Mechanical Engineering Volume 209, Issue 2


KOWLOON BRIDGE
HONG KONG


Stellar daisy

- Weighing idler set

Belt weighing system



Ramsey

- Integrator

- Speed sensor

Single idler set

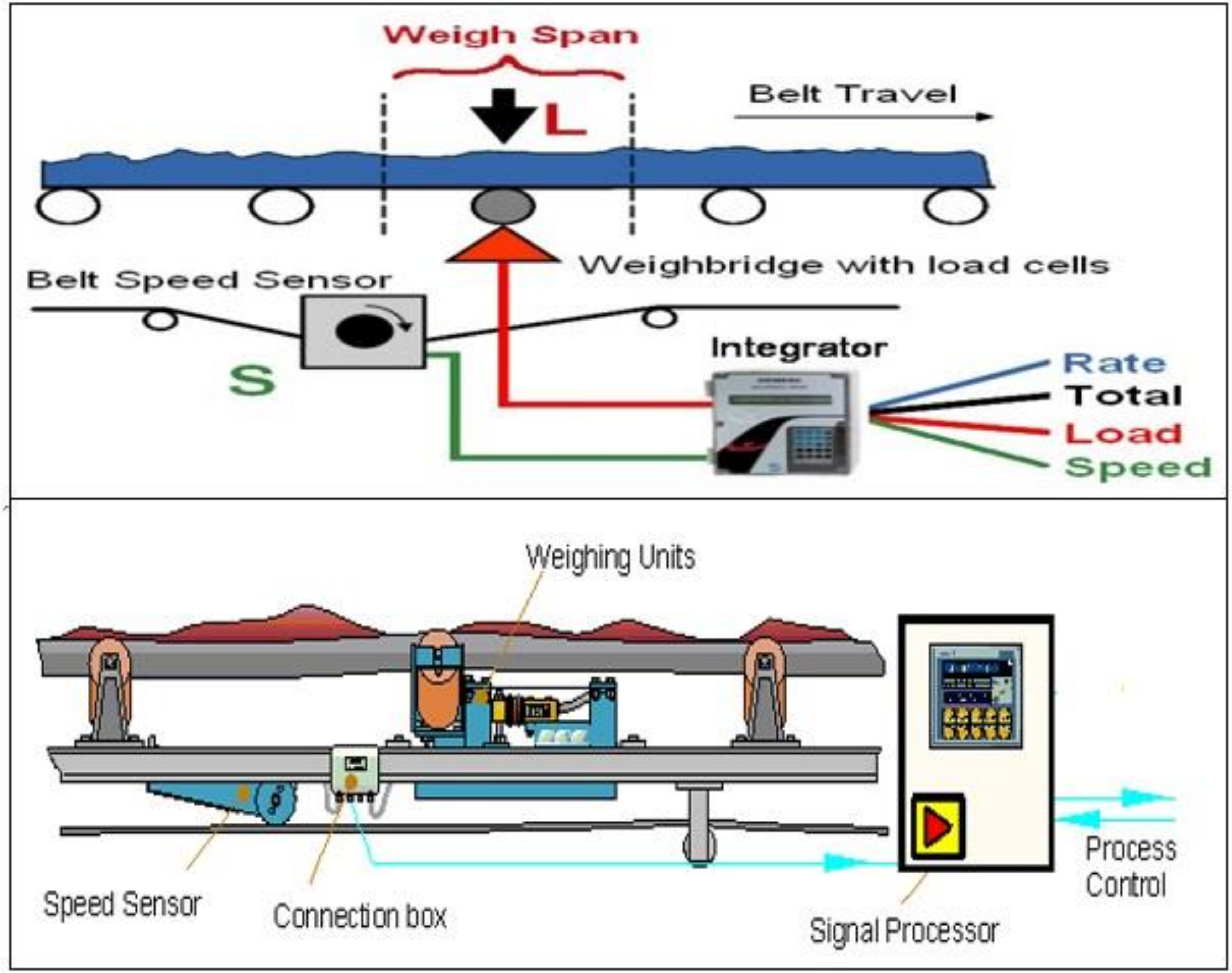
~1% accuracy

Flow rate Q = belt speed x mass per unit length

Total flow in time $t = \int_0^t Q\,dt$ (added numerically)

Multiple idler set

~0.25% accuracy



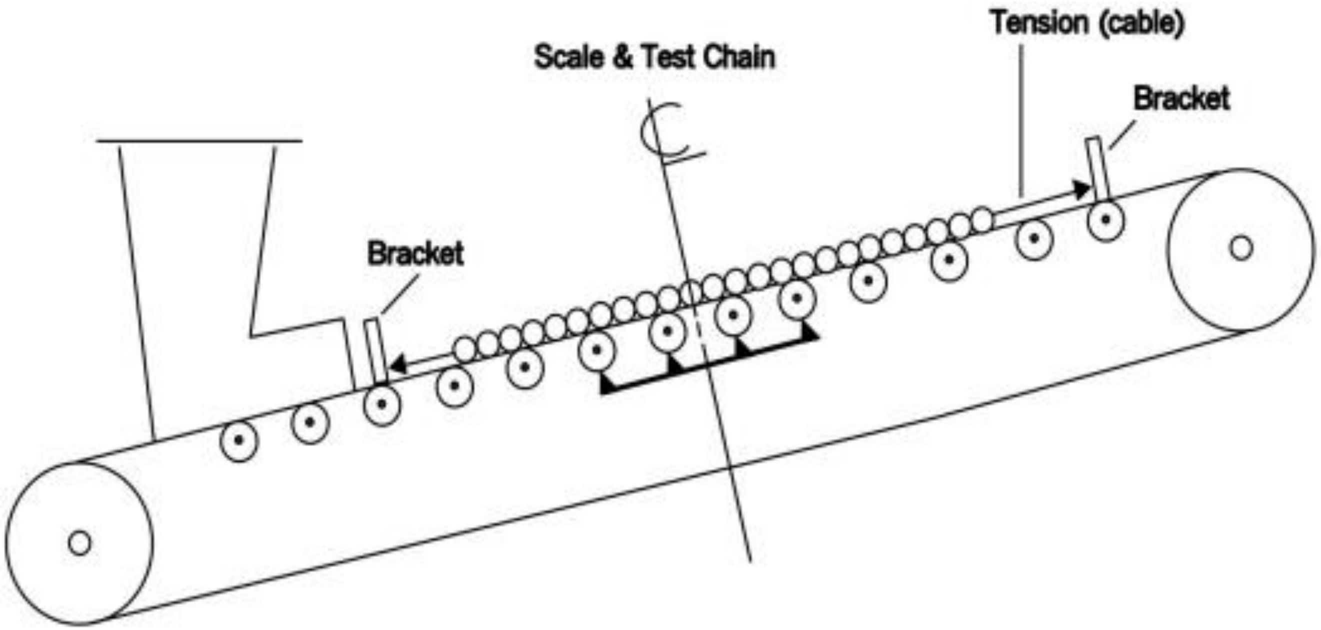
Coalhandling plants.com

Significant errors due to changes in belt tension, stiffness of belt and structure etc

Calibration with dead weights on the weighing idler set

Superior

scalesu.com

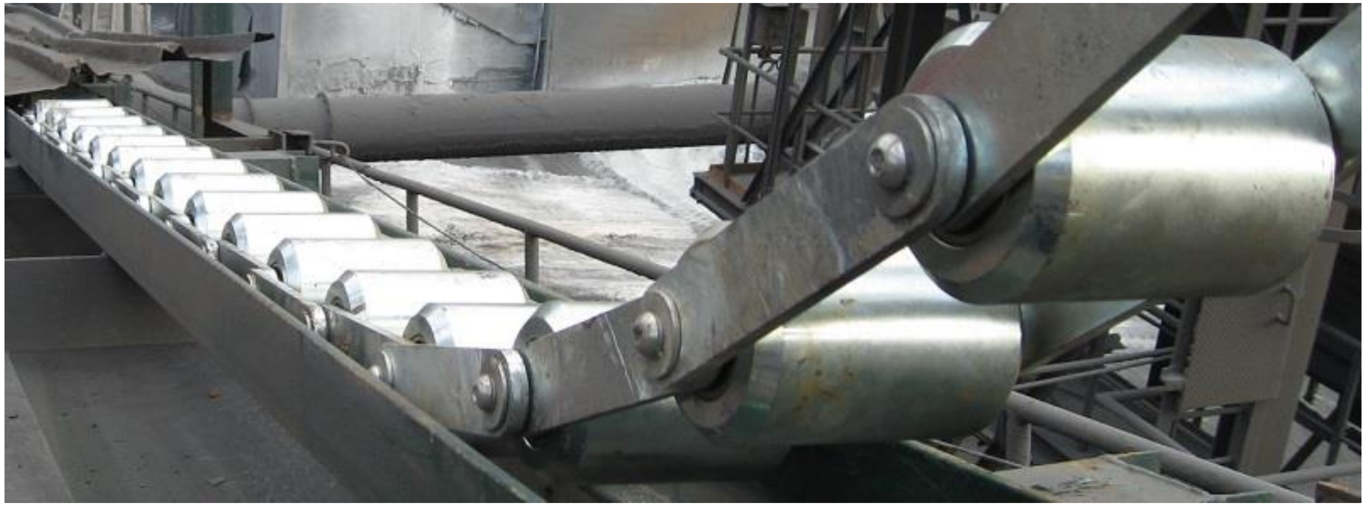


Calibration with weight chains

For best accuracy

Avoids effect of belt and structure stiffness and idler height

Performed the day before the incident



Mettler-Toledo.com

Speed sensor

- It just counts pulses – what could possibly go wrong?

New head pulley

- Fitted the day before
- Dropped from wagon
- Shaft end bent
- Sensor counting ~60% of teeth

Clearing the Trade Daring Wreck

5 weeks to cut up, refloat and remove the bits

LOSSES:
$$ Value of the ship $$
$$$ Cutting up the ship $$$
$$$ Towing the pieces out for scuttling $$$
$$$$$$$$ 3 months of iron ore exports $$$$$$$
$ Hundreds of millions

Loading and unloading sequence

- Bulk carriers highly susceptible to structural damage from bending
  - Masters must be very conservative about trim during unloading
- Control of bending moment by maintaining trim
  - Switching between holds during operation
- Agree with master in advance of docking
- Ensure weighing system on discharge route working properly to avoid damage

Acknowledgements

- Beumer Group
- Geo. Robson & Co

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Ship Unloading:
Choice of Equipment