

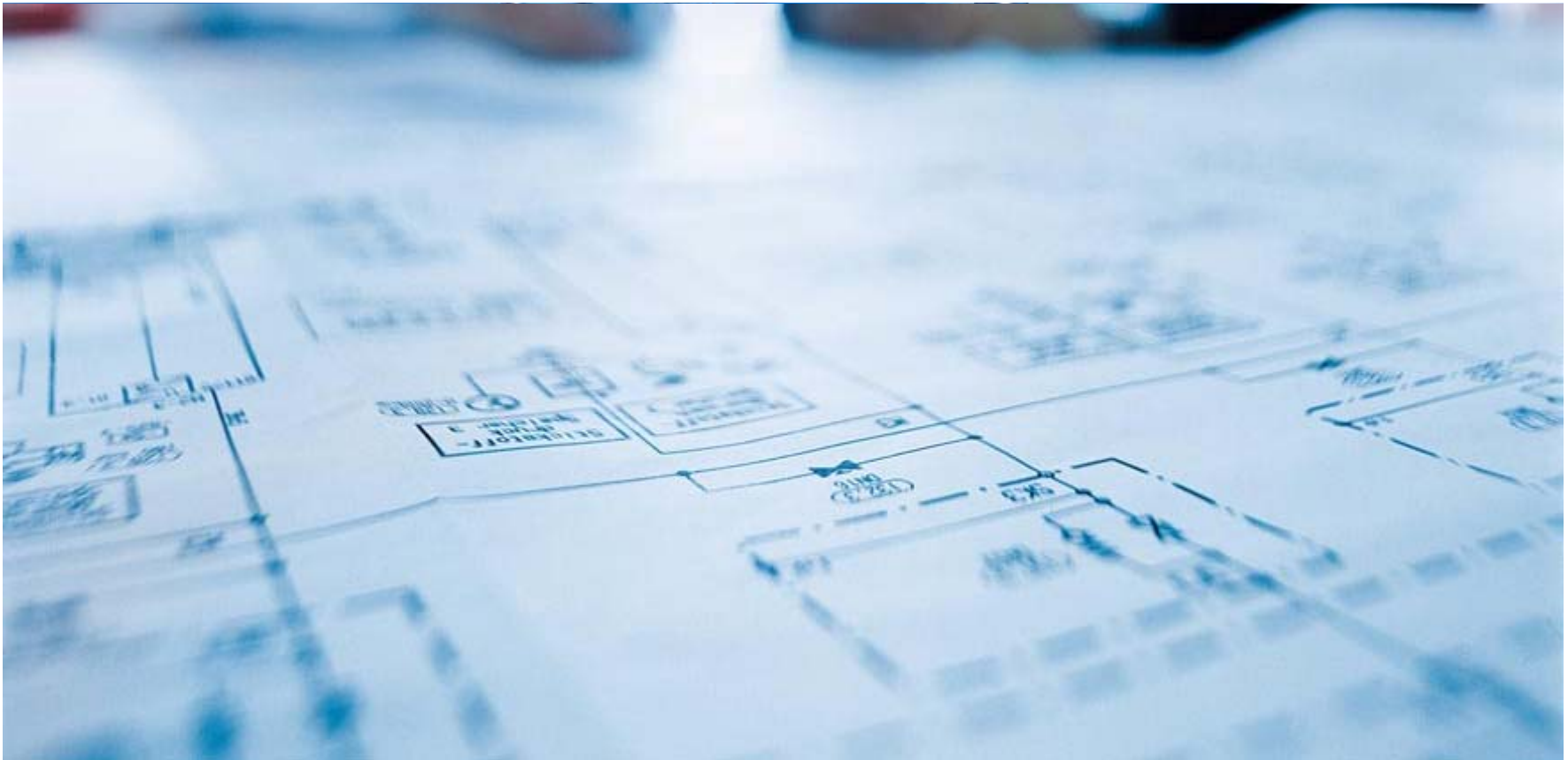


“Rustiger vaarwater”

Wait or create?

Even voorstellen....

Naam: Maarten Kuijpers (34)
Bedrijf: Bosch Rexroth
Divisie: Systems & Engineering
Functie: Technical Project Manager.....







Hydraulics

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Wave generation

Rexroth
Bosch Group

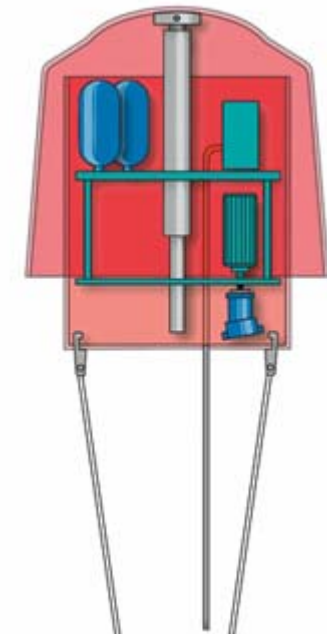


Renewable Energy

Rexroth
Bosch Group



Renewable Energy

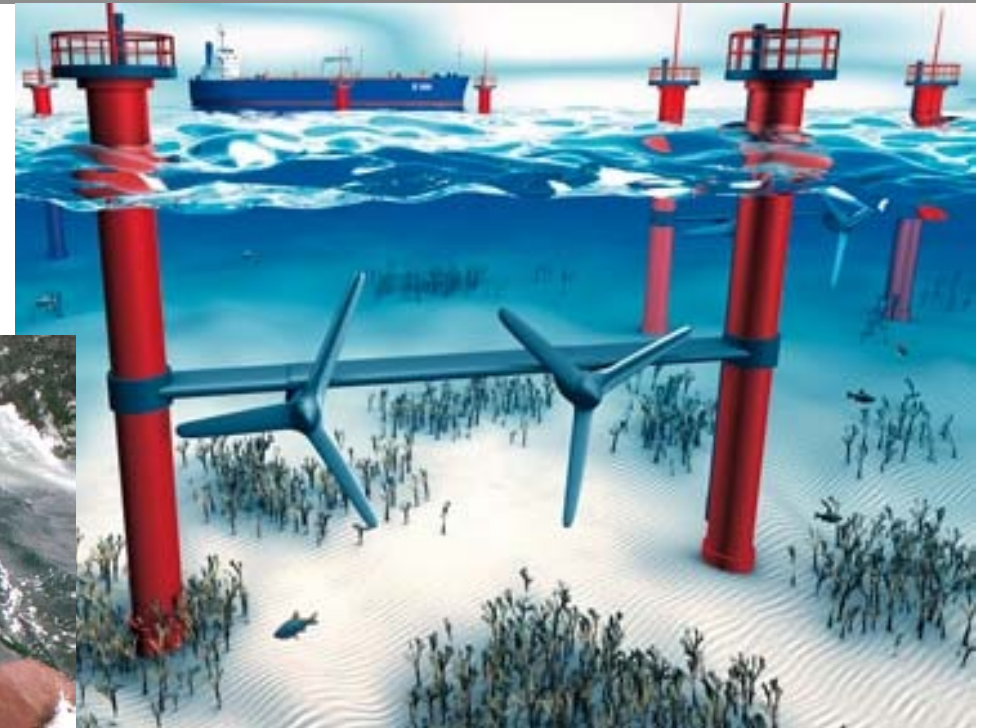


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Renewable Energy

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Power from
the sea

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Jacking

Rexroth
Bosch Group



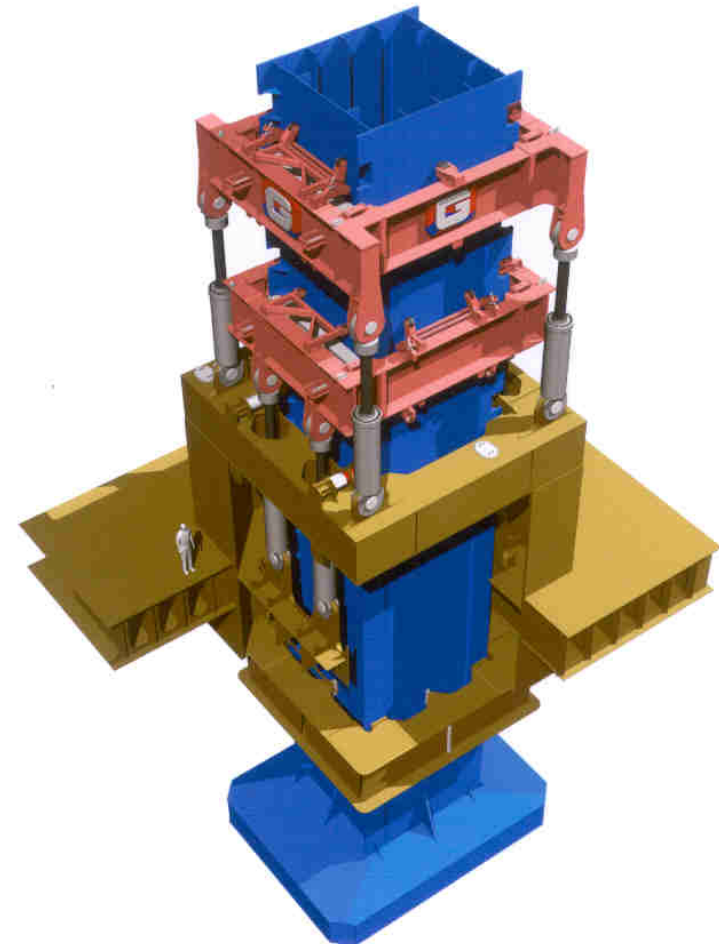
Hydraulic Jacking System

Rexroth
Bosch Group

- 2500 tons per leg
- 60 m/h



Gusto / Rexroth Hydraulic Jacking system



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- Jacking Capacity 2500 Tonnes per Leg
- Holding Capacity 5000 Tonnes per Leg
- Cylinder Speed under load 60 m/h

Riser Tensioning

Rexroth
Bosch Group



Heave compensation

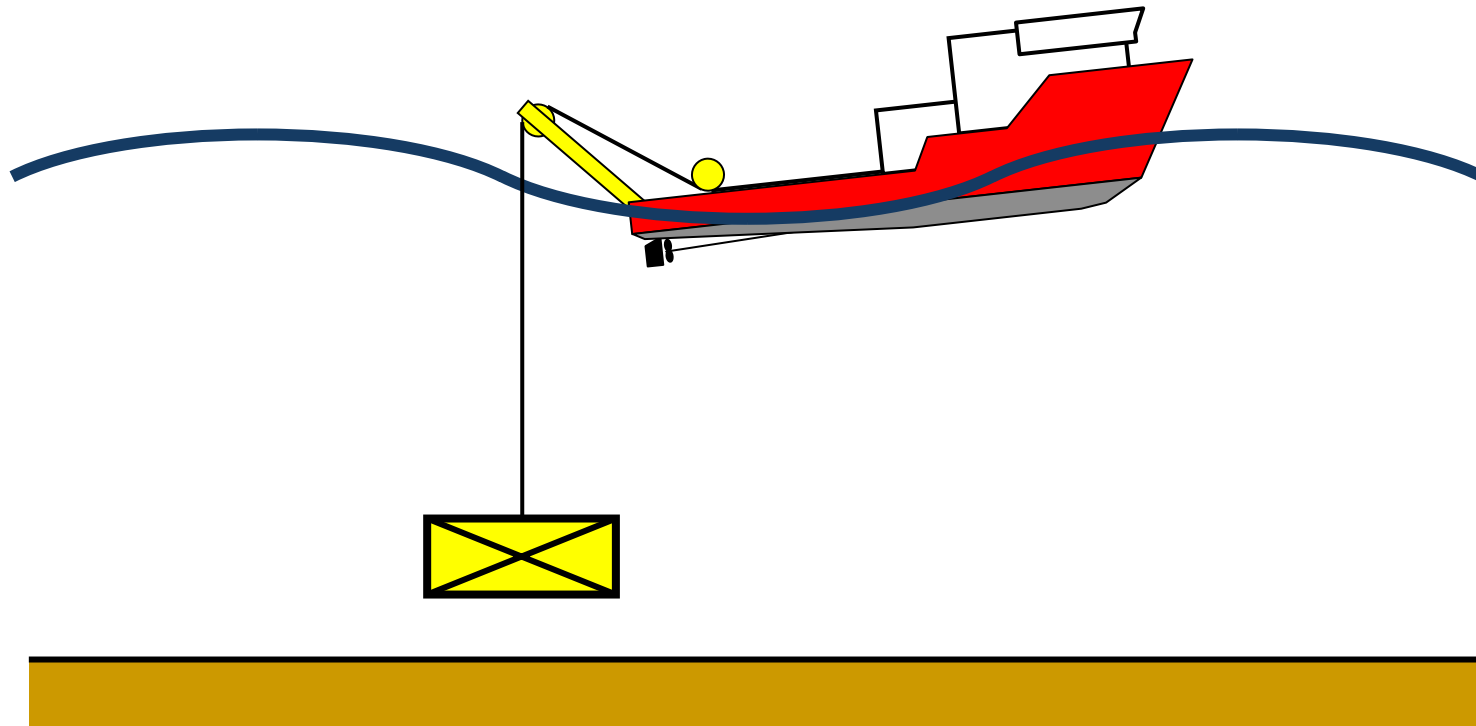
Rexroth
Bosch Group

drive



deep-sea coronate medusa

Heave Compensation - General

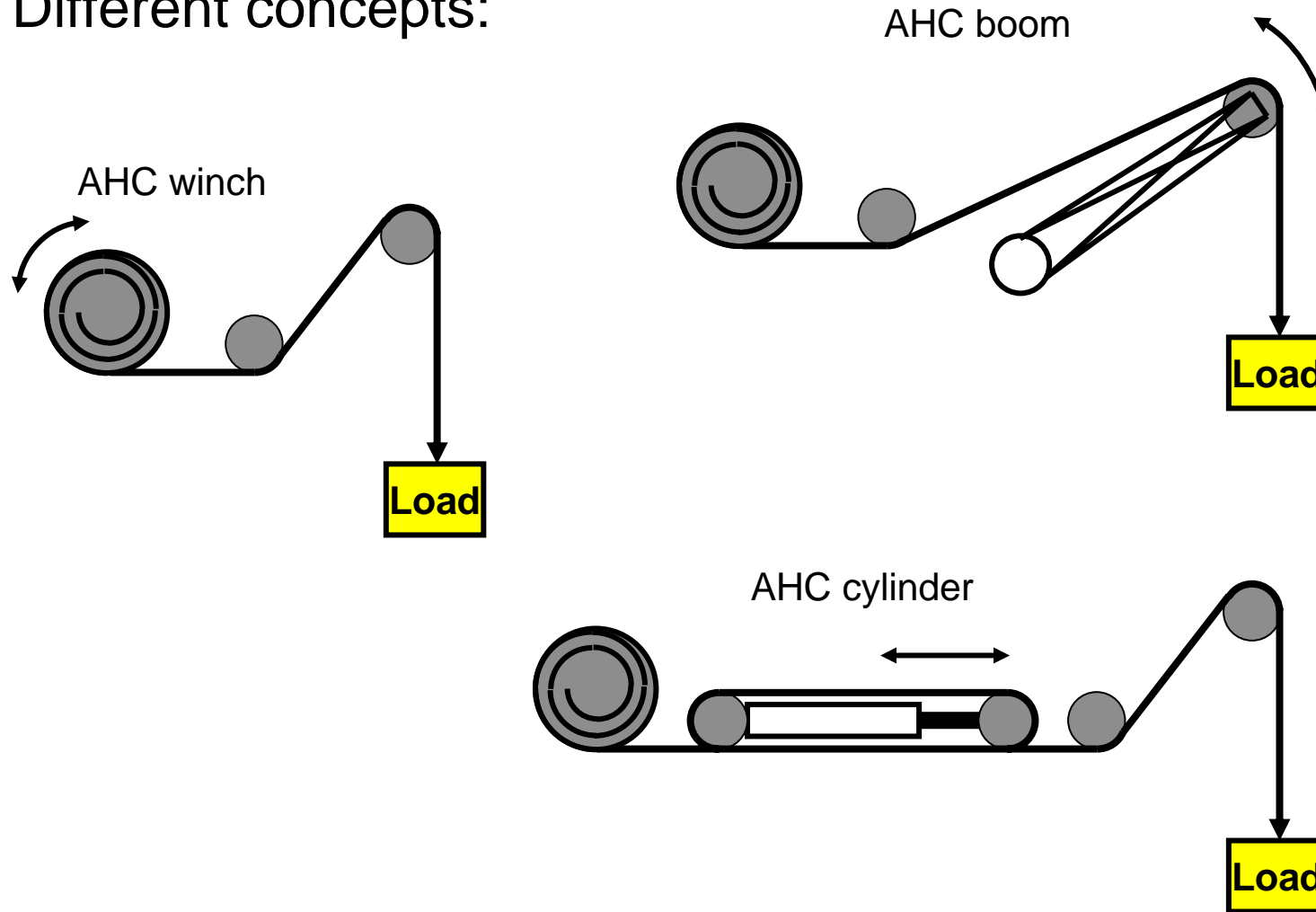


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Heave Compensation - General

Different concepts:

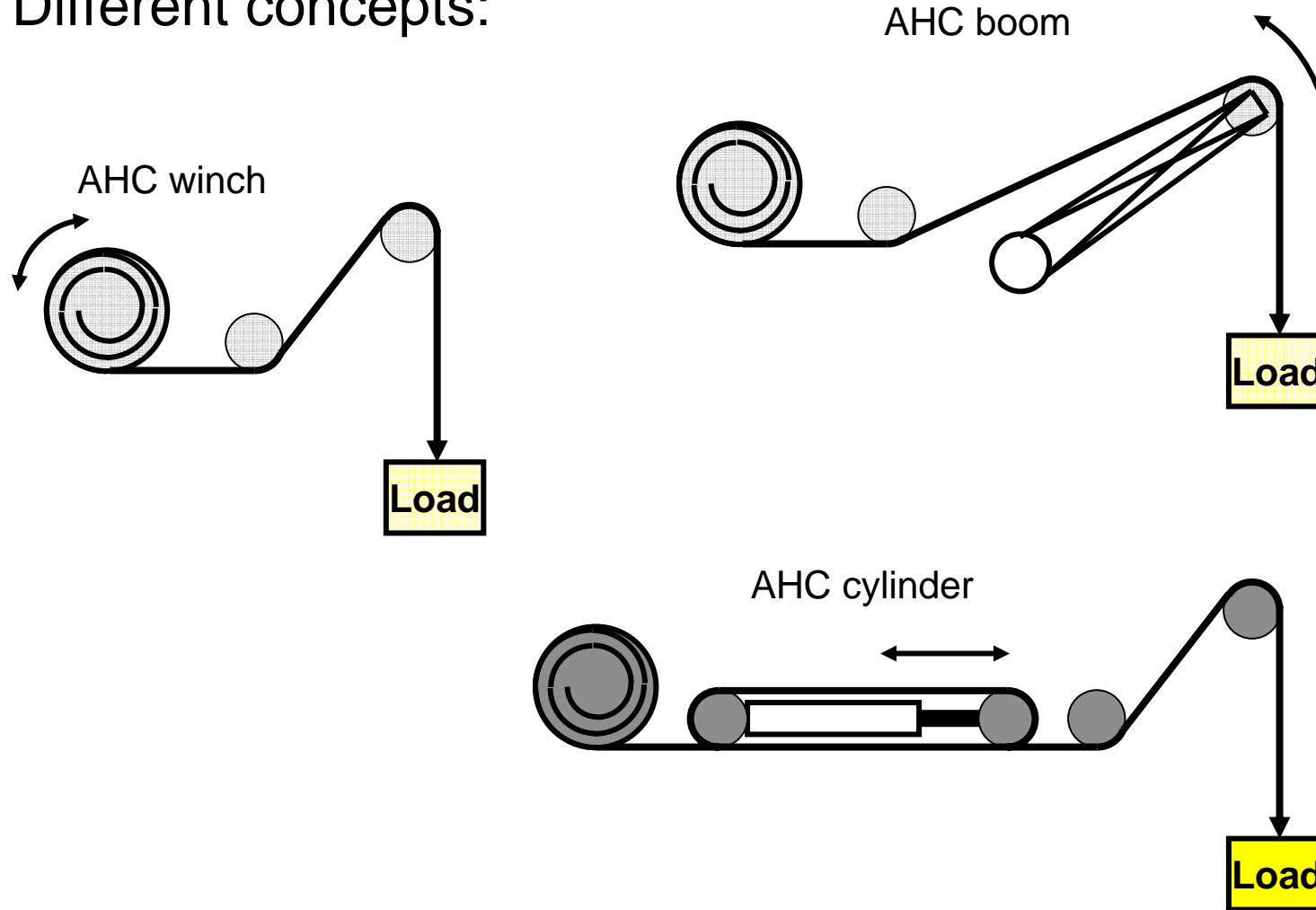


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Heave Compensation - General

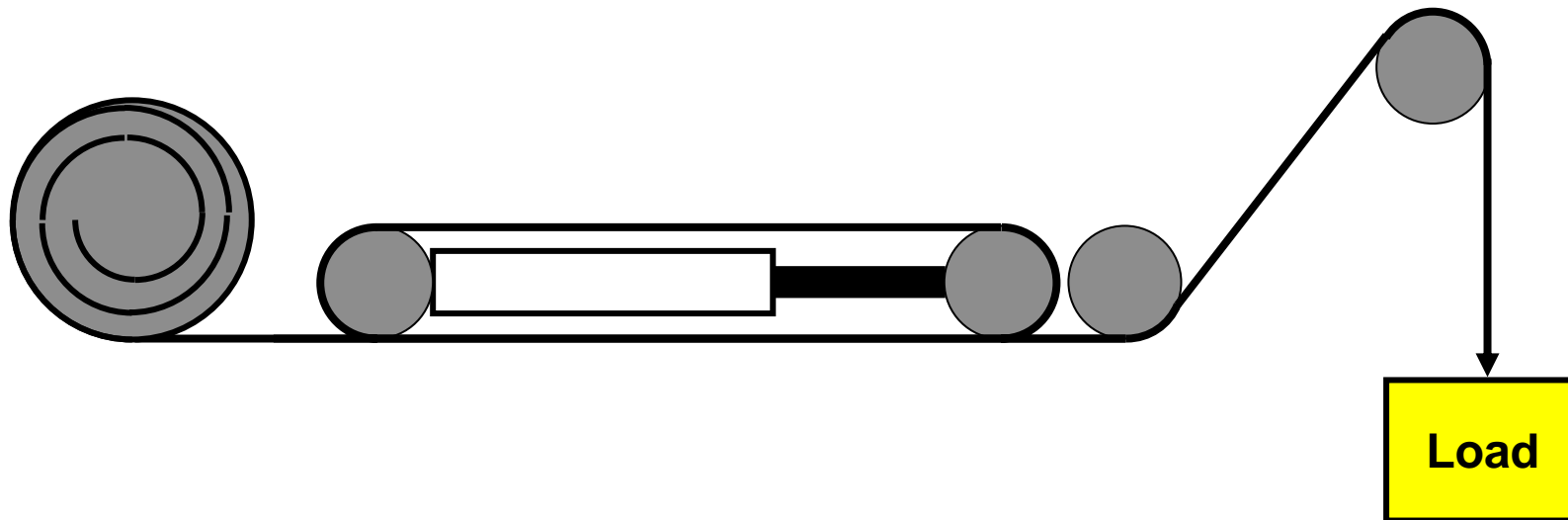
Different concepts:



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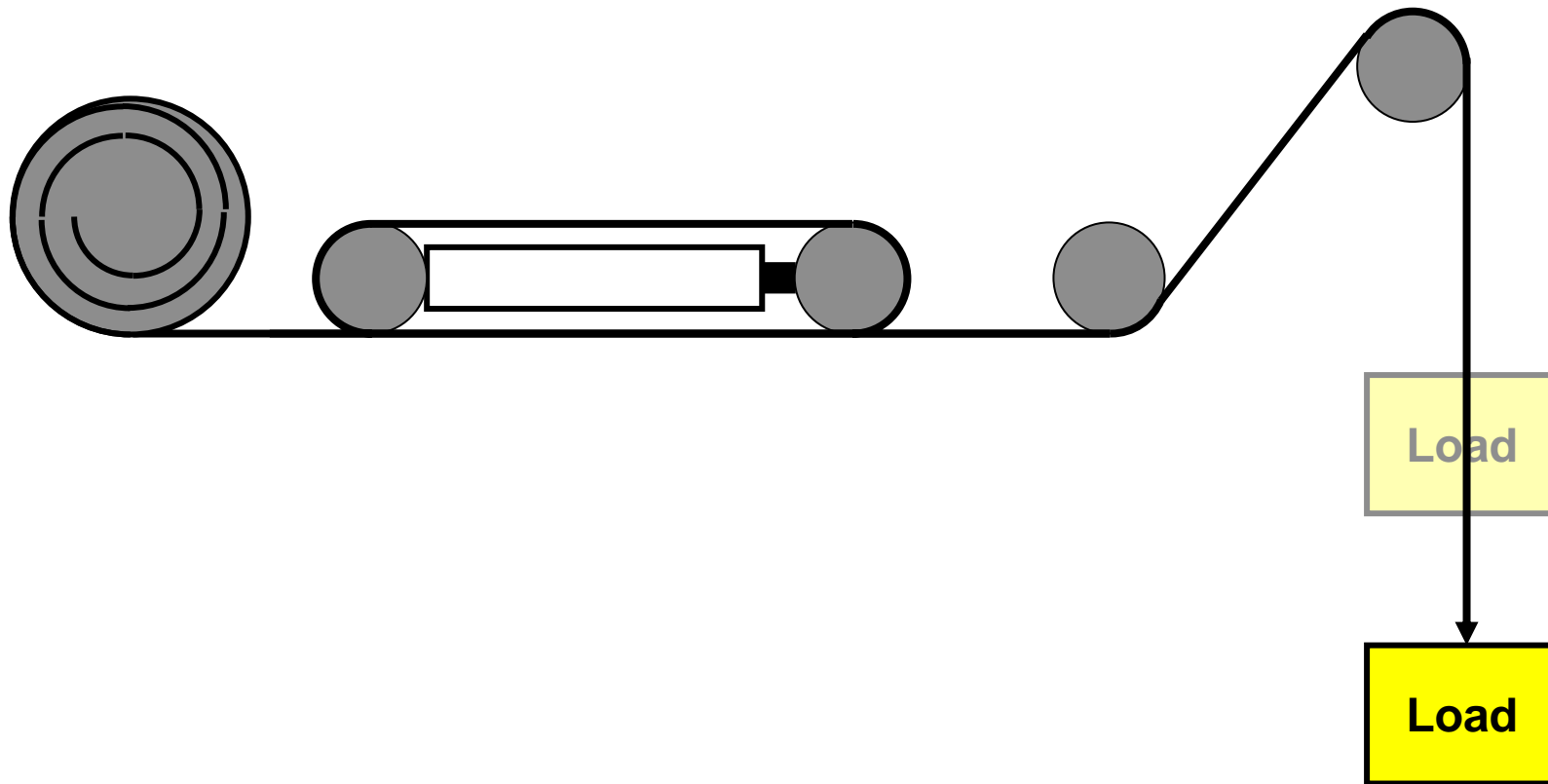
Cylinder concept



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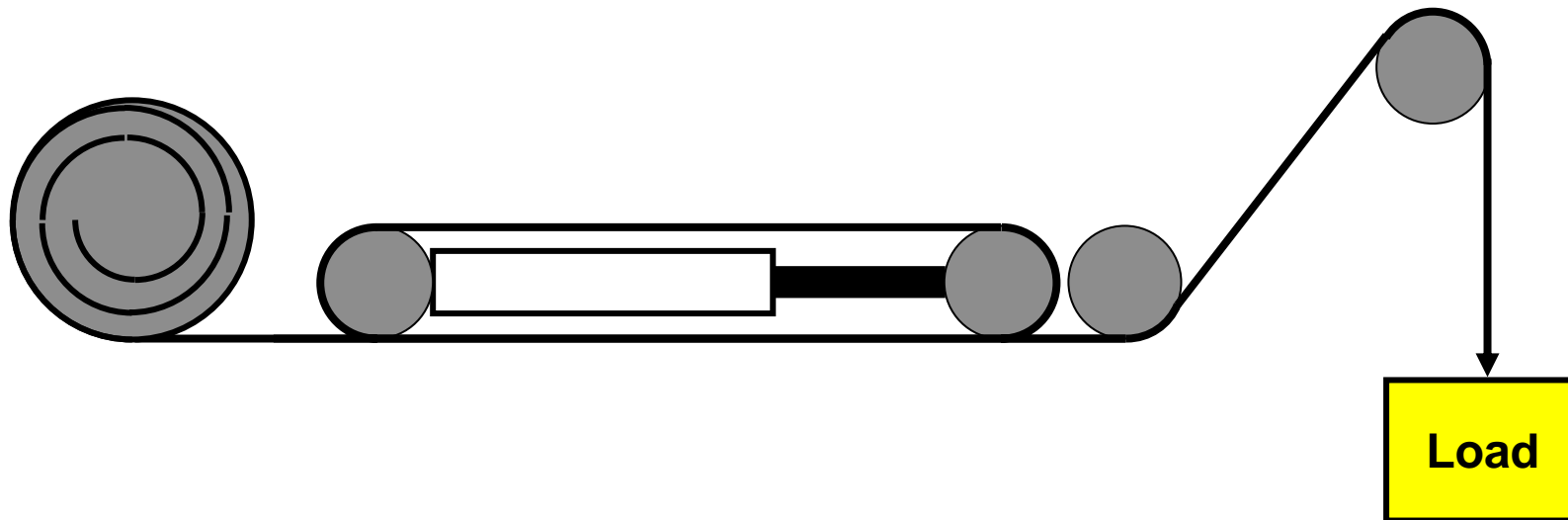
Cylinder concept



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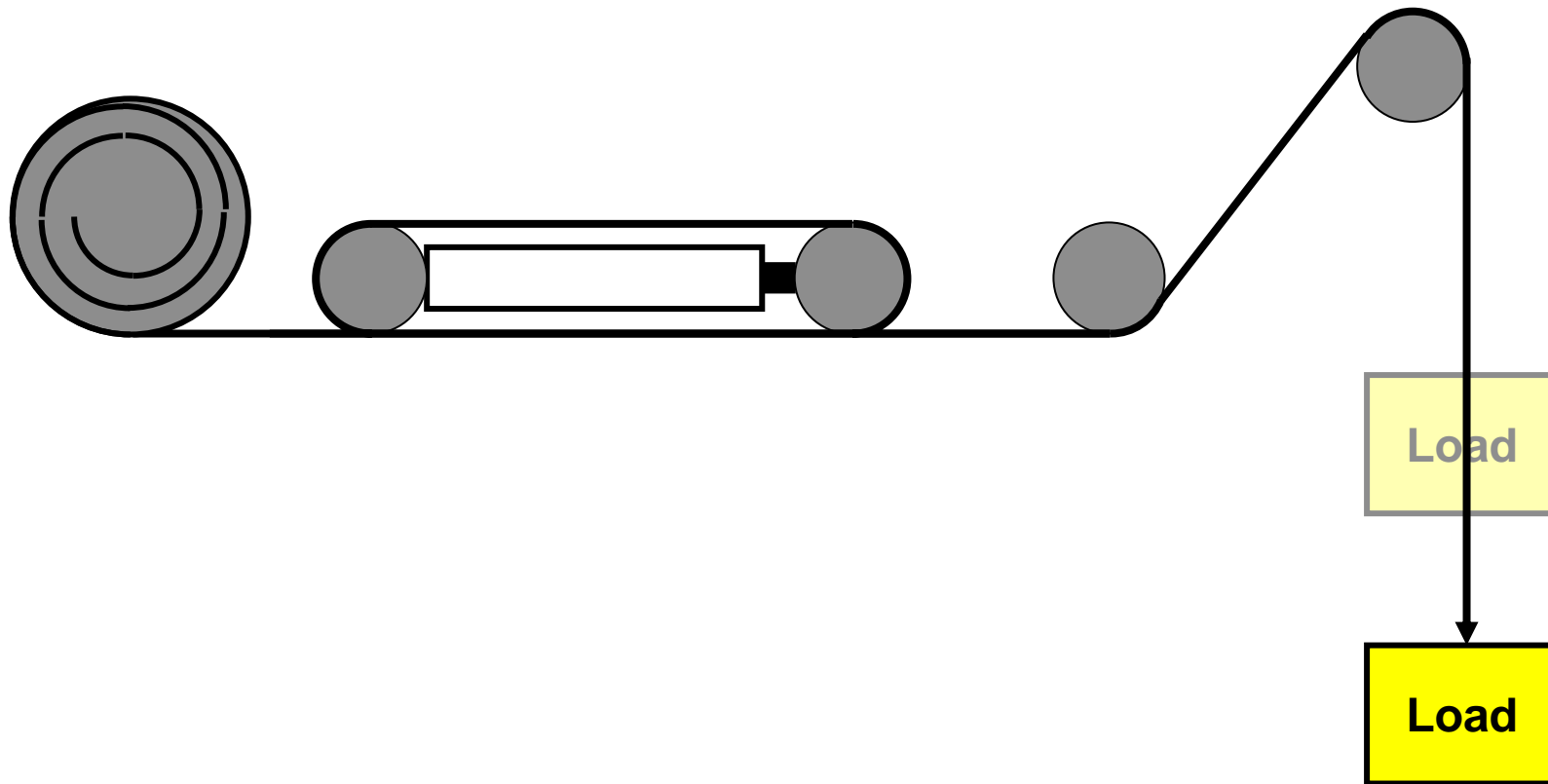
Cylinder concept



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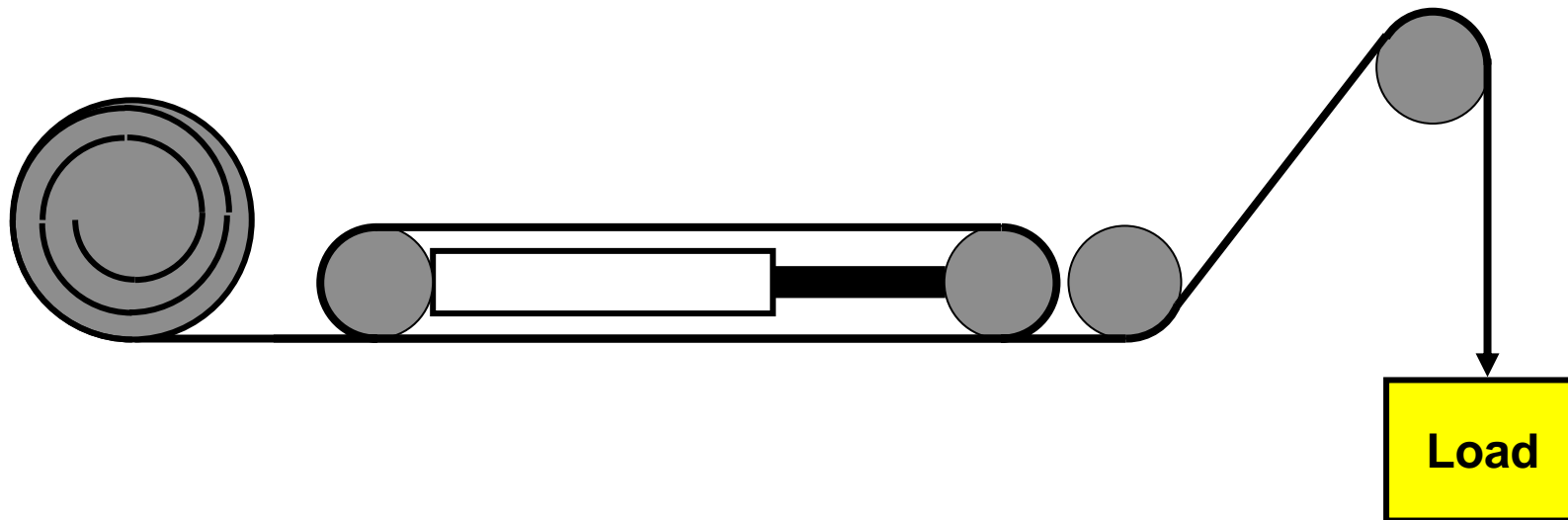
Cylinder concept



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Cylinder concept



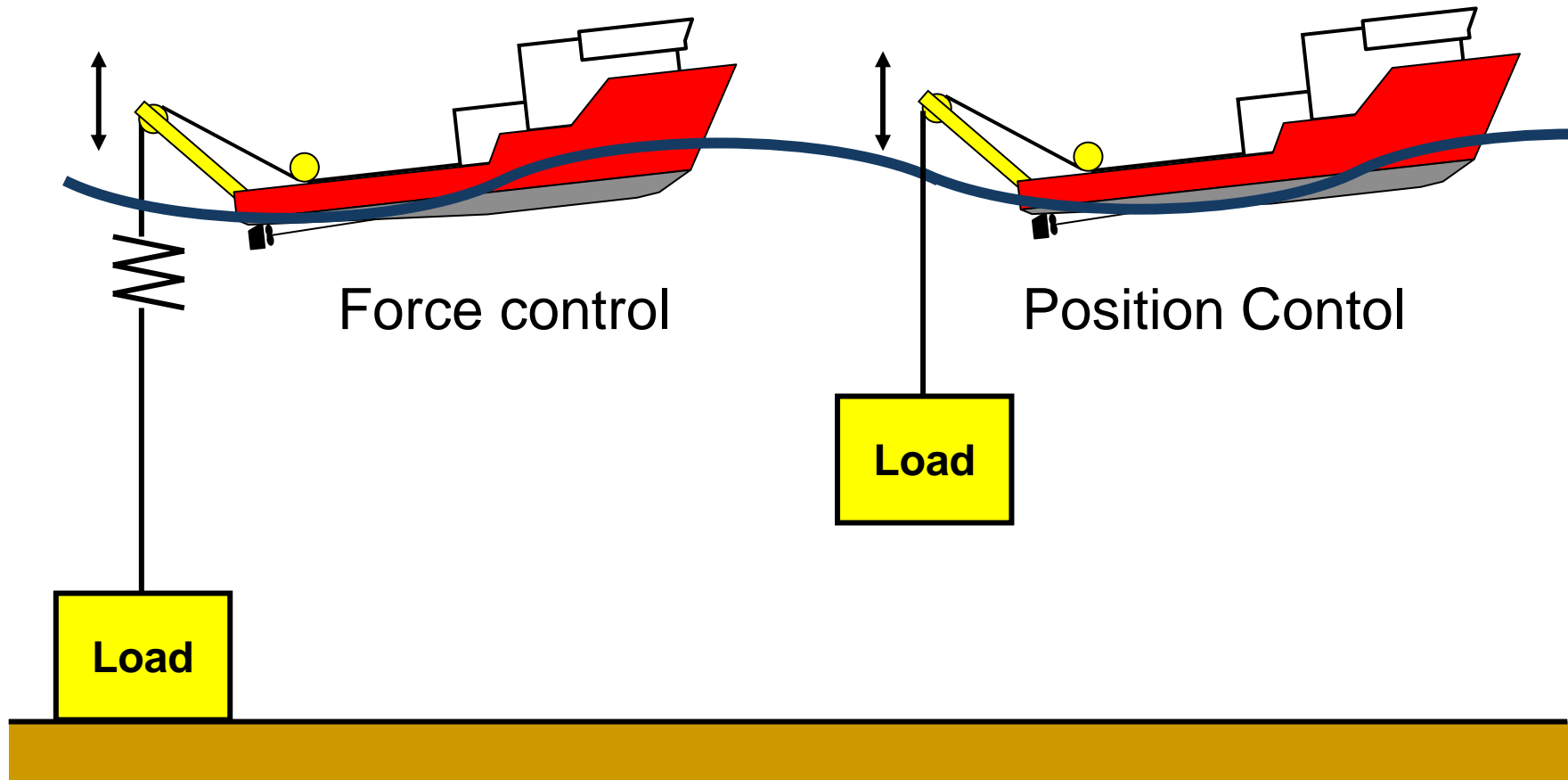
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Active HC (AHC) vs Passive HC (PHC)

Passive:

Active:

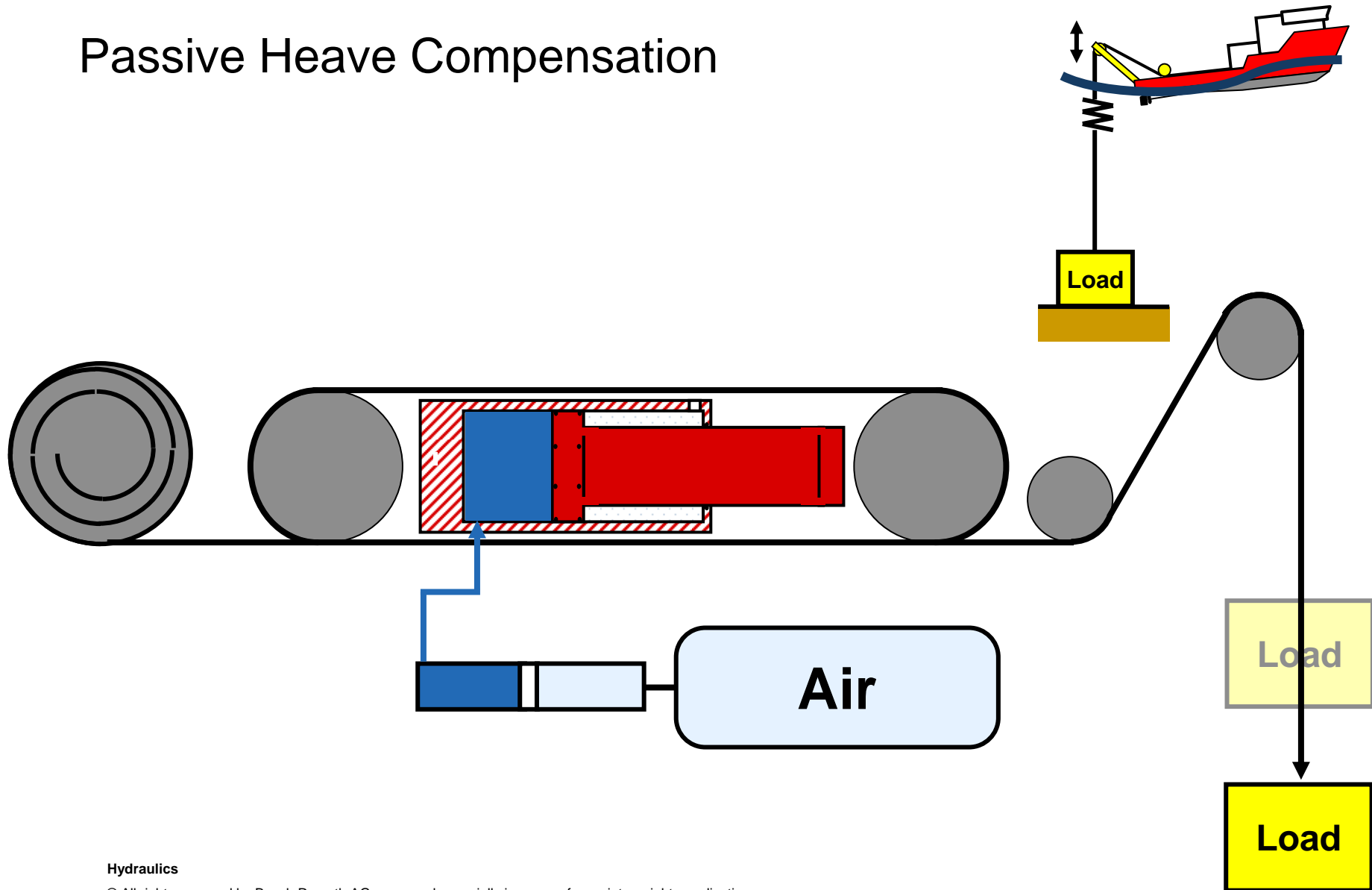


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Active HC (AHC) vs Passive HC (PHC)

Passive Heave Compensation

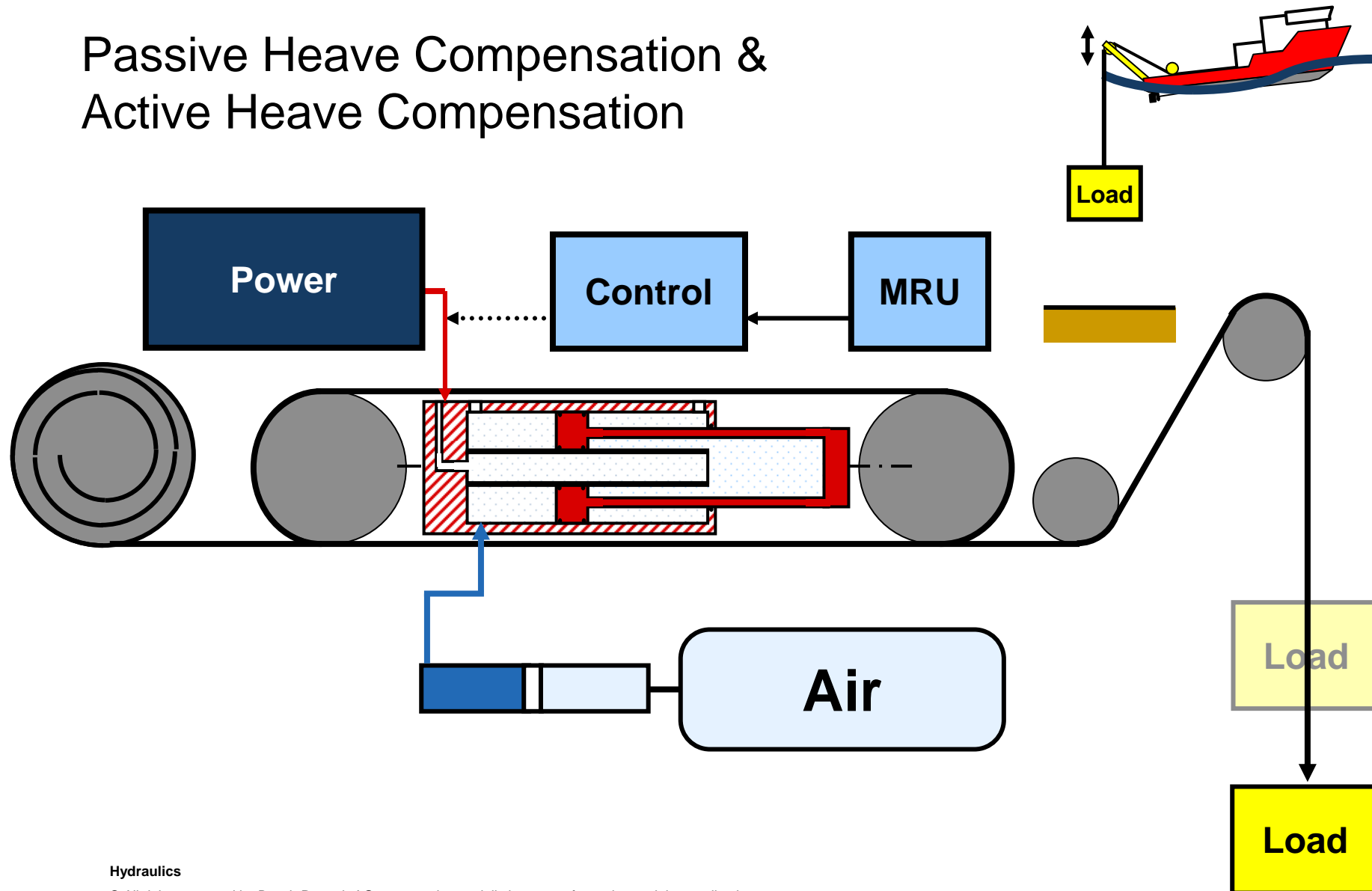


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Active HC (AHC) vs Passive HC (PHC)

Passive Heave Compensation & Active Heave Compensation



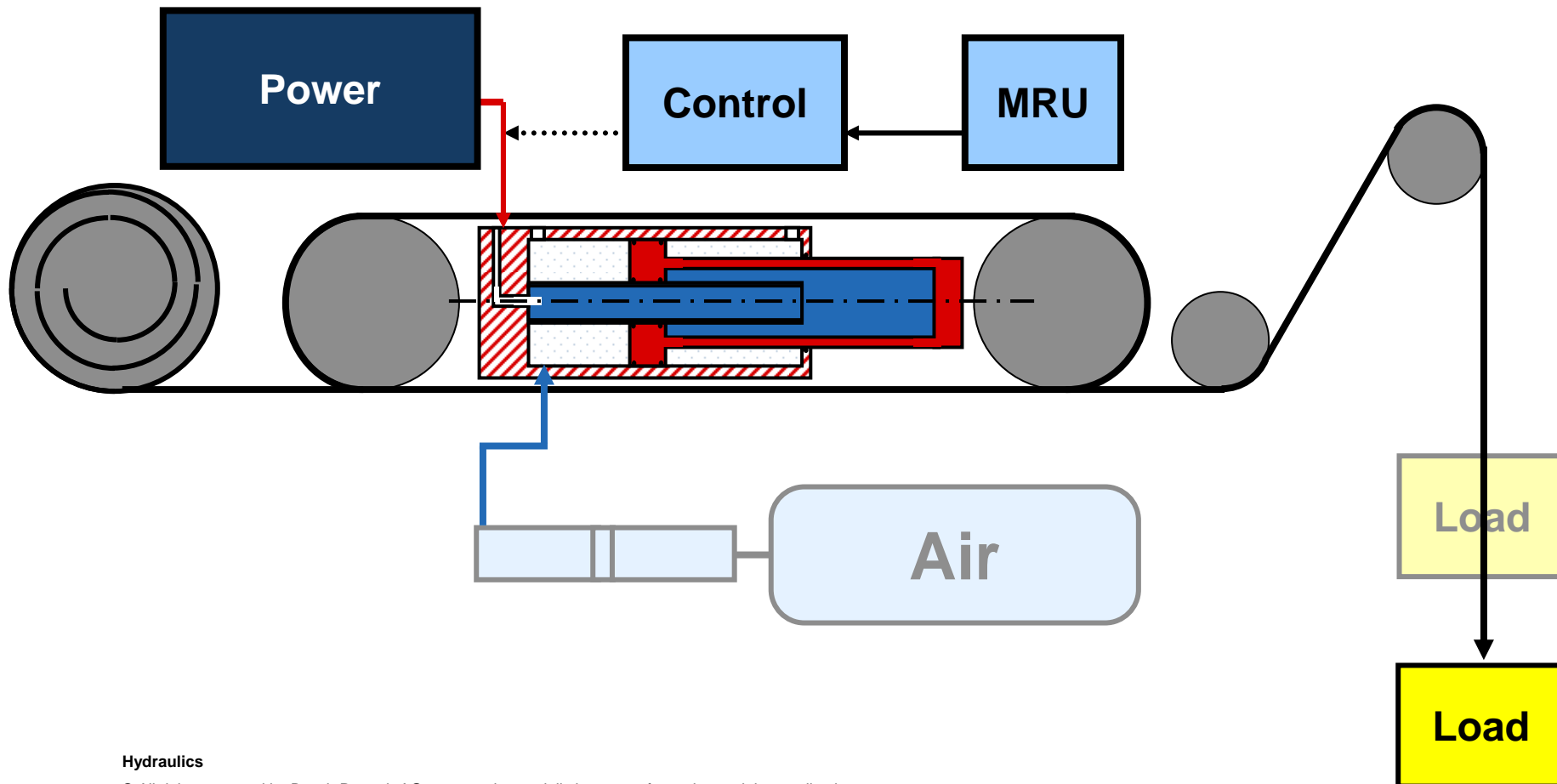
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Active HC (AHC) vs Passive HC (PHC)

Passive Heave Compensation & Active Heave Compensation

Active part I



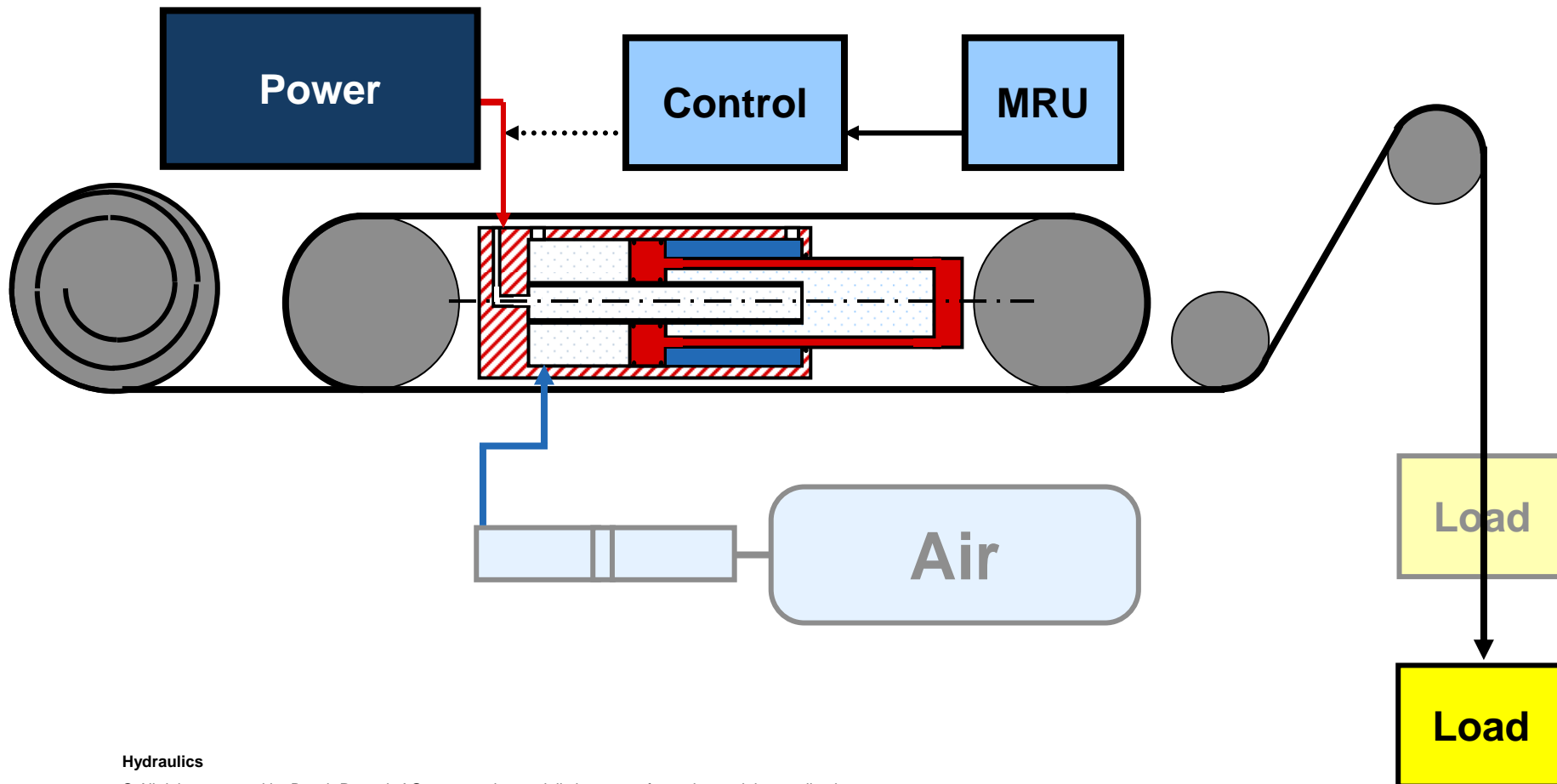
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Active HC (AHC) vs Passive HC (PHC)

Passive Heave Compensation & Active Heave Compensation

Active part II



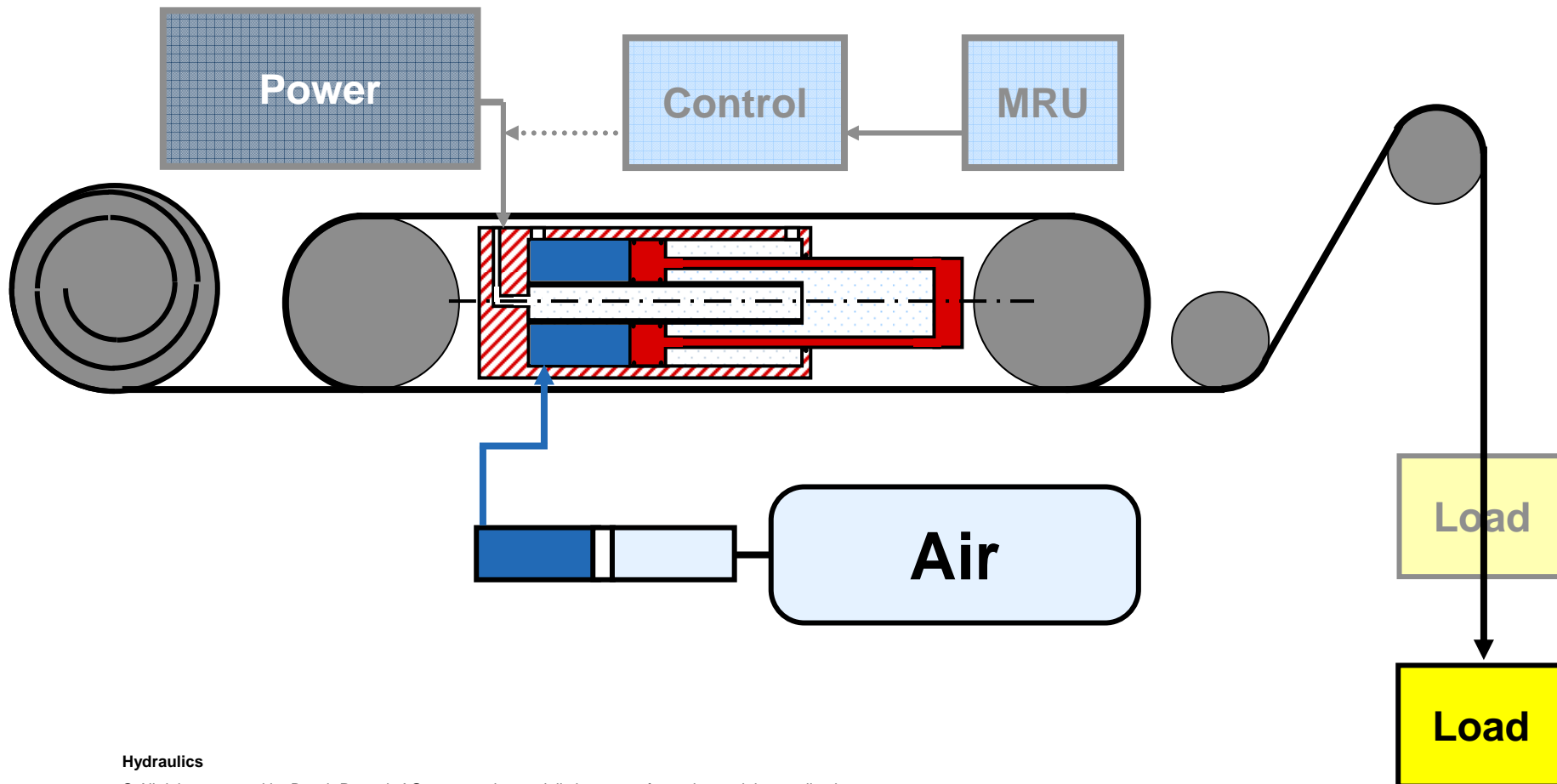
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Active HC (AHC) vs Passive HC (PHC)

Passive Heave Compensation & Active Heave Compensation

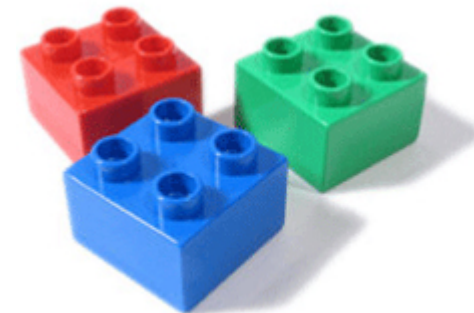
Passive part



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- Active tension control for Heave Compensators
- Draghead Heave Compensation for Dredge



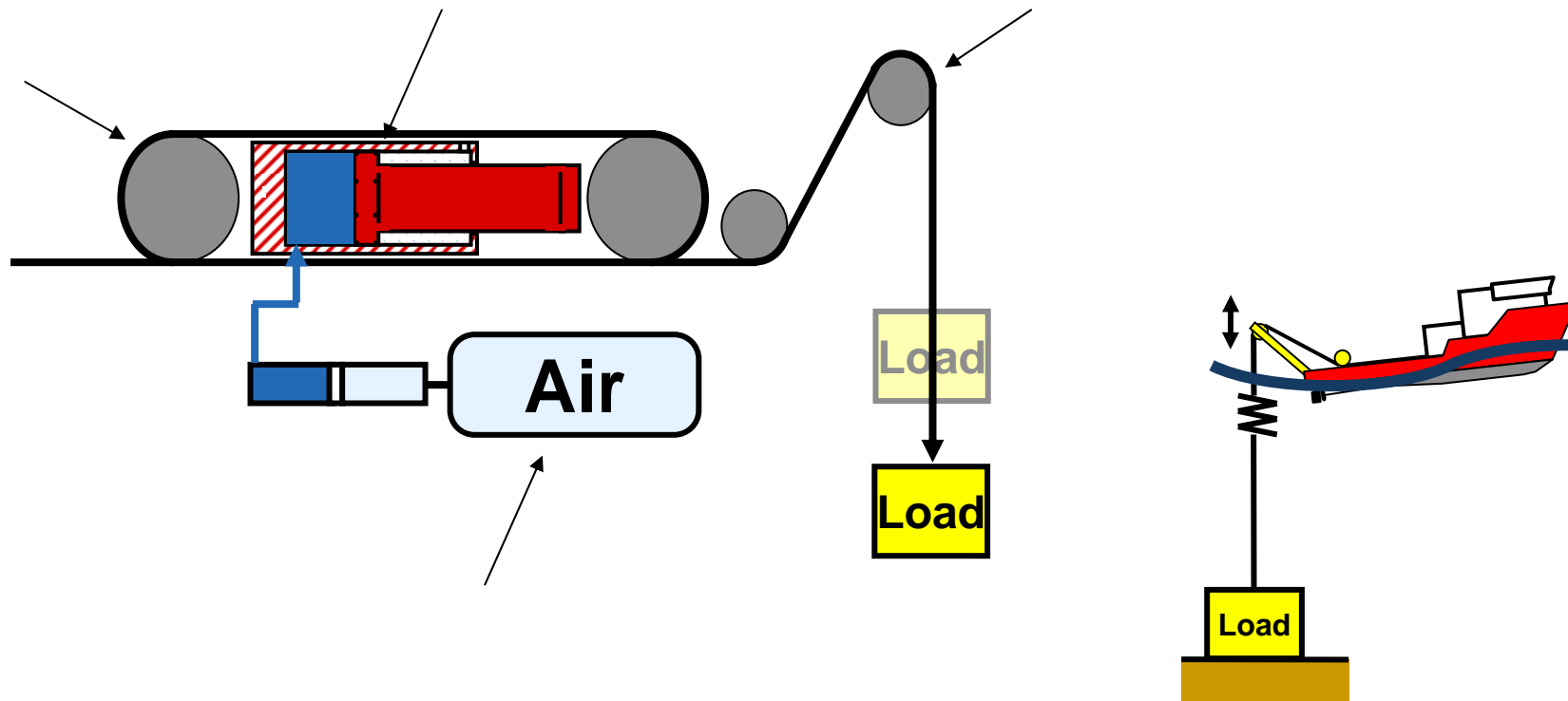
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Active Tension Control (ATC)

Why Active Tension Control?

- Pressure variation, inertia and Friction give load variation in Passive Heave Compensation
- More accuracy in tension control required



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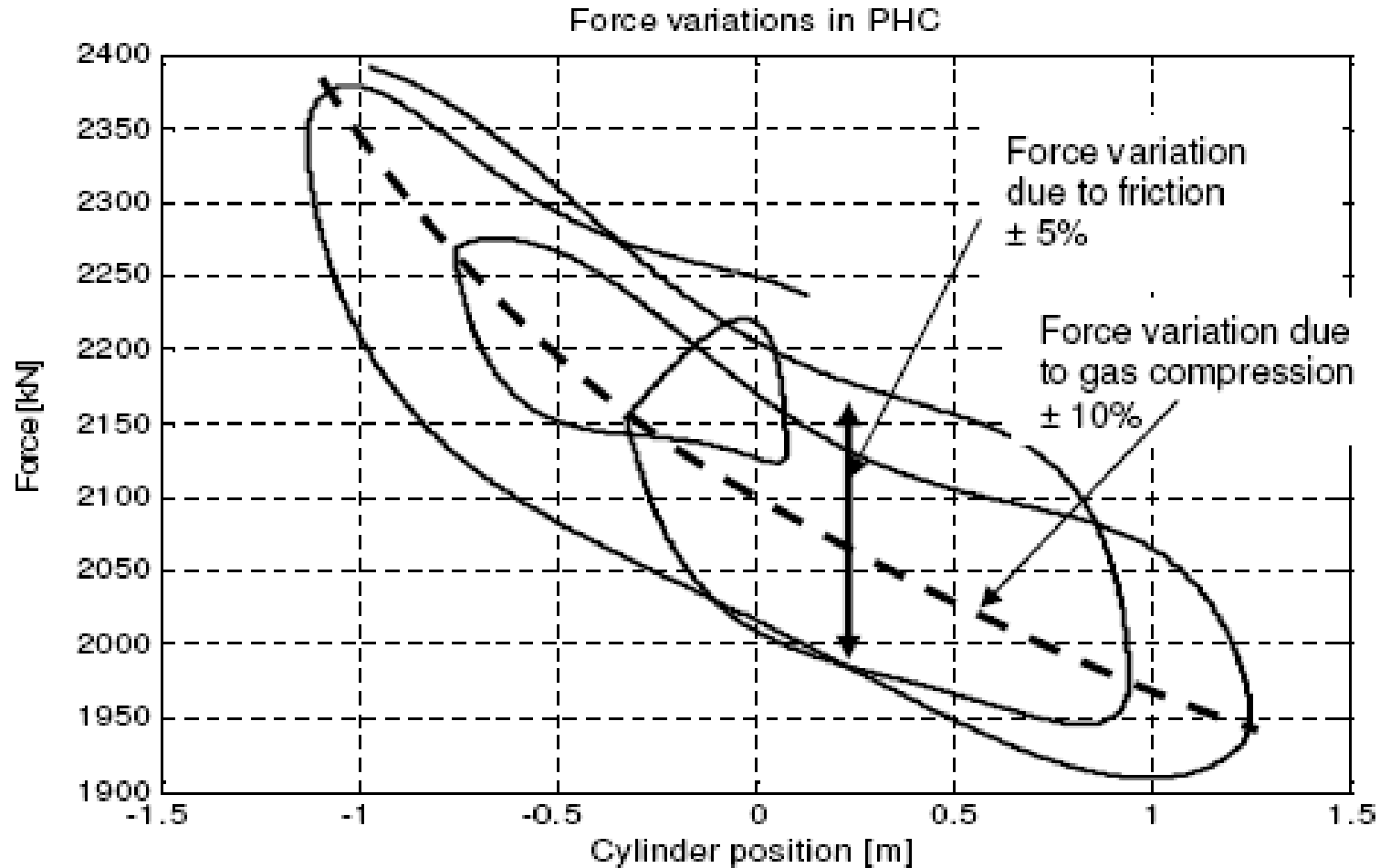


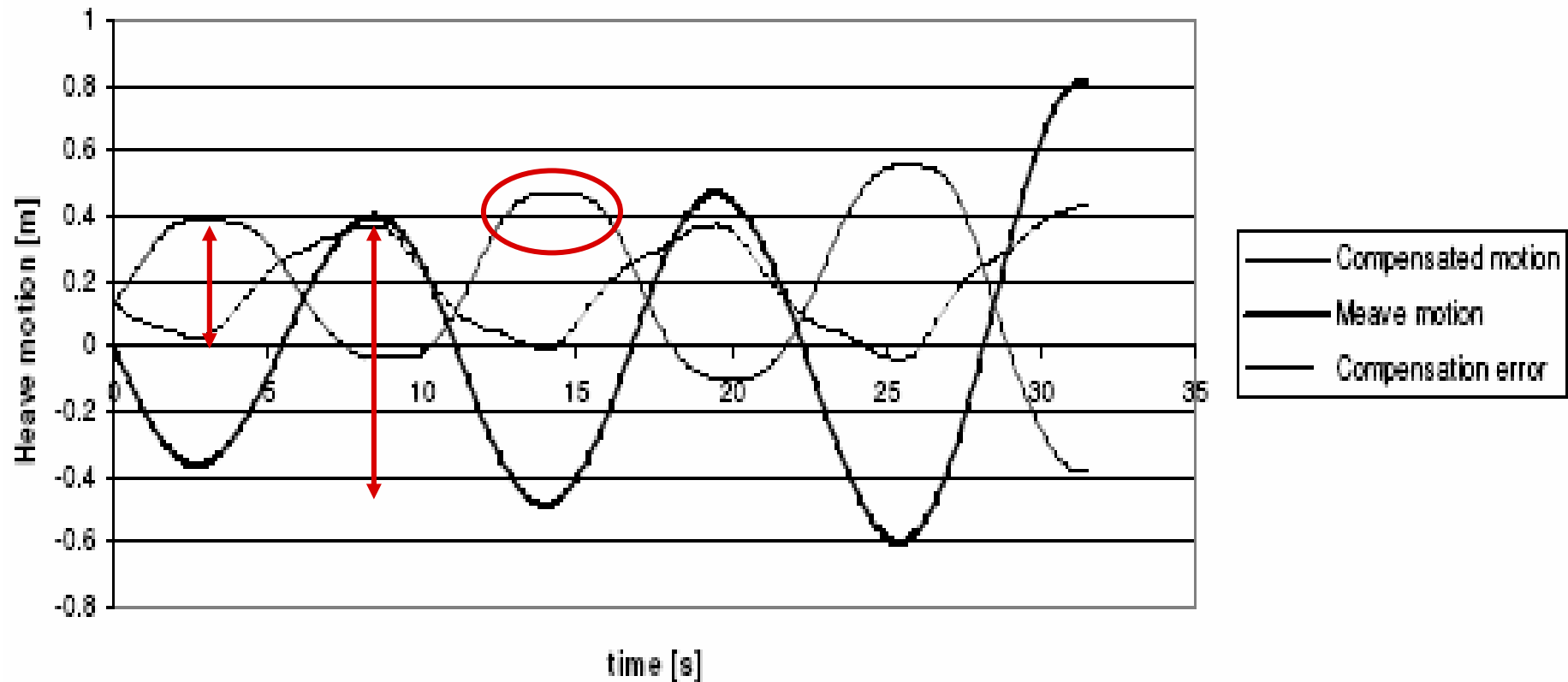
Fig 2: Force variations in PHC

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Measurements on Saipem 3000

PHC motion (200T load on seabed)



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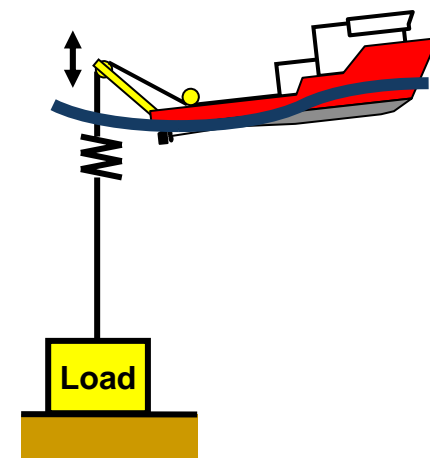
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Why Active Tension Control?

- Pressure variation, Inertia and Friction give load variation in Passive Heave Compensation
- More accuracy in tension control required
- Transition between AHC to PHC requires bypassing of AHC cylinder part
transition between AHC and ATC only requires control parameters to change.

So:

- Active force control instead of passive compensation.



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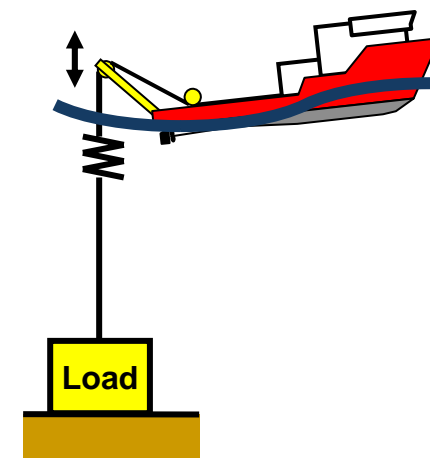
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Why Active Tension Control?

- Pressure variation and Friction give load variation in Passive Heave Compensation
- More accuracy in tension control required
- Transition between AHC to PHC requires bypassing of AHC cylinder part
- Transition between AHC and ATC only requires control parameters to change.

Challenges

- Force control is sensitive to disturbances



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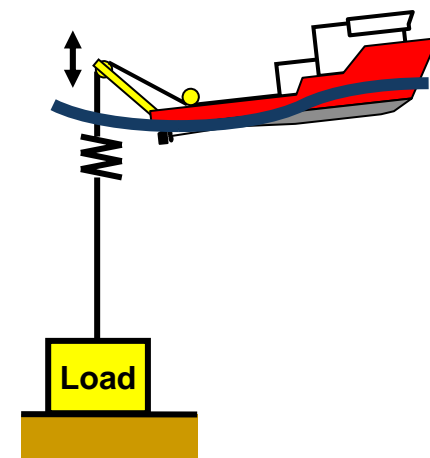
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Why Active Tension Control?

- Pressure variation and Friction give load variation in Passive Heave Compensation
- More accuracy in tension control required
- Transition between AHC to PHC requires abrupt bypassing of AHC cylinder part
- Transition between AHC and ATC only requires control parameters to change.

Challenges

- Force control is sensitive to disturbances
- Use MRU data Force Control

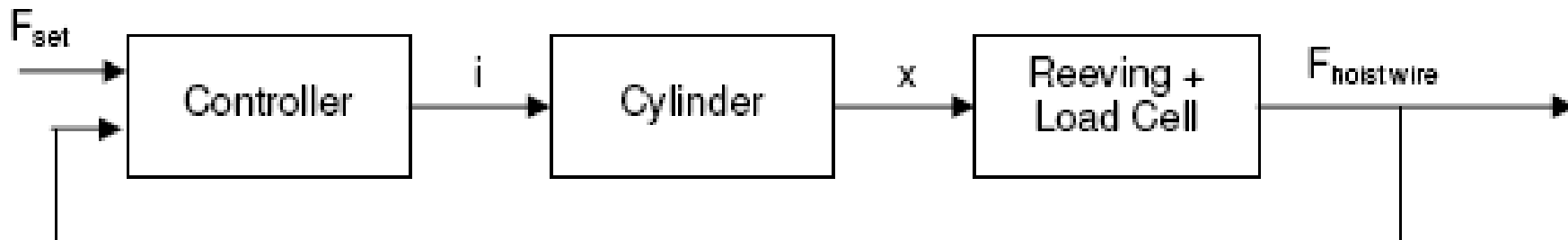


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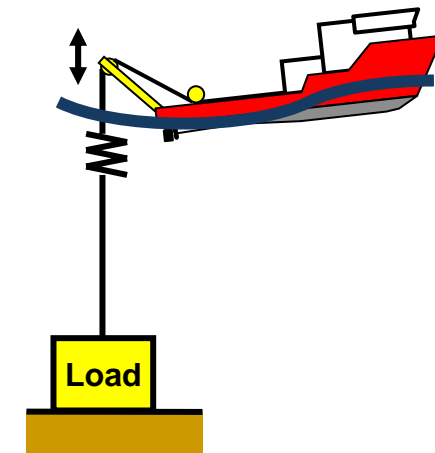
Direct Force control

- Uses a load cell at the fairleader
- Tests onboard Saipem 3000, show control loop can be sensitive to disturbances and is not very robust.



However!

Tests onboard Saipem 3000,
show AHC performance is very accurate...

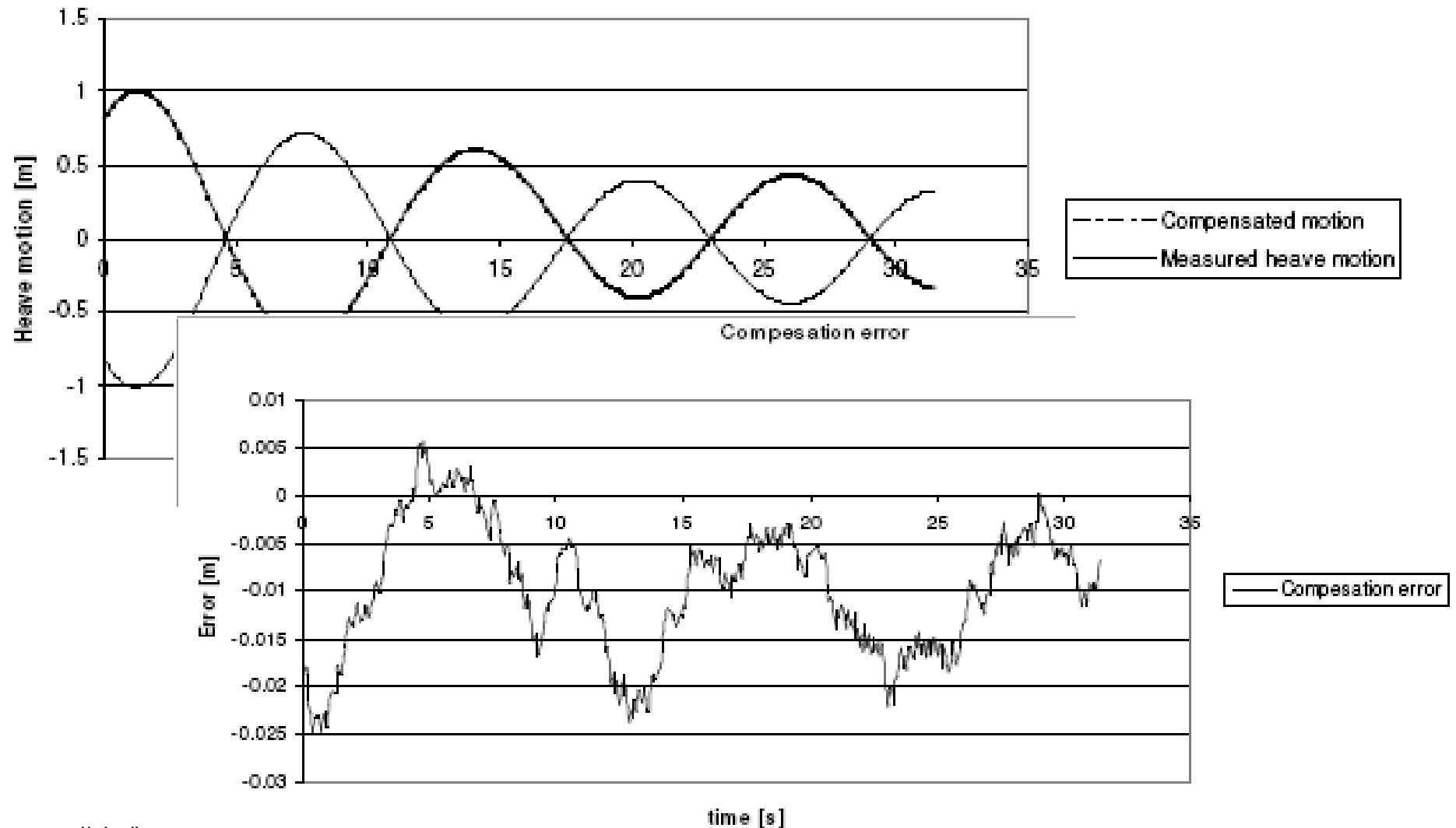


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Measurements on Saipem 3000

AHC motion



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Current development

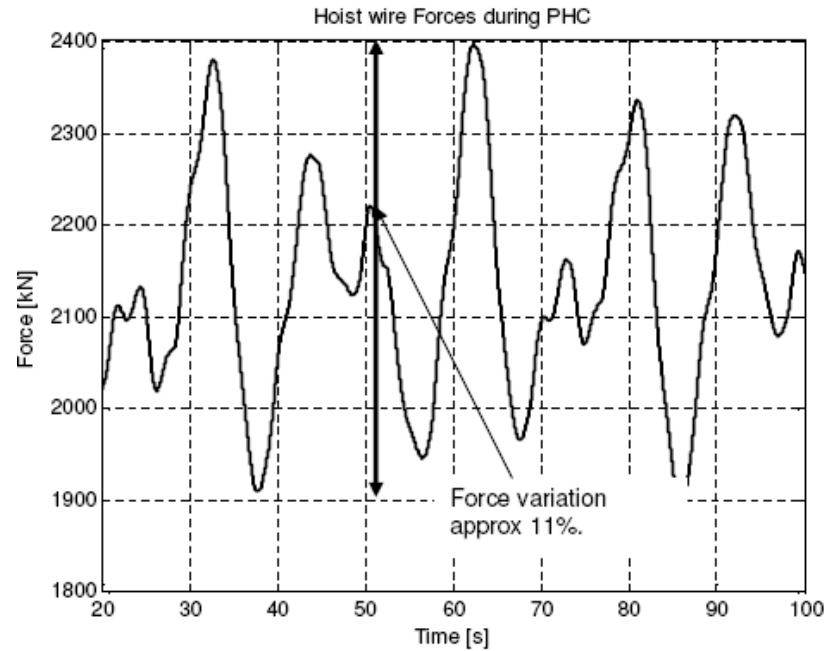
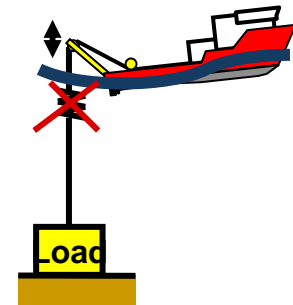
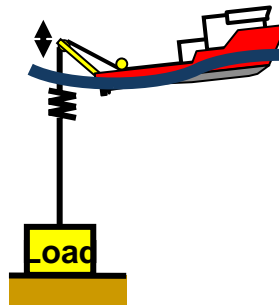


Fig 13: Force variation in PHC

Passive HC

11% force variation



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Current development

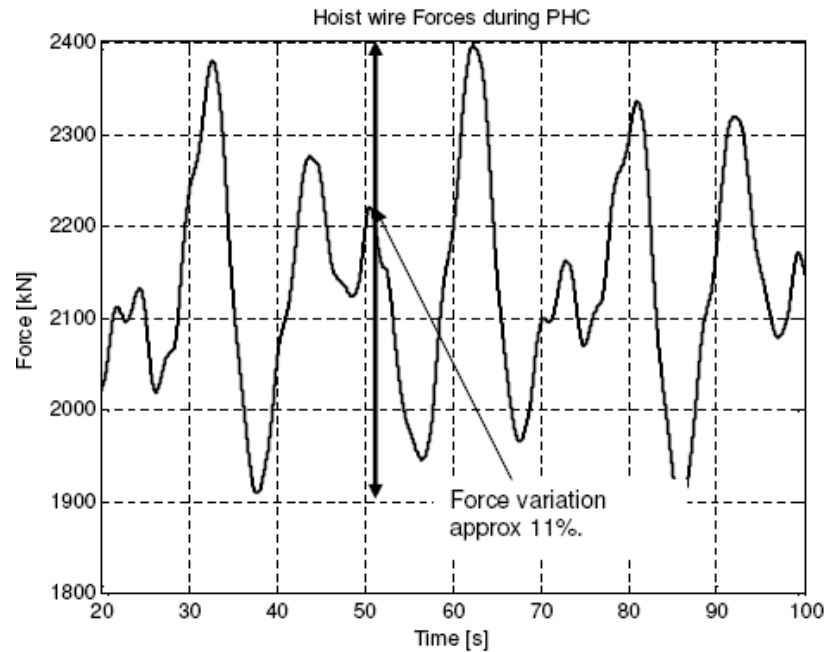


Fig 13: Force variation in PHC

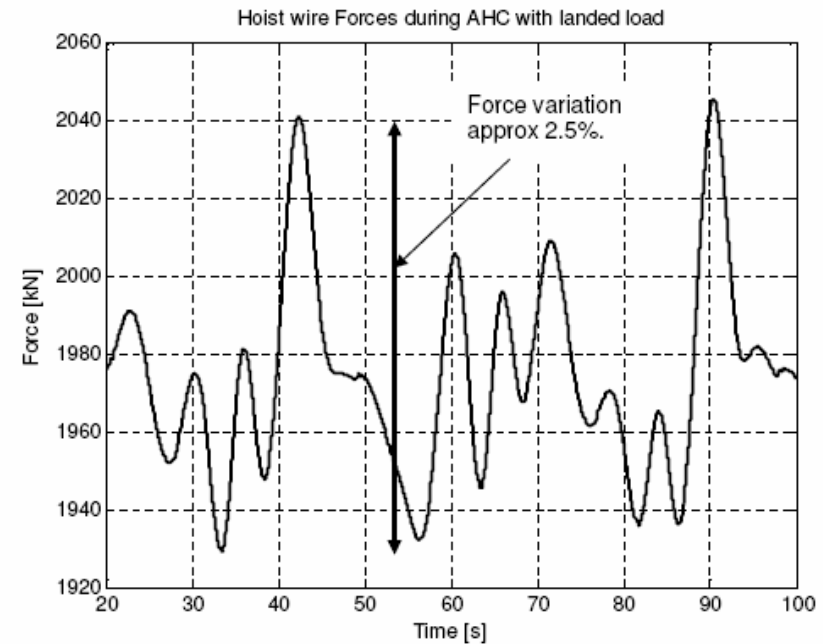
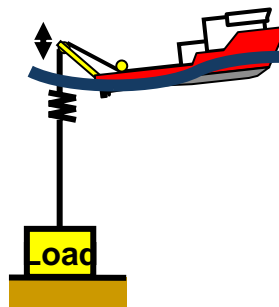


Fig 12: Force variation in AHC

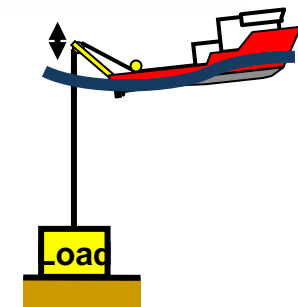
Passive HC

11% force variation



Active HC

2.5% force variation

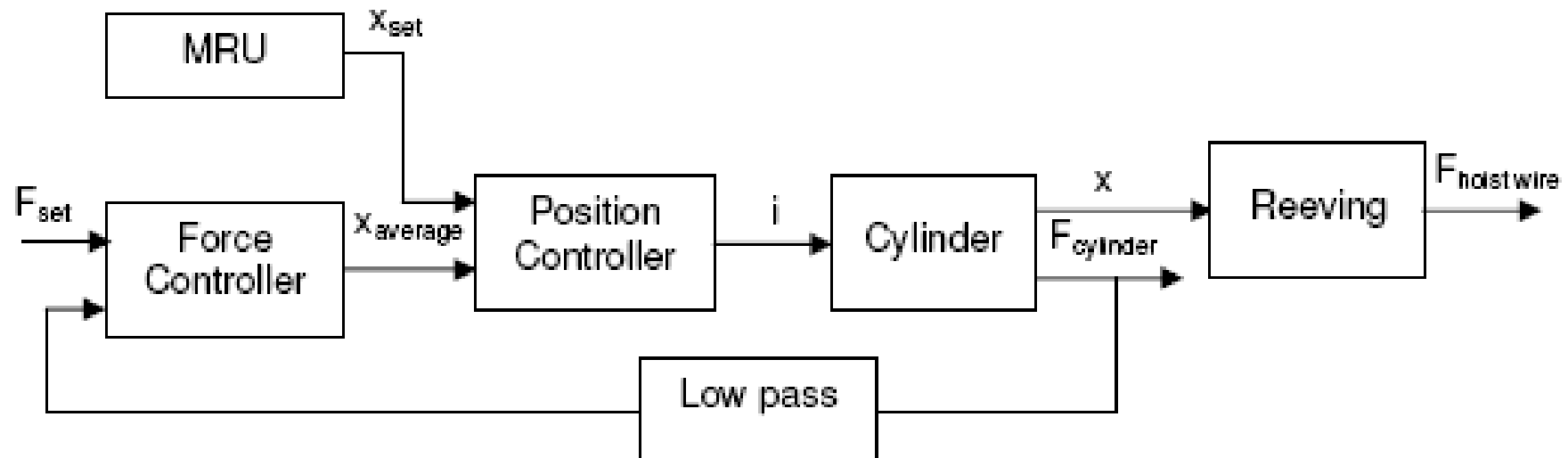


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Cascade control

- Much less sensitive, more robust
- Also uses MRU data



hydraulics

Cascade control

- Much less sensitive, more robust
- Also uses MRU data

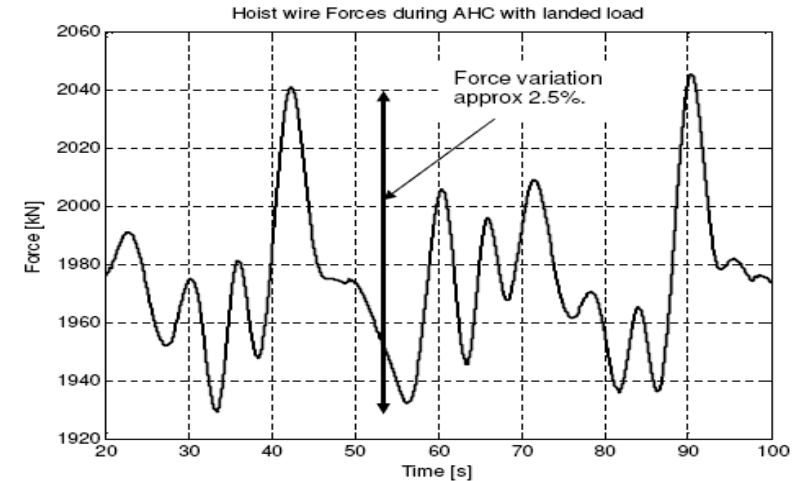
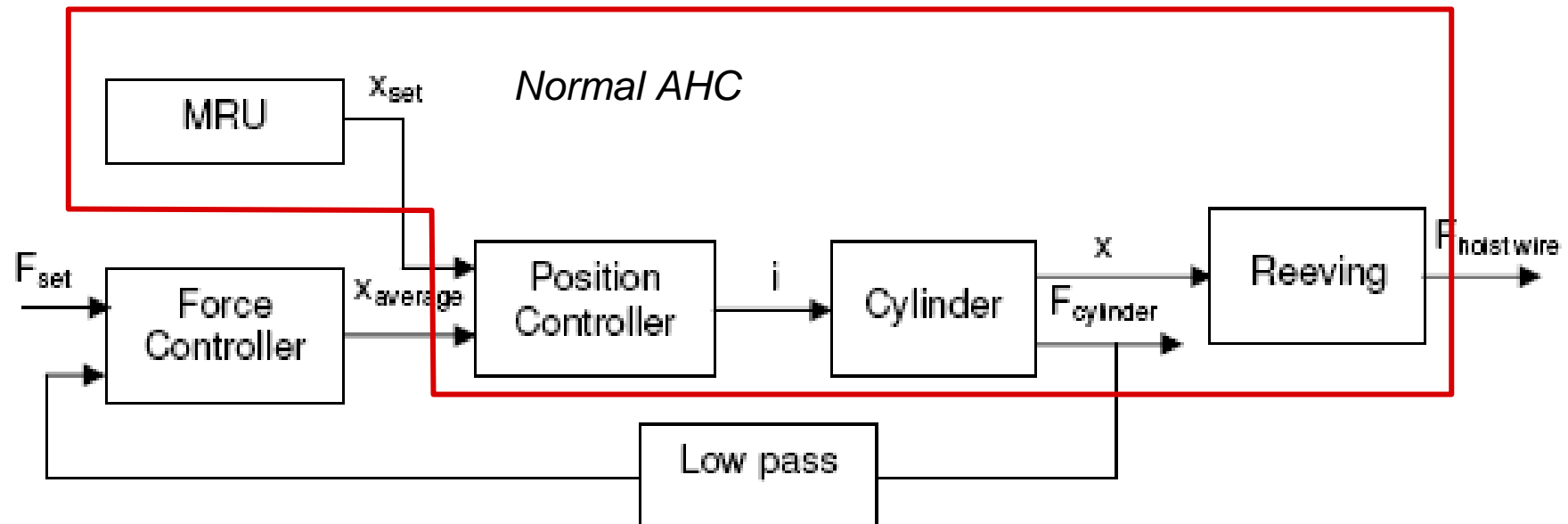


Fig 12: Force variation in AHC



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Cascade control

- Much less sensitive, more robust
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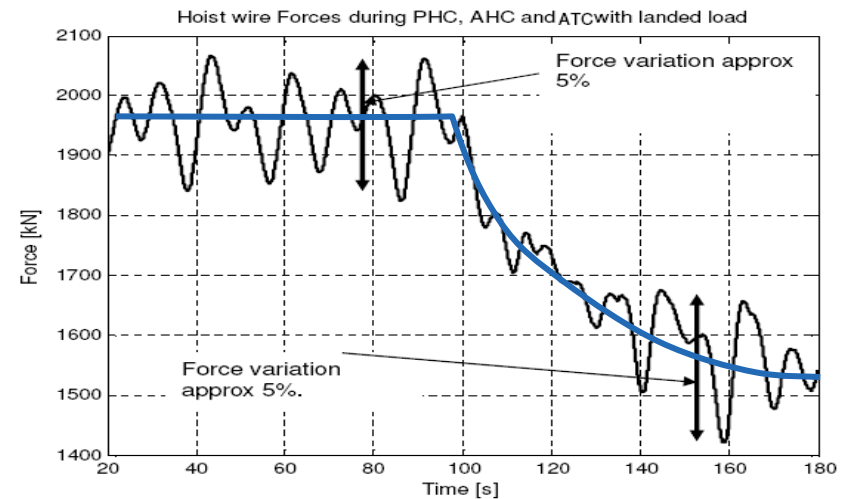
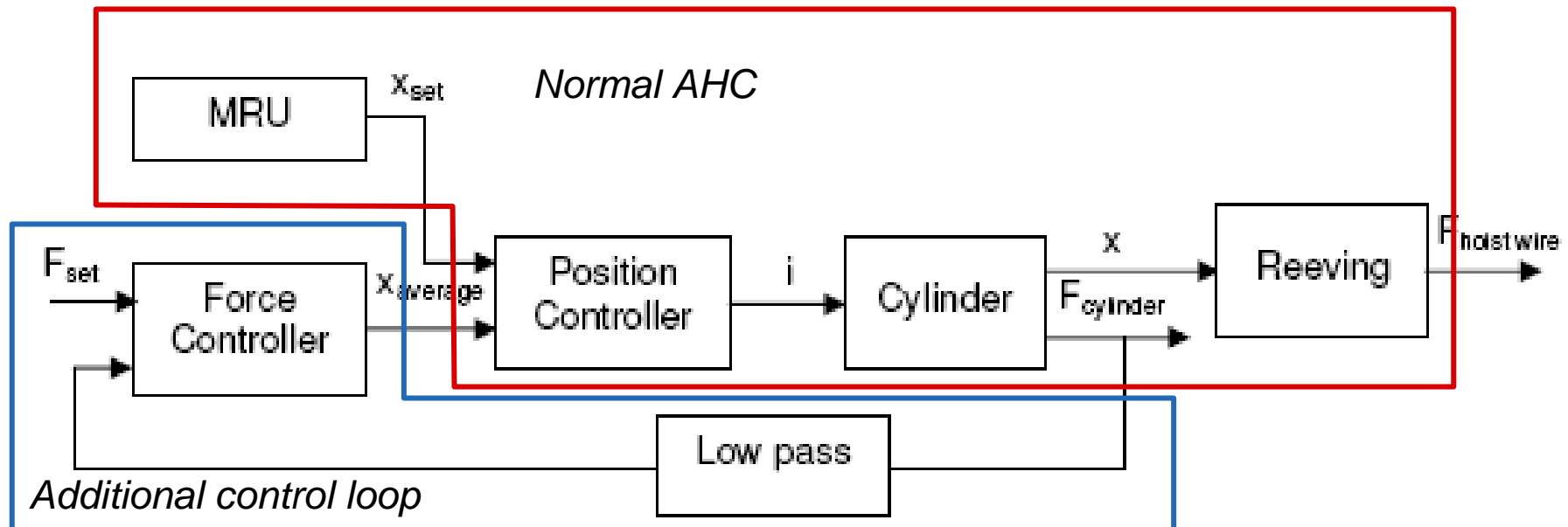


Fig 15: Force variation in combined AHC and ATC control



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Heave compensators in Dredge Technology

Rexroth
Bosch Group



Draghead control

Rexroth
Bosch Group

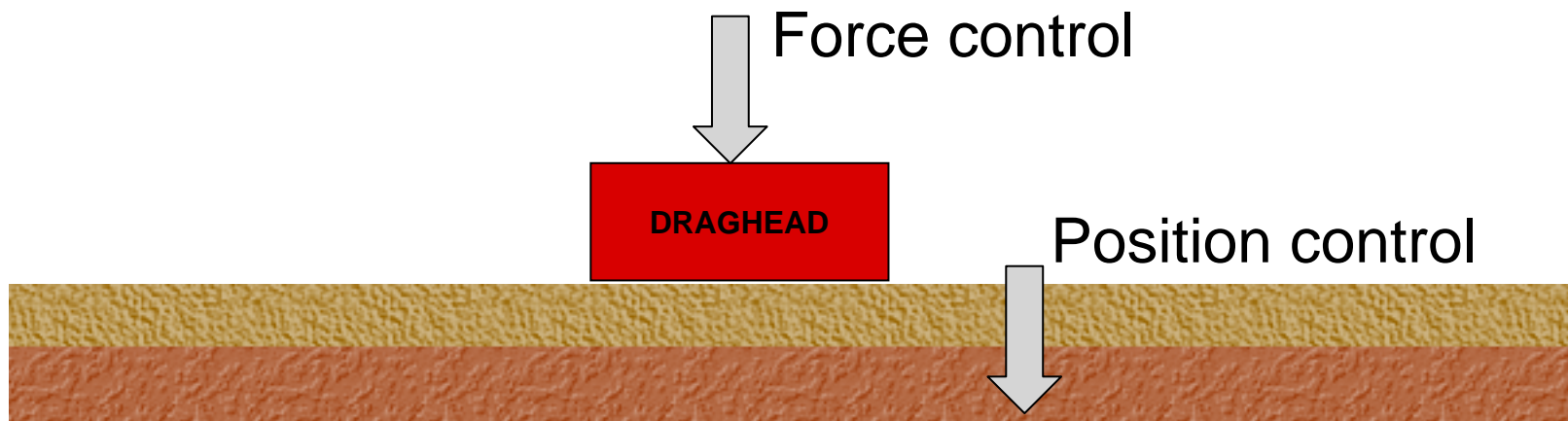


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Active heave compensation force and position

Benefits of active heave compensation with position control



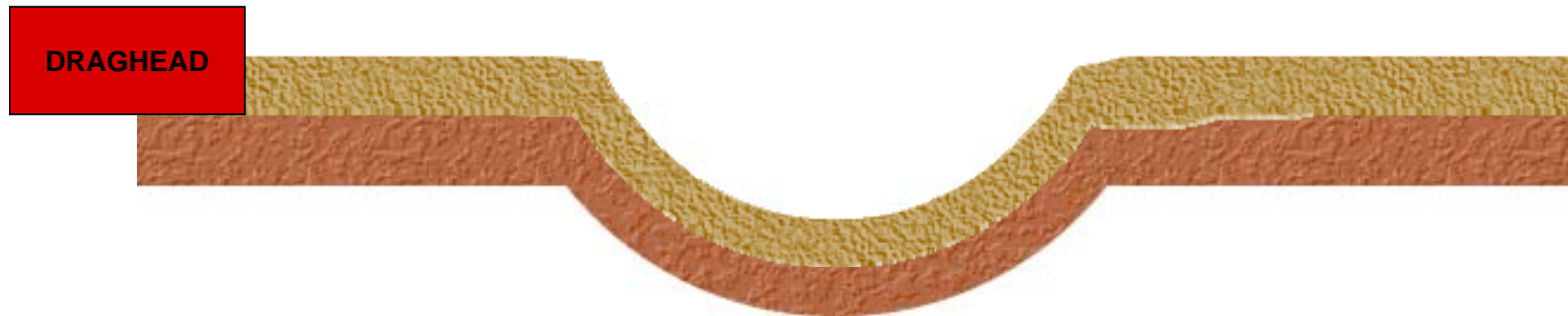
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Active heave compensation force and position

Benefits of active heave compensation with position control

Deepening of seabed to certain level (only removal of necessary soil)



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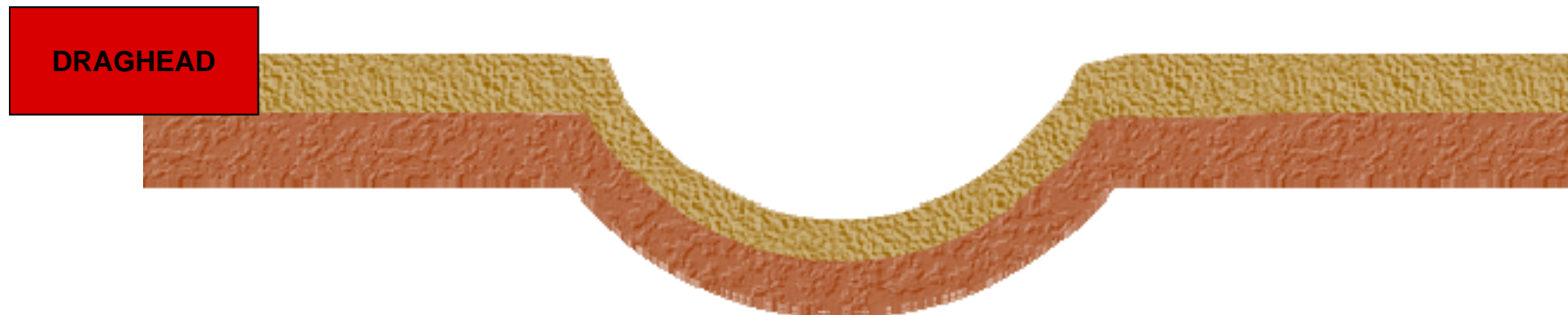
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Active heave compensation force and position

Benefits of active heave compensation with position control

Rexroth
Bosch Group

Dredging layers with accuracy of 5%
(poluted layers, or layers with high % rich minerals)



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“Questions?”