Budapest Univesity of Technology and Economics
Department of Building Machines, Materials Handling Machines and Manufacturing Logistics
and Department of Construction Technology and Management

Construction Equipment
Concrete & Asphalt Works

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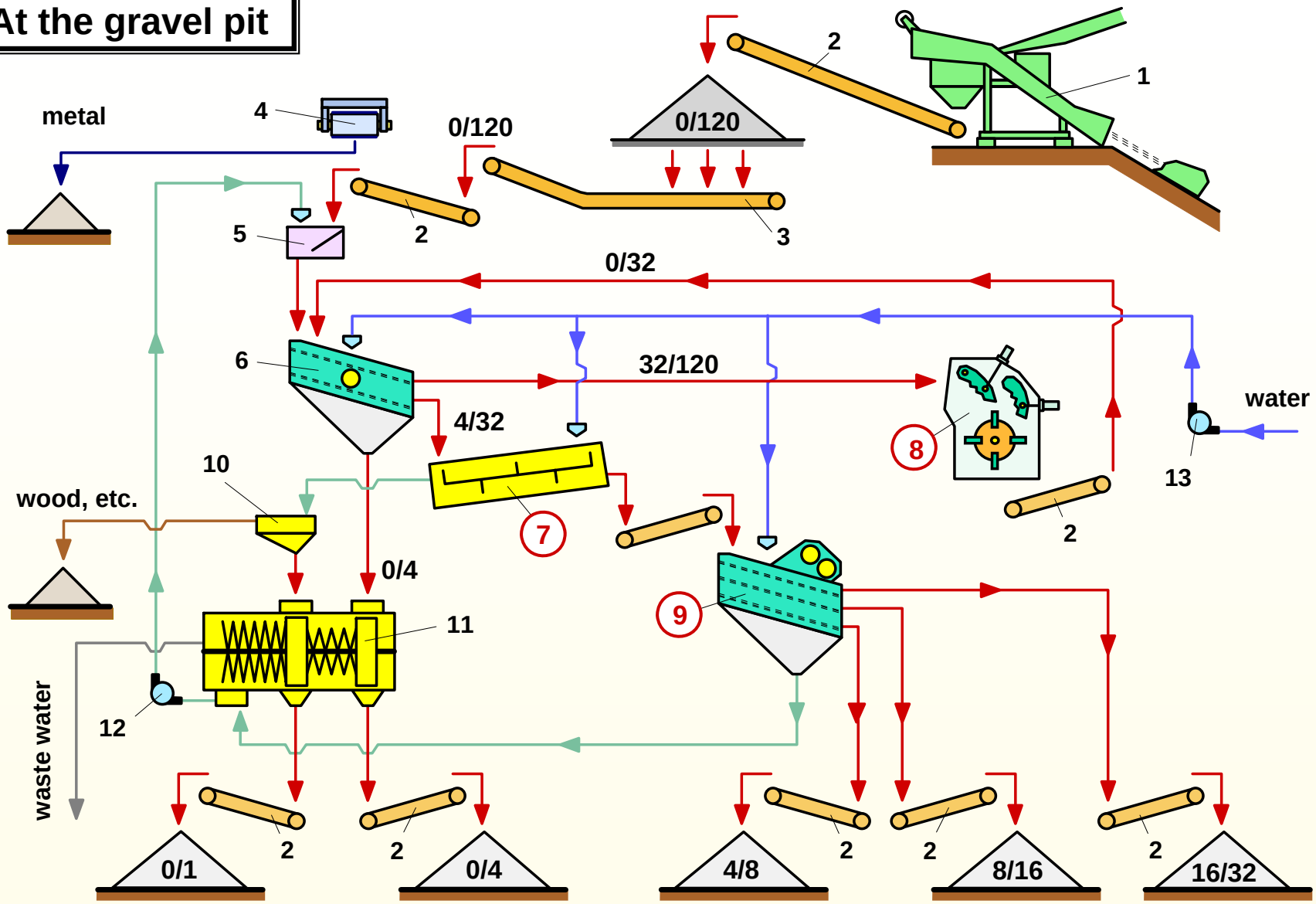
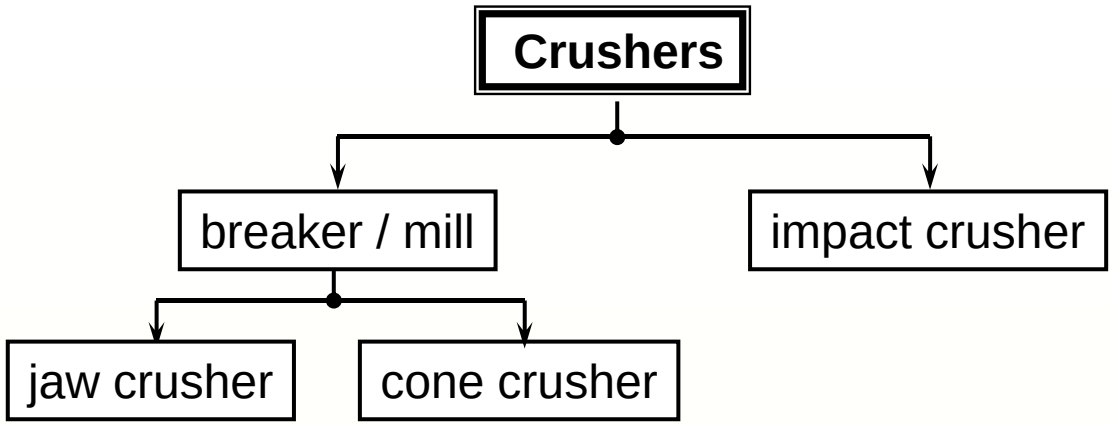
Concrete and asphalt works

- **Aggregate production (at pit or quarry):**
  - ⇨ extraction (excavation)
  - ⇨ processing – crushing
    – sizing
    – washing
- **Batching (mixing) at plant:**
  - ⇨ Receiving and storing rough material:
    - – aggregates: by fractions, in open-air deposits or in chambered silos
    - – fines (cement, limestone dust): in silos (handled by compressed air)
    - – bitumen: in tanks, as heated liquid
  - ⇨ Scaling and batching components:
    - – weight measuring, batching according to mixing formulas
    - – pan-, conveyor belt- or electronic scales
  - ⇨ Drying aggregates (asphalt only):
    - – intermittent mixer: in rotary dryer, re-sizing (re-screening) and scaling
    - – continuous mixer: in dryer-mixer drum
  - ⇨ mixing: pug-pressure mixing (kneading) (asphalt, continuous: dryer-mixer drum)
  - ⇨ transporting: dumper truck (asphalt), mixer truck (concrete)
- **Processing mixtures on site:**
  - ⇨ spreading, compacting: by asphalt- or concrete finisher
  - ⇨ heat-curing, aging (concrete)
  - ⇨ curing (concrete)

At the gravel pit

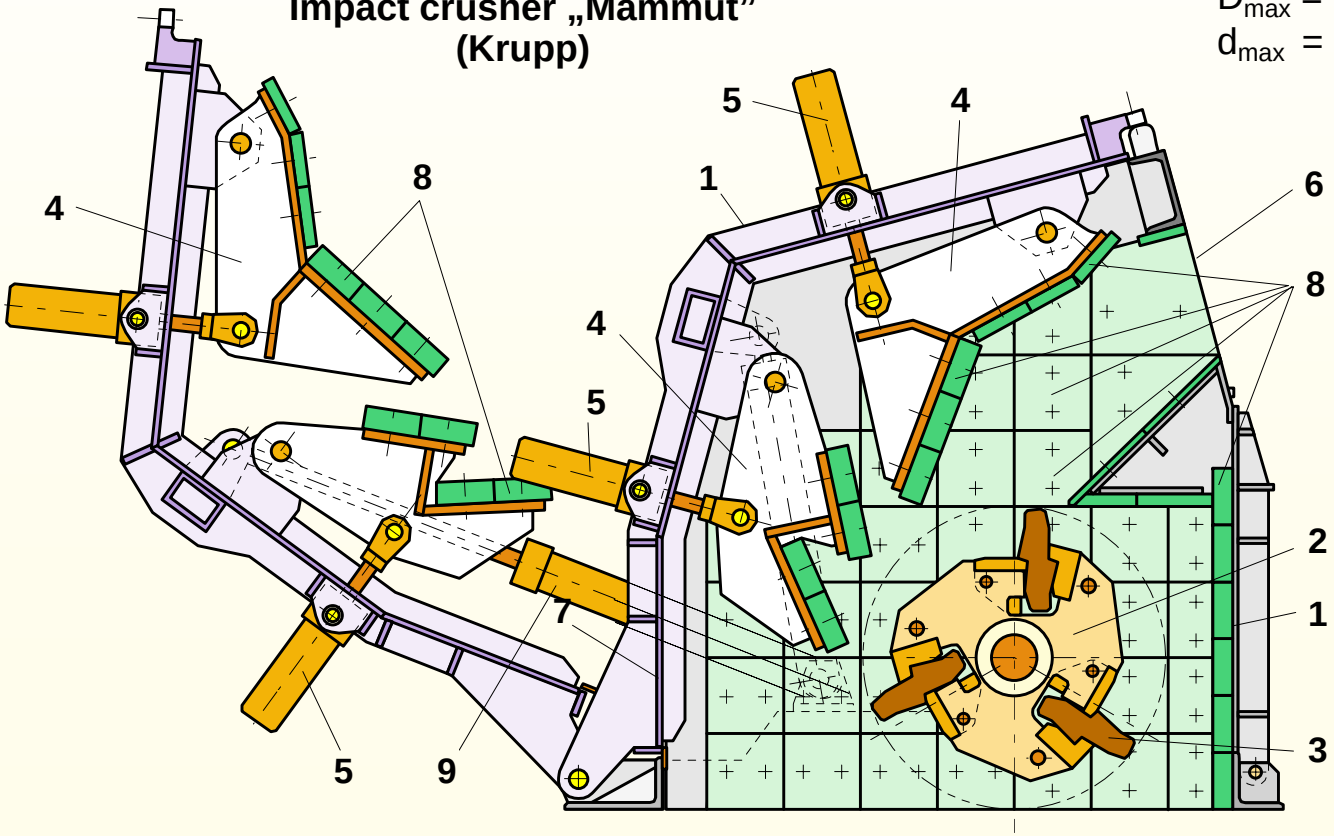


1. dragline excavator
2. conveyor belt
3. tunnel conveyor
4. metal separator
5. feeder
6. screen
7. washer
8. crusher
9. screen
10. separator basin
11. hydraulic sizer
12. slurry pump
13. water pump



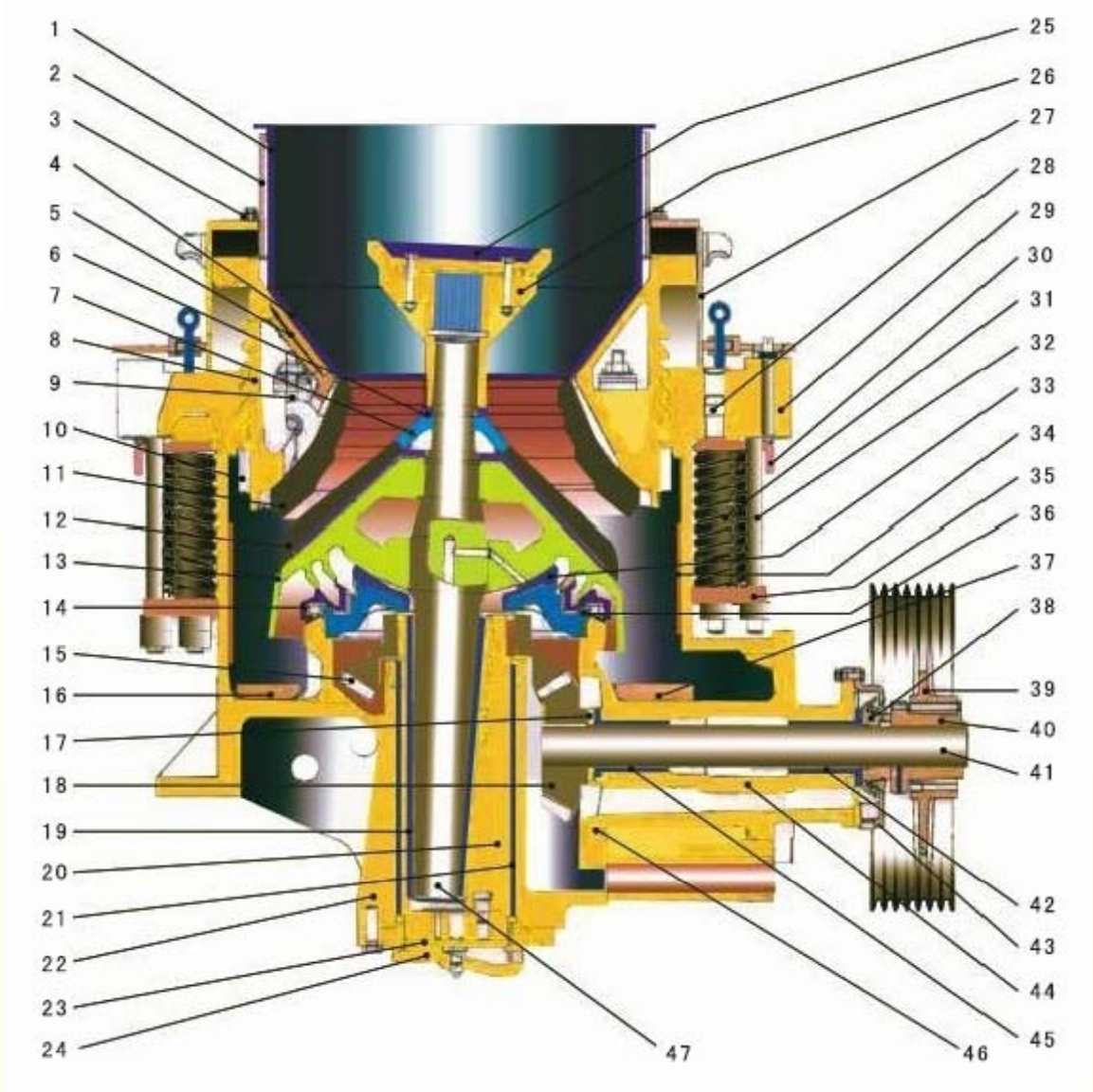
Impact crusher „Mammut”
(Krupp)

D_{max} = 2500 mm Q = 2300 to/h
d_{max} = 25 mm P = 3500 kW

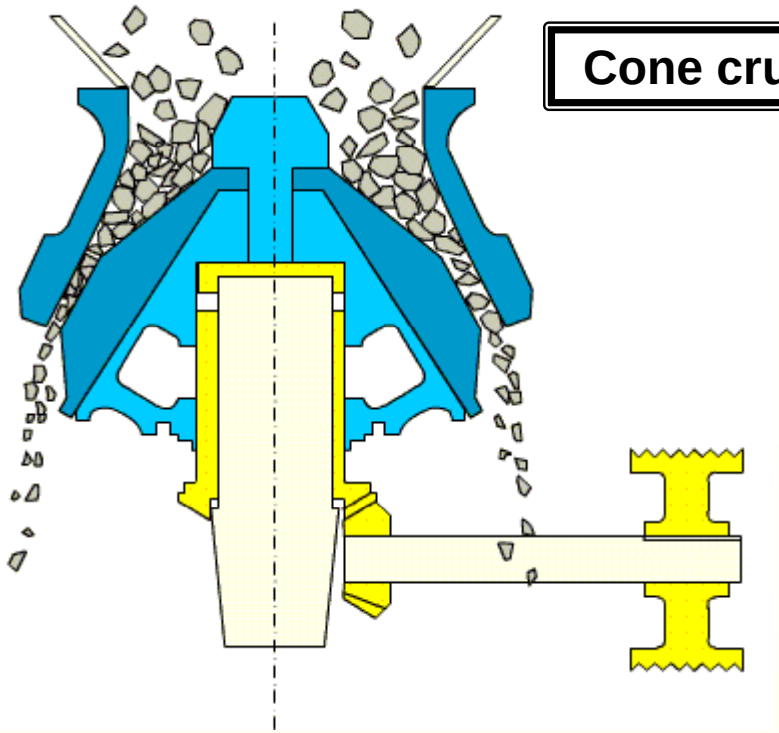


1. case
2. rotor
3. crushing piece
4. impact piece
5. impact piece cylinder
6. feeder
7. tiltable upper case
8. wear parts
9. tiltable upper case cylinder

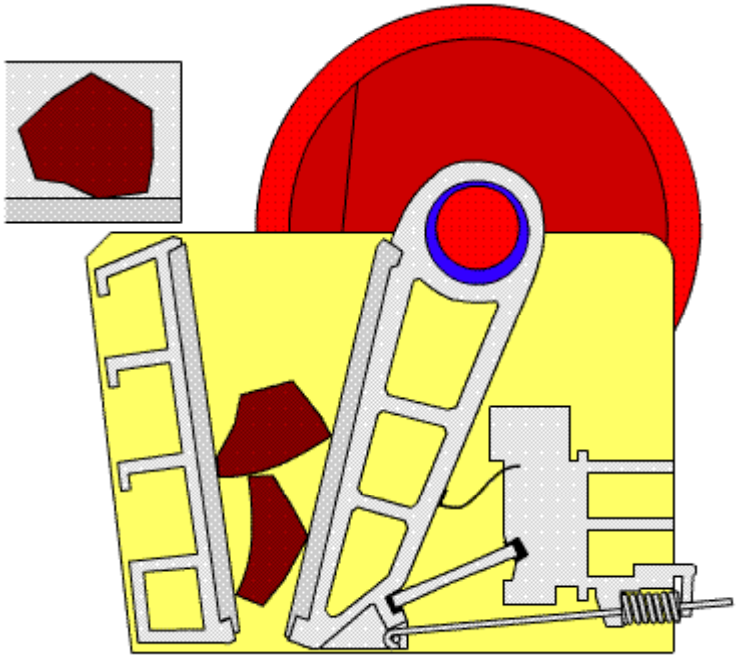
Cone crusher



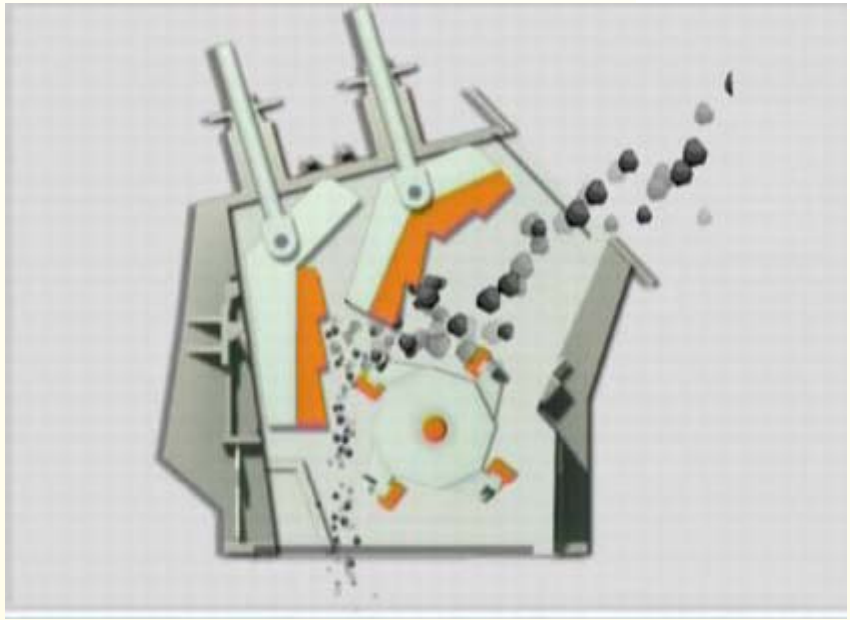
1. Feed hopper
2. Bowl hopper
3. Adjustment cap seal
4. Feed cone
5. Cover plate
6. Torch ring
7. Main shaft sleeve
8. Bowl
9. U-shaped bolt and washer
10. Adjustment ring dust collar
11. Bowl liner
12. Mantle
13. Head
14. Socket seal ring
15. Gear
16. Arm guard
17. Pinion thrust washer
18. Pinion
19. Inner eccentric bushing
20. Eccentric
21. Outer eccentric bushing
22. Main frame
23. Step bearing plate
24. Main frame cap
25. Feed plate
26. Main shaft nut
27. Adjustment cap
28. Main frame pin
29. Adjustment ring
30. Upper spring segment
31. Spring
32. Spring bolt
33. Socket liner
34. Main frame liner
35. Lower spring segment
36. Socket
37. Countershaft box guard
38. Oil flinger
39. Crusher sheave
40. Sheave taper sleeve
41. Countershaft
42. Outer countershaft bushing
43. Oil flinger housing
44. Countershaft box
45. Inner countershaft bushing
46. Countershaft box seal
47. Main shaft



Cone crusher



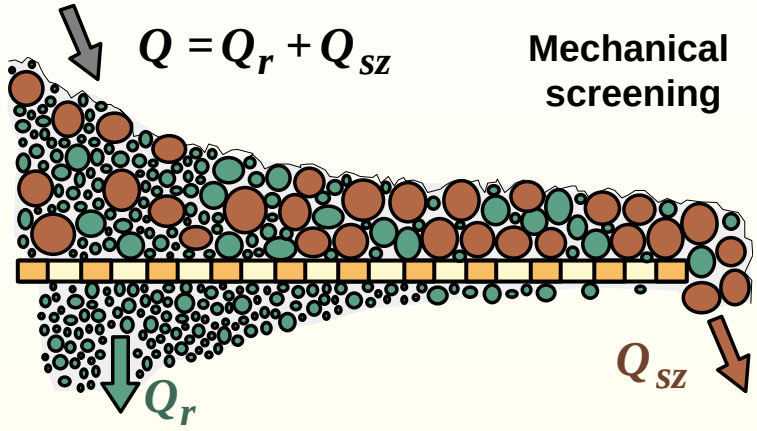
Jaw crusher

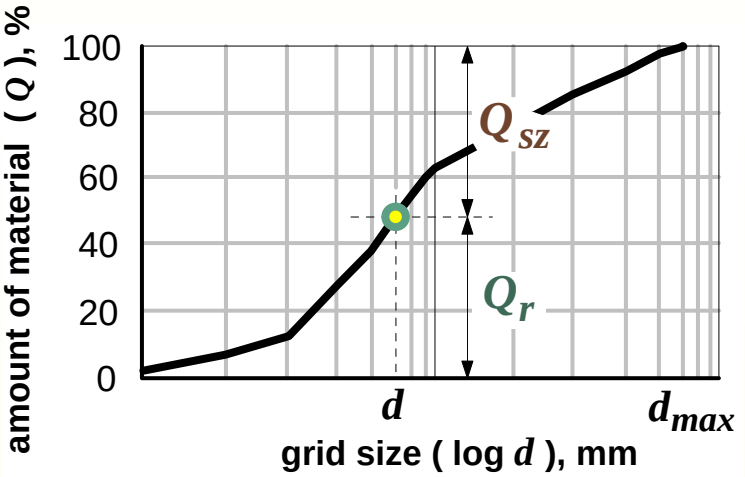


Impact crusher

Gravel sizing (screening)

- mechanical
  - flat screen
  - drum screen
- hydraulic





Hydarulic sizing

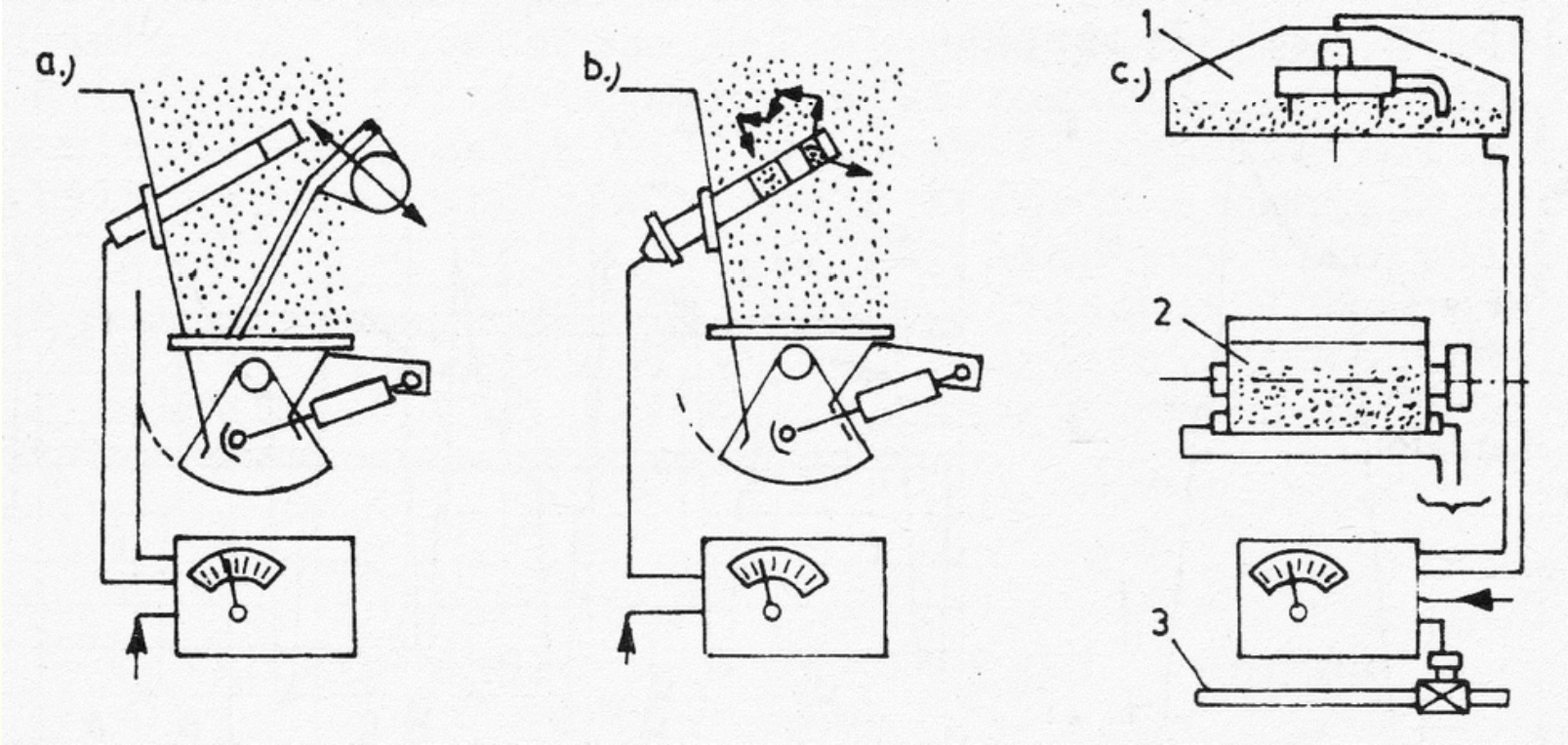
- ⇨ settling velocity of grains heavier than water is function of their sizes
- ⇨ particles lighter than water are floating on the surface and let out to waste tanks (washing)
- ⇨ bigger grains (d > 4 mm) are separated to fractions by water on flat screens
- ⇨ slurry (water + d < 4 mm grains + pollutants) is further screened by hydraulic screens

Water-content detection and measurement

a.) Electric resistance measurement (aggregate)

b.) Neutron radiation measurement

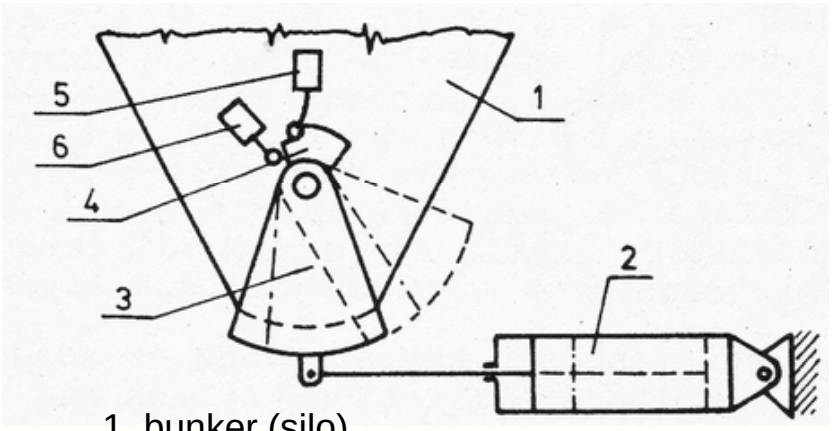
c.) Electric resistance measurement (mixture)



1. mixer pan
2. mixer shaft
3. water inlet

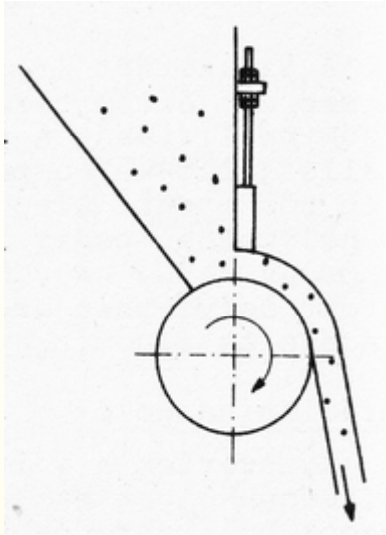
Aggregate (batching-) feeders

Sector gate feeder

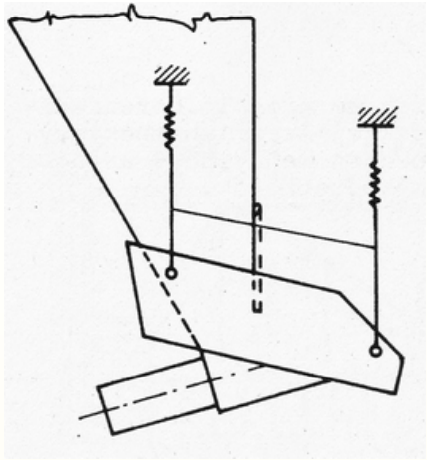


1. bunker (silo)
2. pneumatic (hydraulic) cylinder
3. sector gate
4. control track
5-6. position sensors

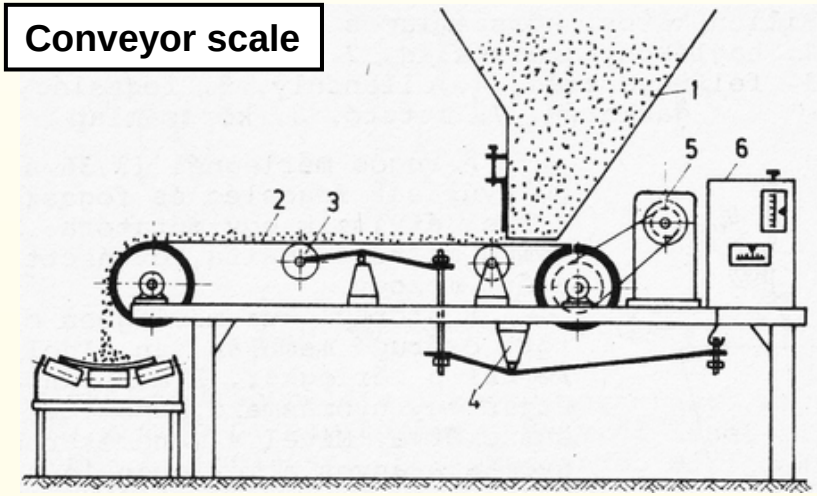
Delivery roller



Vibratory feeder

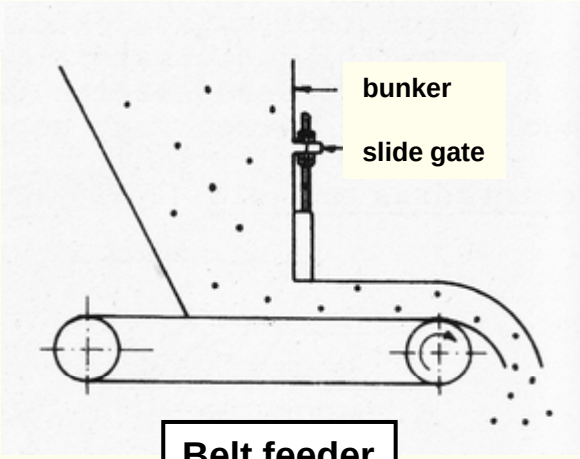


Conveyor scale



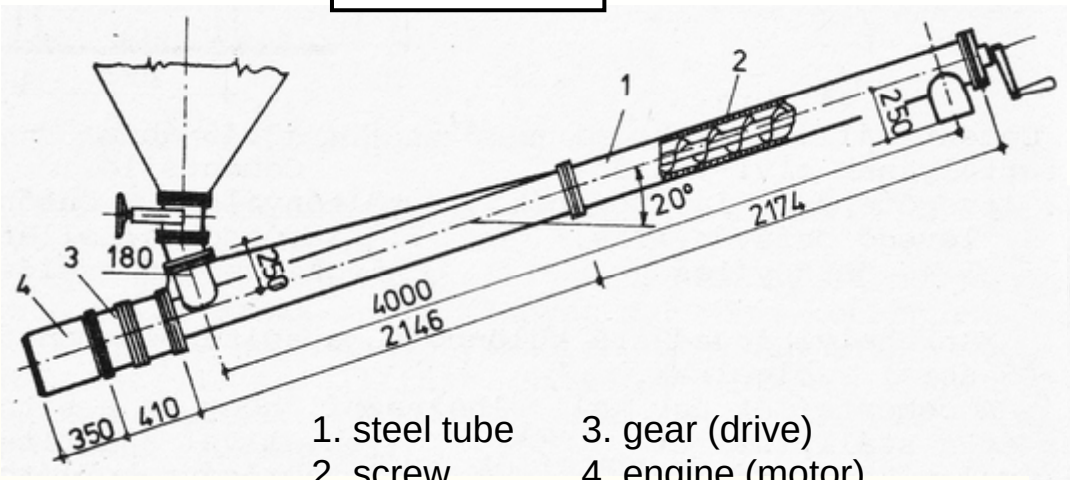
1. bunker (silo)
2. conveyor belt
3. senzor roller
4. manometer
5. driving unit
6. display

Belt feeder



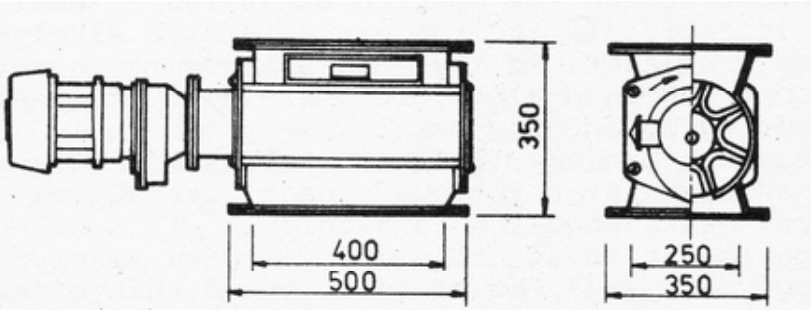
Cement feeders

Screw feeder



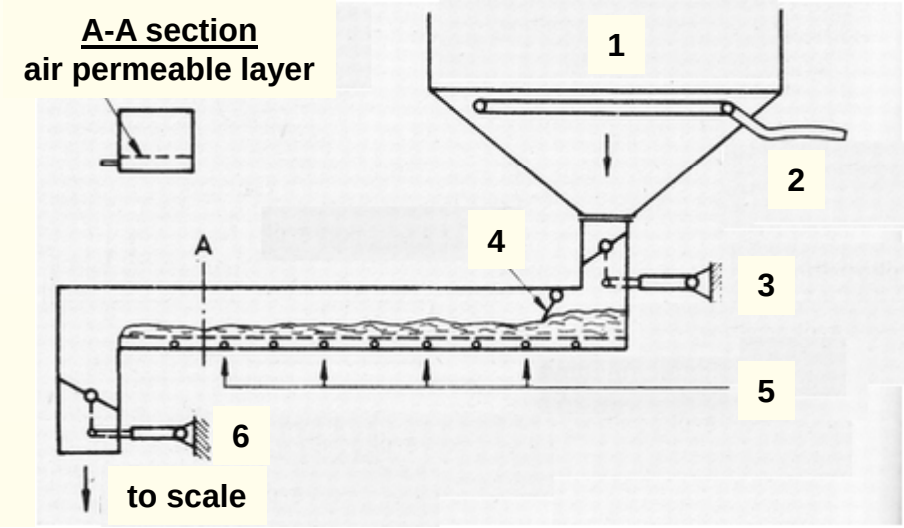
1. steel tube
2. screw
3. gear (drive)
4. engine (motor)

Cellular wheel (drum) feeder

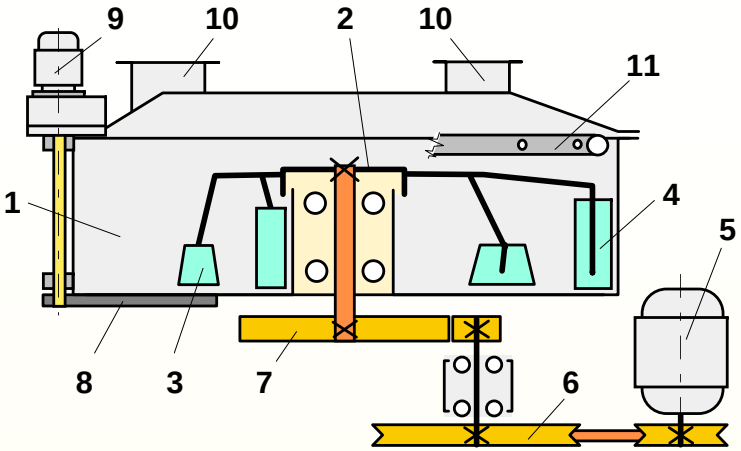


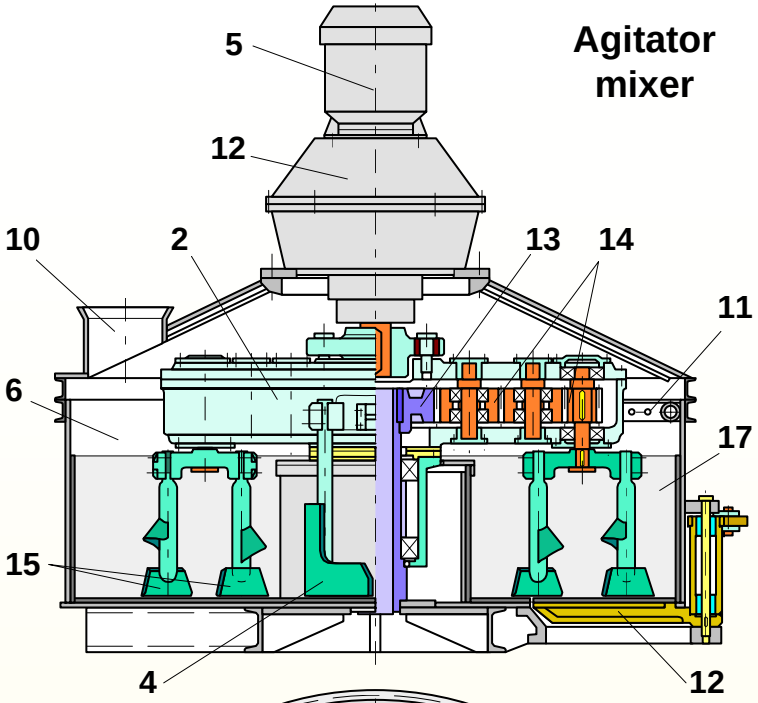
Pneumatic feeder (aerator)

1. cement bunker (silo)
2. compressed air
3. pneumatic lock and cylinder
4. baffle (spreader)
5. compressed air (P = 0.05 Bar)
6. pneumatic lock and cylinder

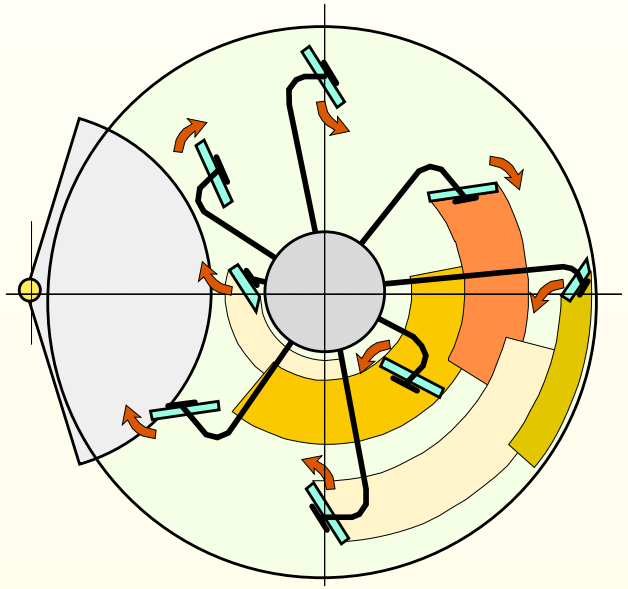


Vertical-axle (pan) concrete mixers

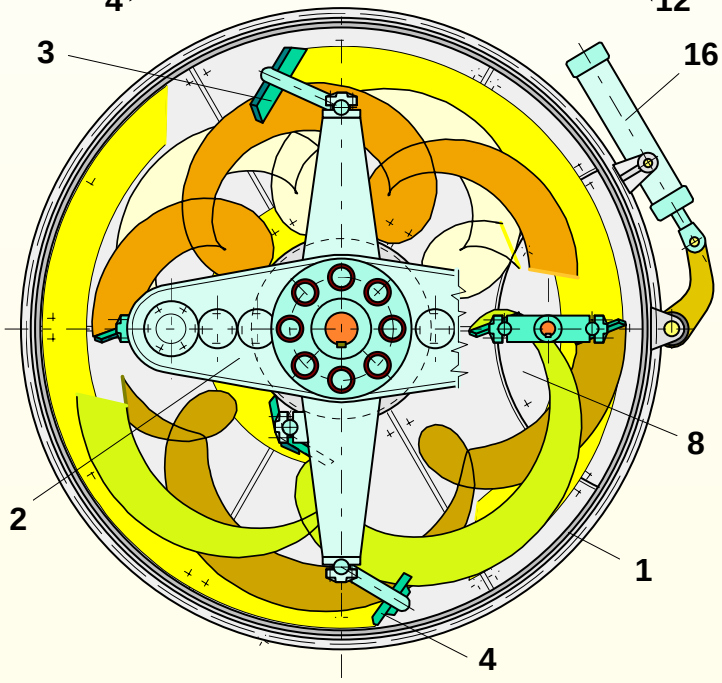




Agitator mixer



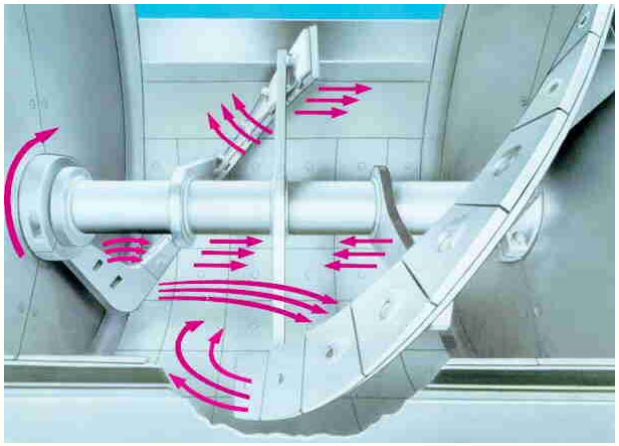
Pan mixer



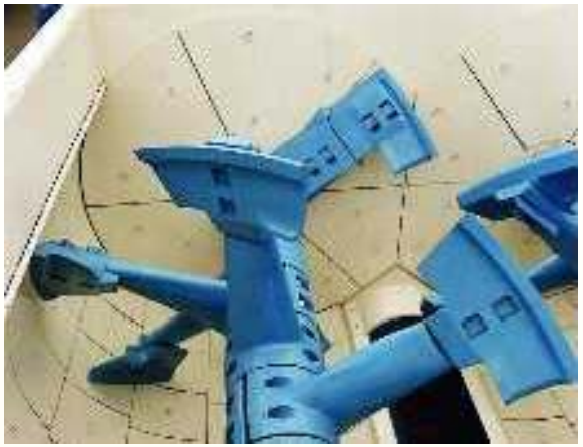
1. mixer pan
2. agitator
3. mixing blade
4. clearing blade
5. engine
6. V-belt drive
7. geared transmission
8. discharge door
9. discharge door drive
10. feeder
11. water inlet
12. driver
13. dead-axle (sun) gear
14. revolver gear
15. planetary mixing blades
16. cylinder
17. wear lining

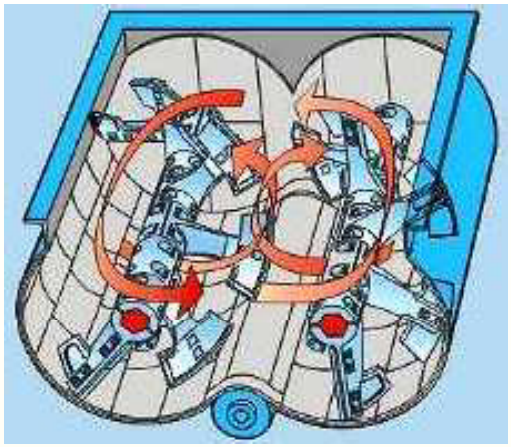
Horizontal axle (shaft) mixers

Single-shaft mixer, blades



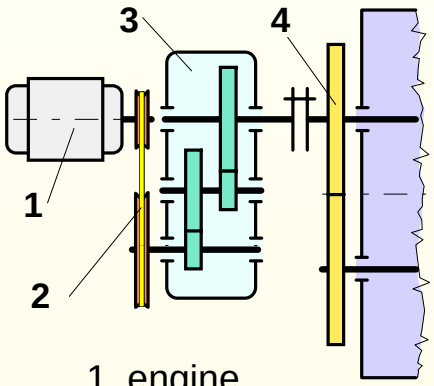
Twin-shaft mixer, blades and material flow





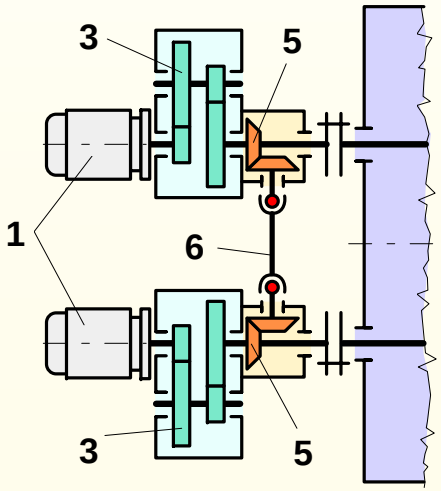
Twin-shaft mixer drive

A. Single engined



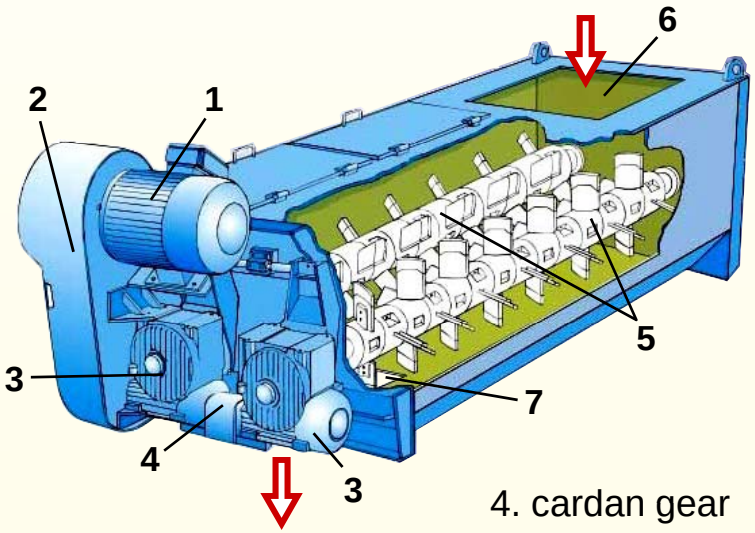
1. engine
2. V-belt drive
3. gear
4. synchronizer gears

B. Double engined



5. bevel gear
6. cardan axle

Continuous mixer

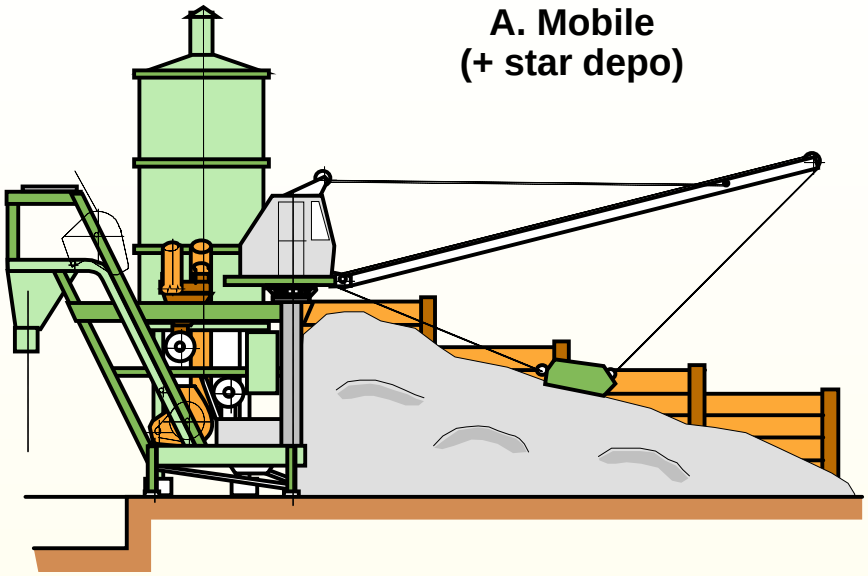


1. engine
2. V-belt drive
3. worm-gear
4. cardan gear
5. mixer shaft
6. charging
7. discharging

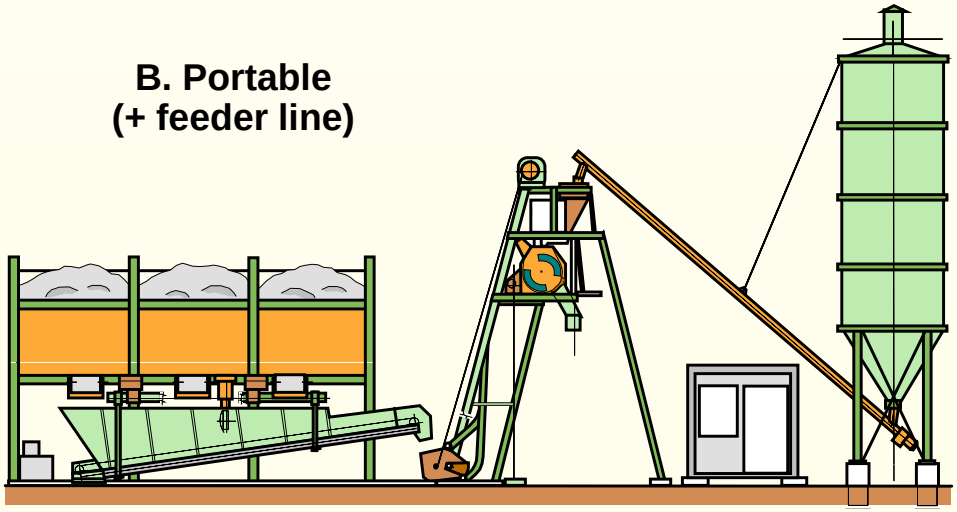
Concrete batching plants

Horizontal system

A. Mobile (+ star depo)

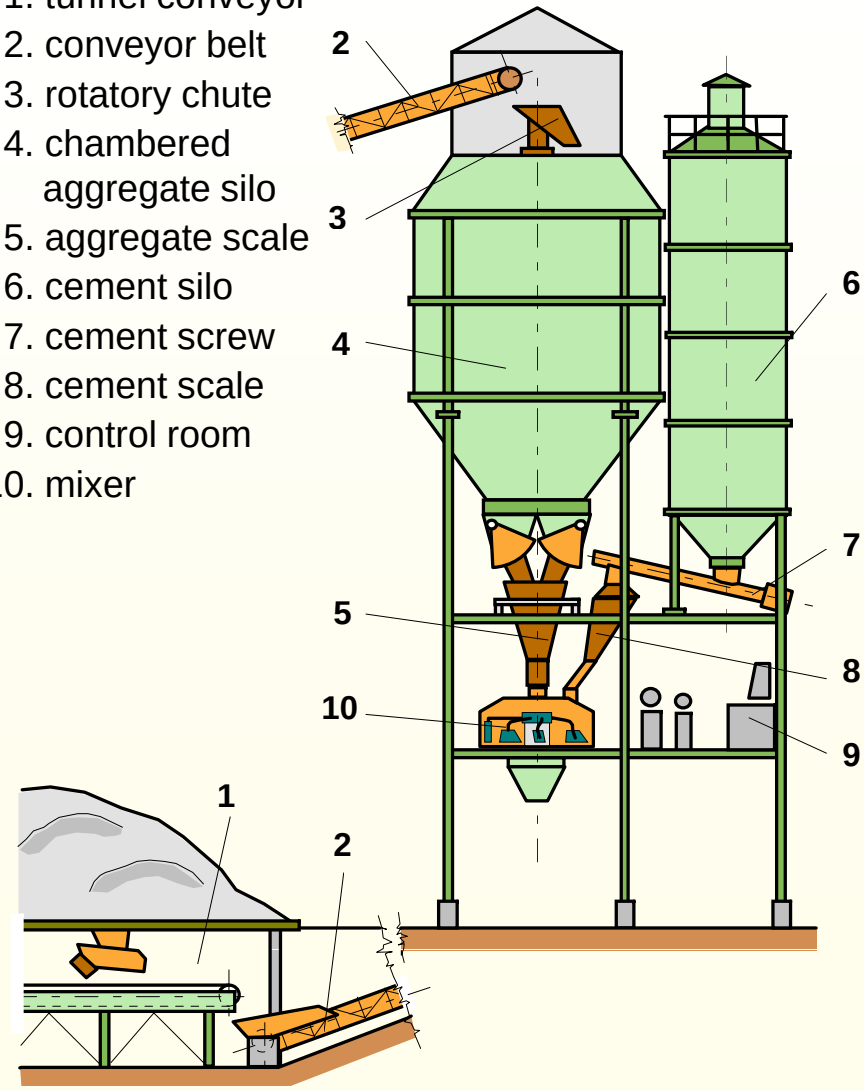


B. Portable (+ feeder line)



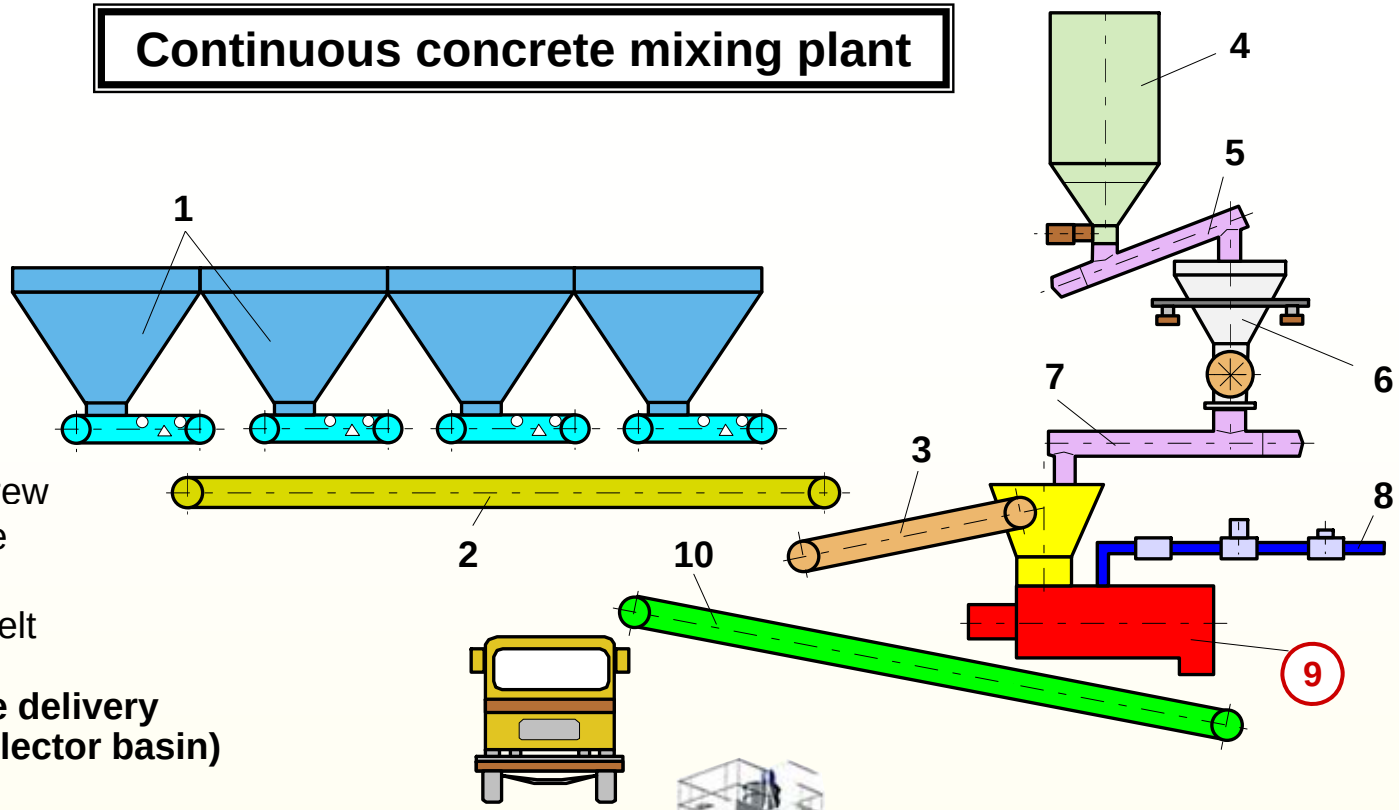
Vertical (tower) system

1. tunnel conveyor
2. conveyor belt
3. rotatory chute
4. chambered aggregate silo
5. aggregate scale
6. cement silo
7. cement screw
8. cement scale
9. control room
10. mixer



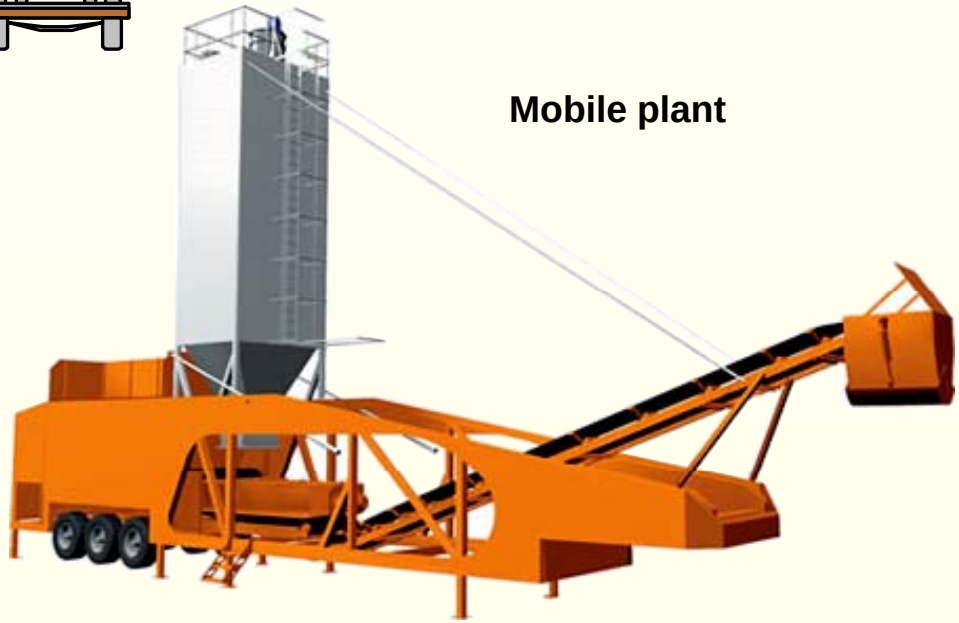
Continuous concrete mixing plant

1. feeder line with batching belt scale
2. conveyor belt
3. charging belt
4. cement silo
5. cement conveyor screw
6. cement scale
7. cement batcher screw
8. water batcher scale
9. continuous mixer
10. concrete delivery belt

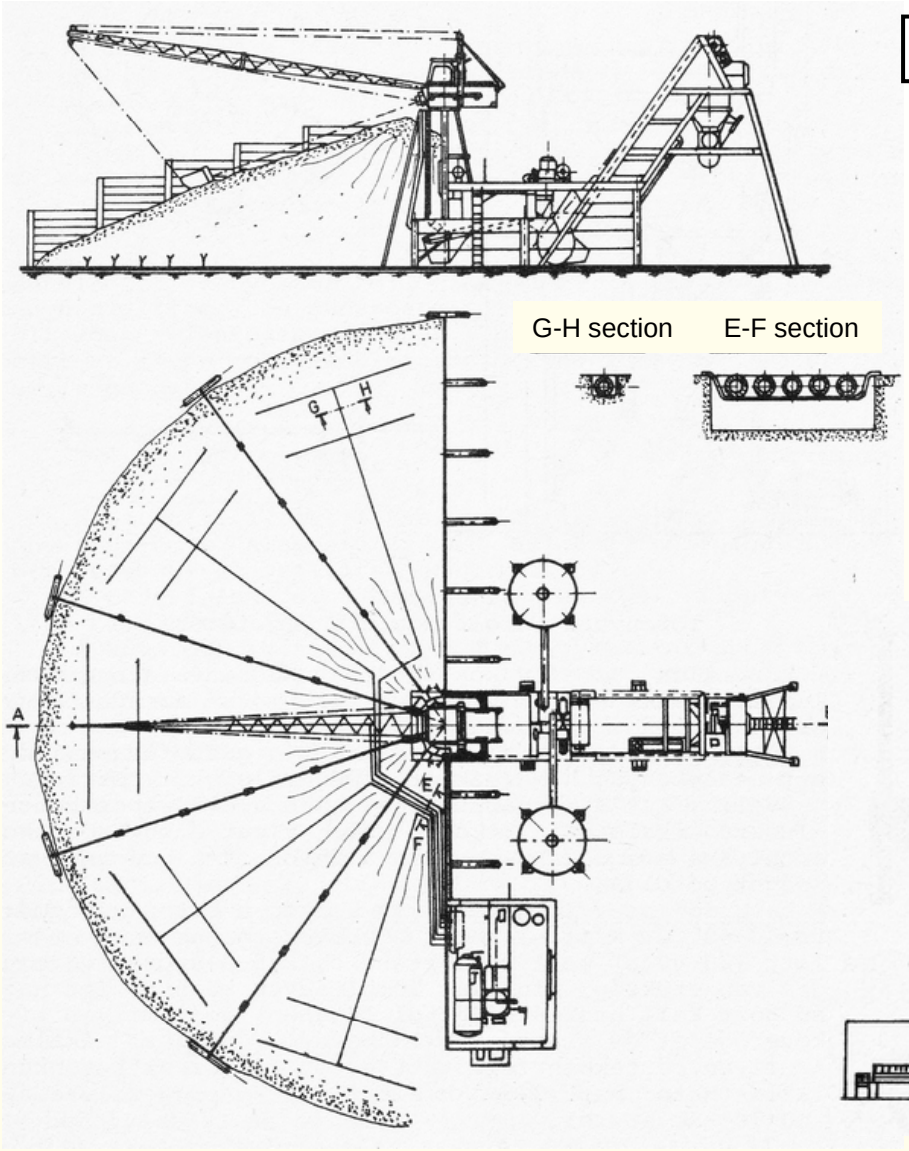


Concrete delivery (through collector basin)

Mobile plant



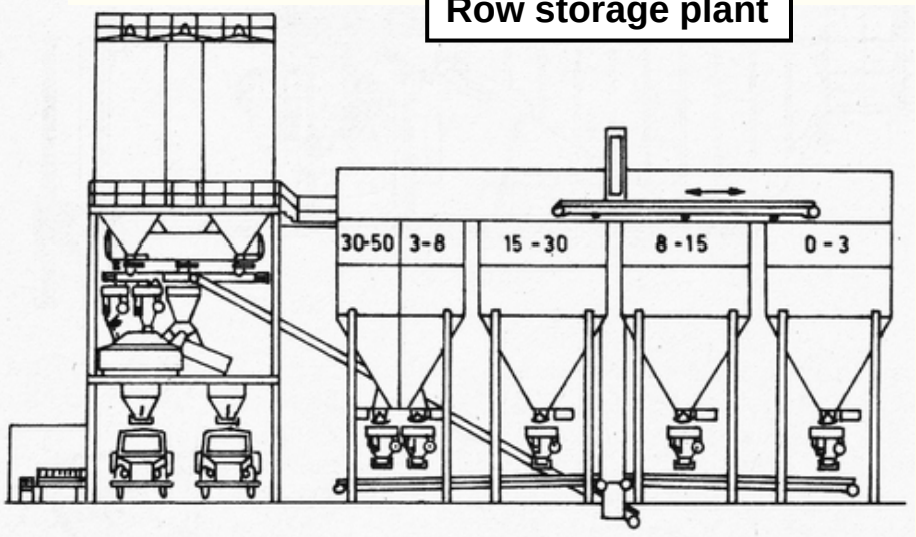
Aggregate storage and batching



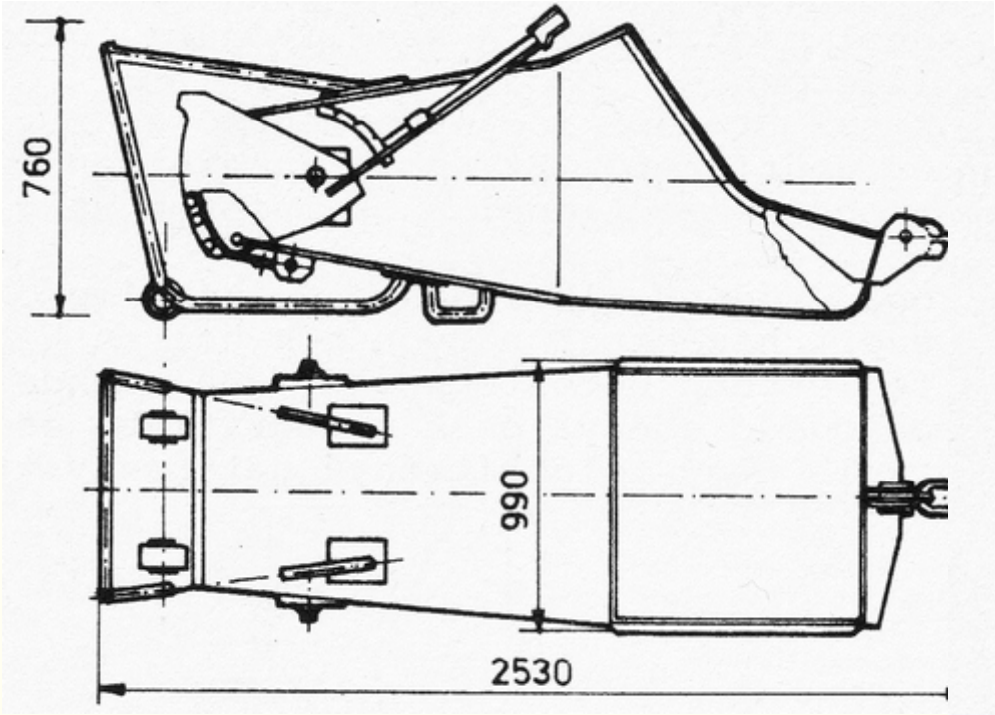
Semicircular („star") deposit

- fractions of aggregate are separated
- water content measured and controlled
- heating facilities for hot concrete (winter-time concreting)
- grain-size distribution composed and fit to concrete when batching

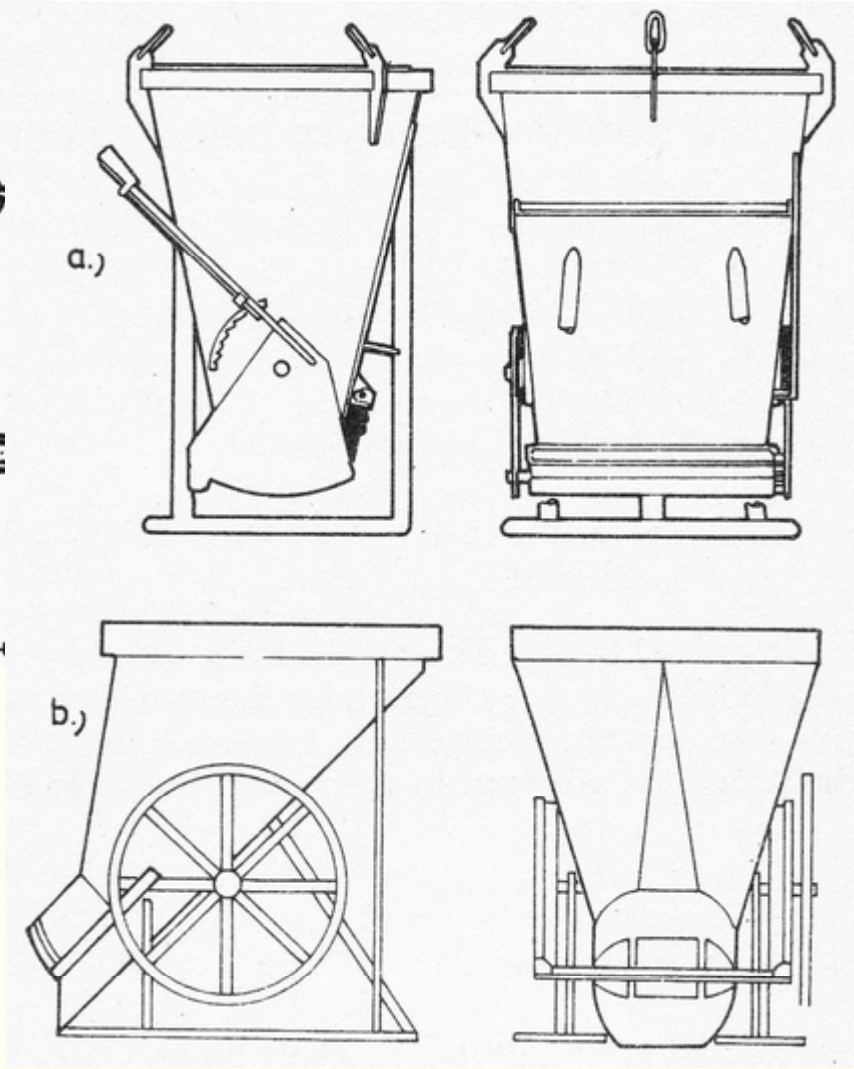
Row storage plant



Concrete (wet) hoppers and containers

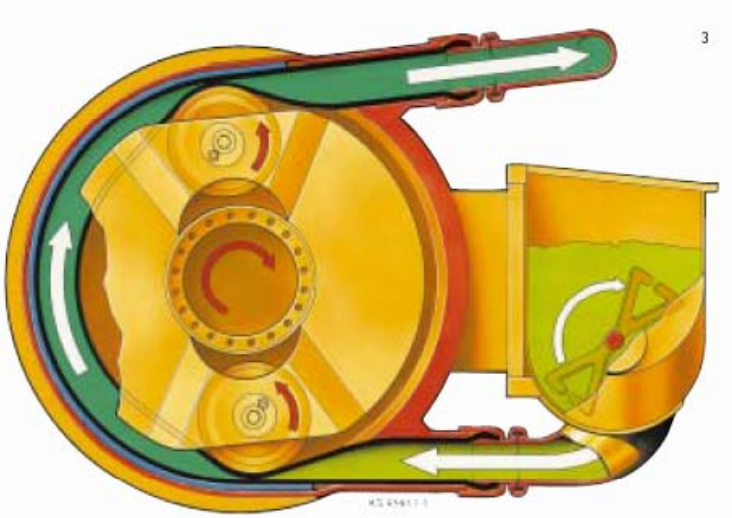


„Shoe”-Container

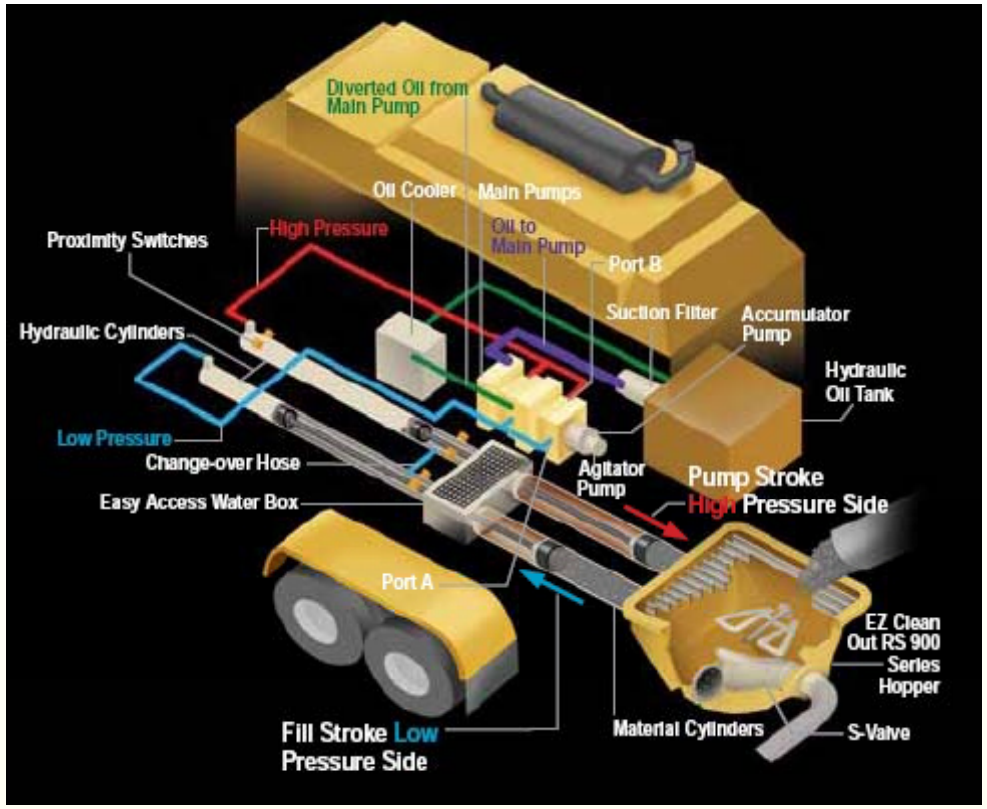


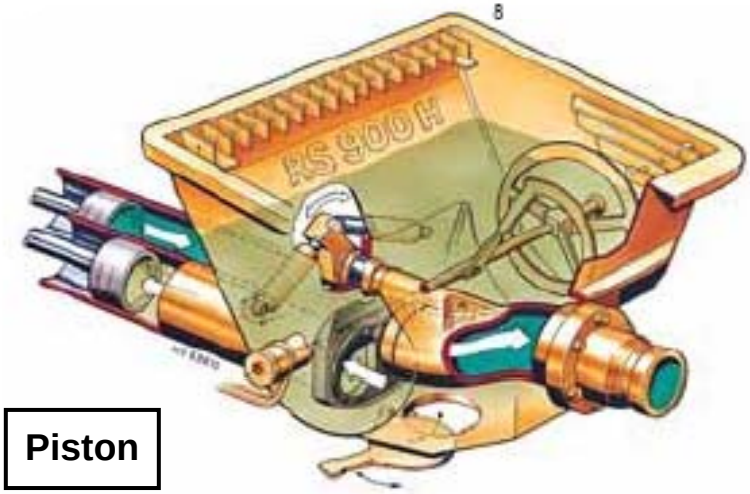
On smaller hopper containers the sector gate is operated by simple levers (a) but on bigger ones segment gears and handwheels are provided (b)

Concrete pumps



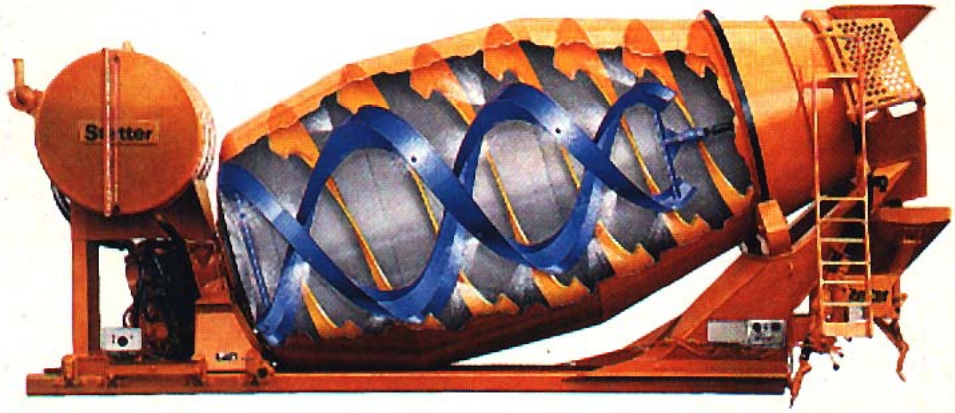
Rotary





Piston

Truck mounted mobile mixer drum, cross section



Mixer truck (charger chute open)

Truck mounted concrete pump and delivery boom

Mobile concrete pump

Mixer truck with concrete pump and delivery boom (”pumix”)

Concrete pump spare parts

Mixer truck and ”pumix” co-operating at the site

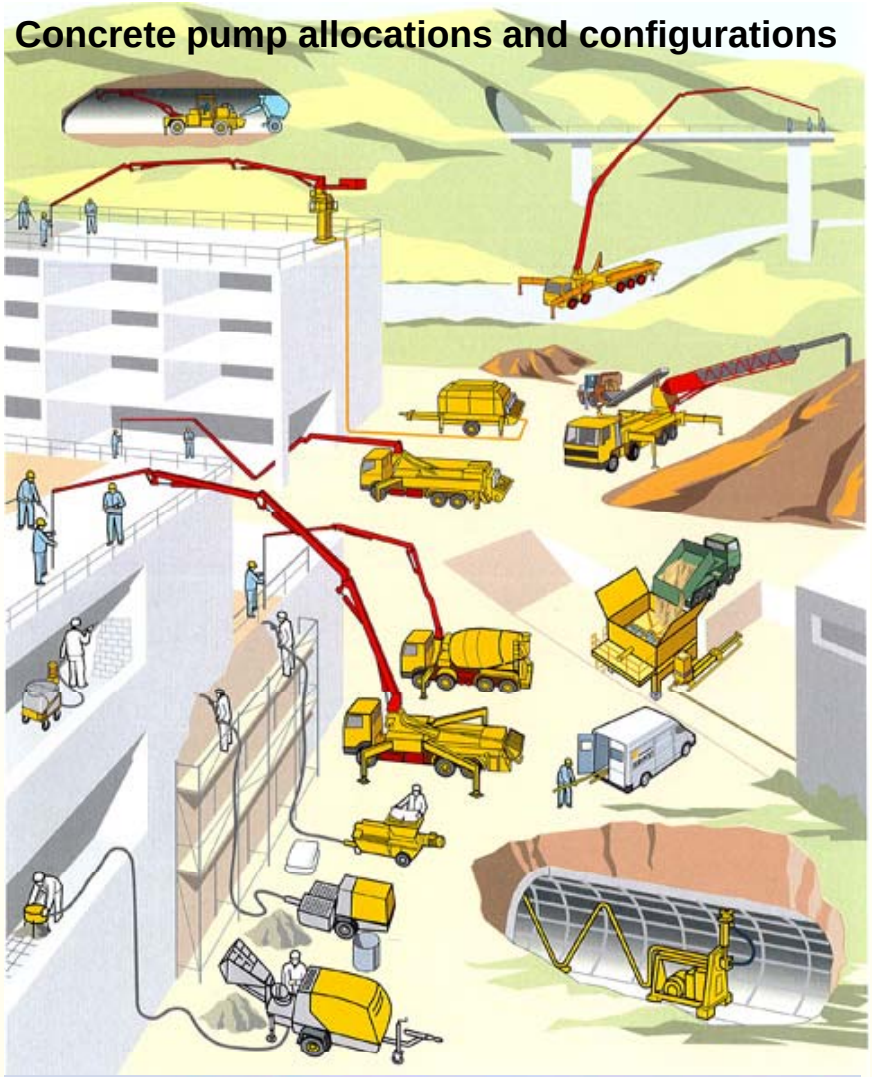
Mixer truck with delivery conveyor (in action)

Pump - mixer truck (”pumix”)

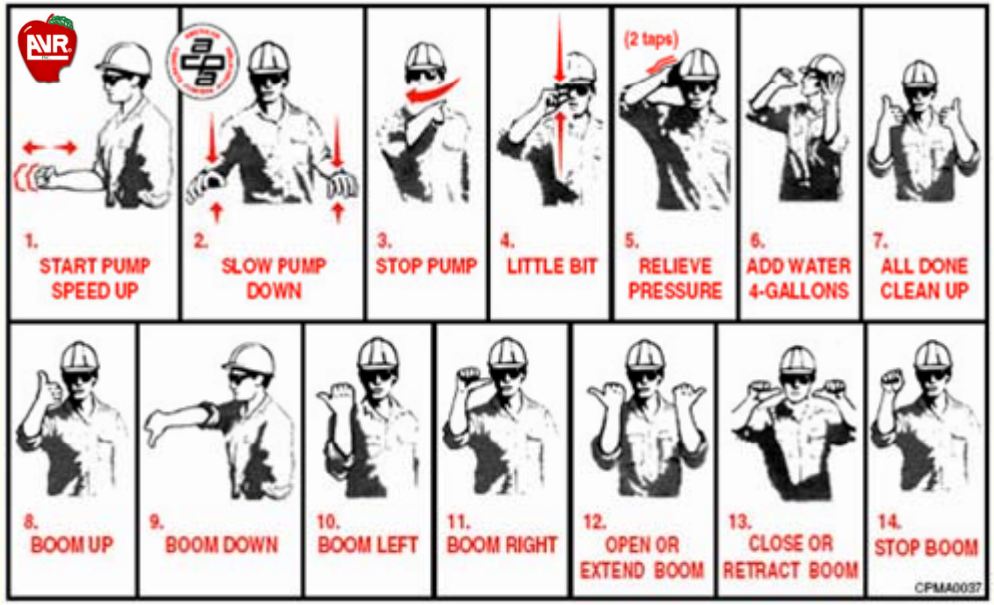
Mixer truck with delivery conveyor (riding position)

Mixer feeding the pump

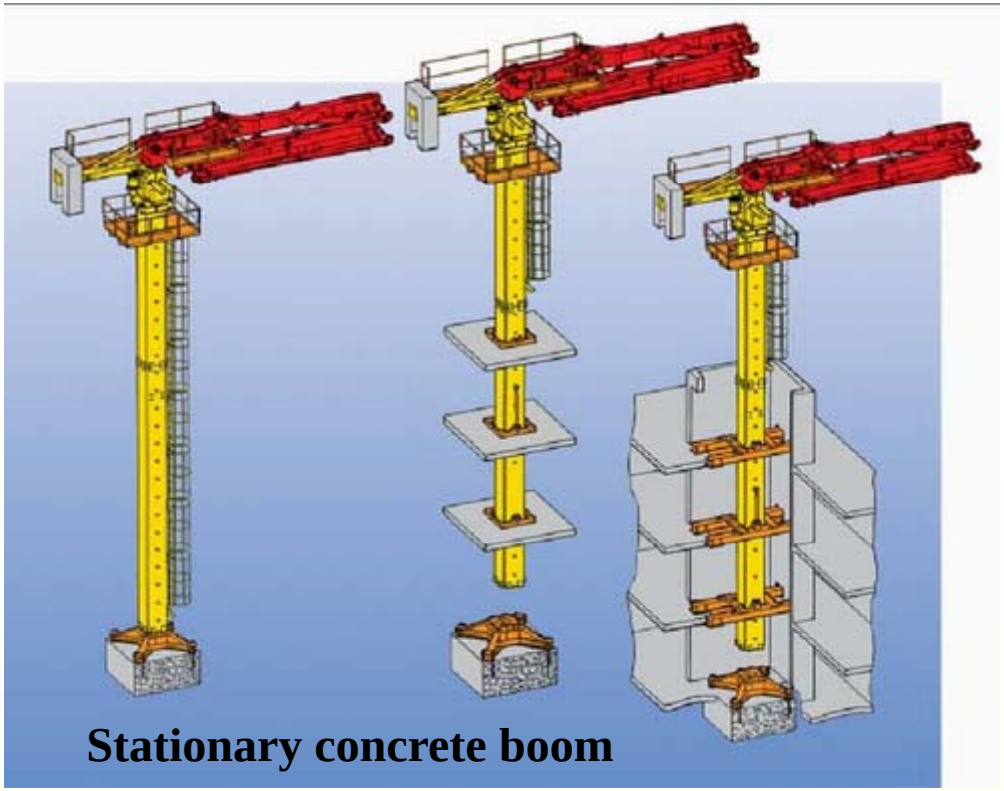
Concrete pump allocations and configurations

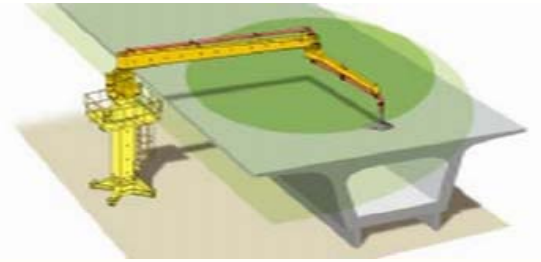


(Concrete) pump directing hand signals

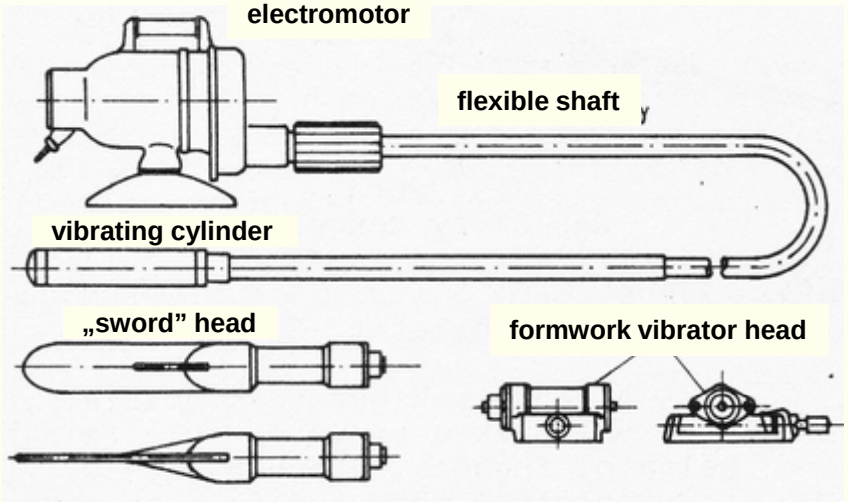


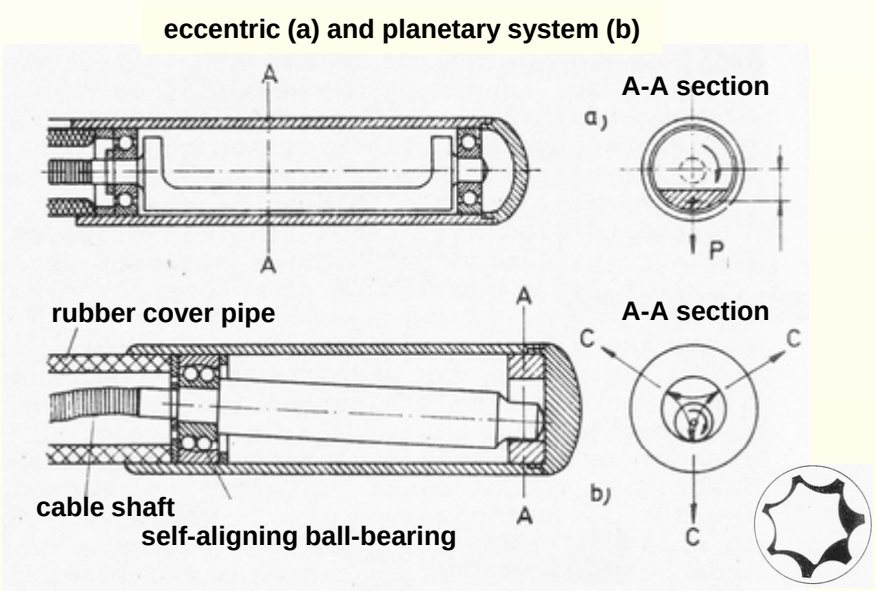
Concrete work-in (booms and vibrators)



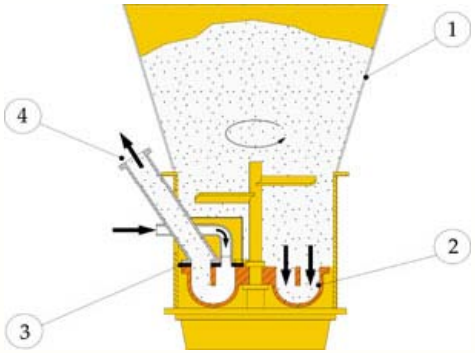


Immersible (poker) vibrators

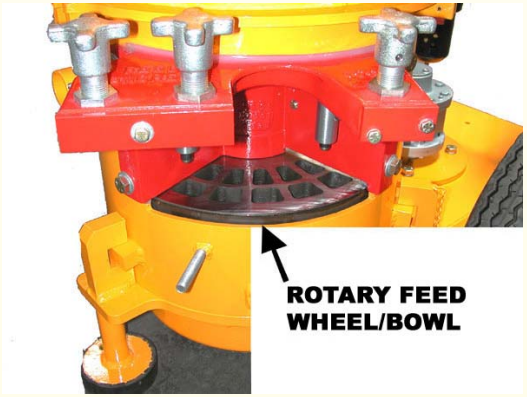


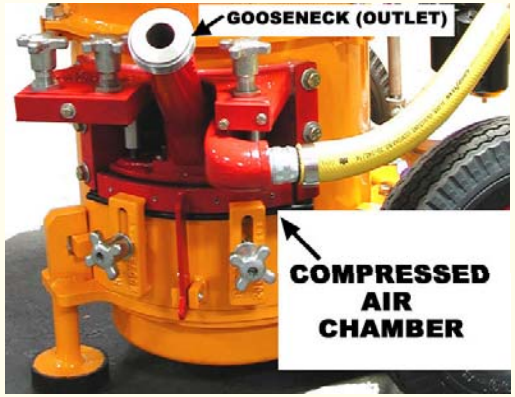


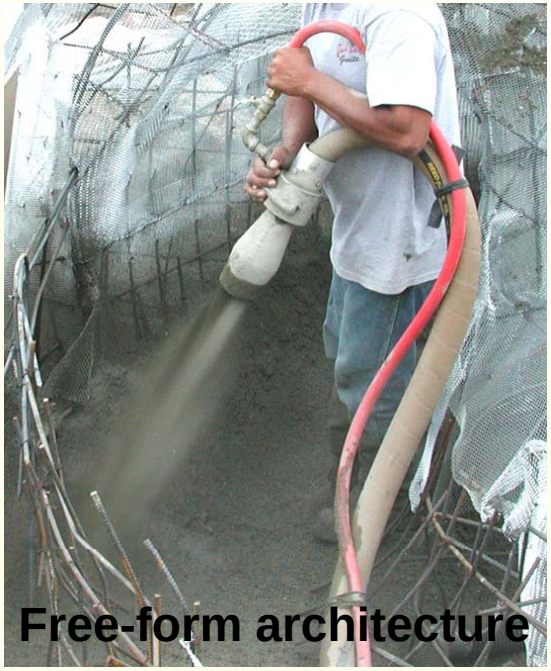
Shotcrete (Gunite) pumps



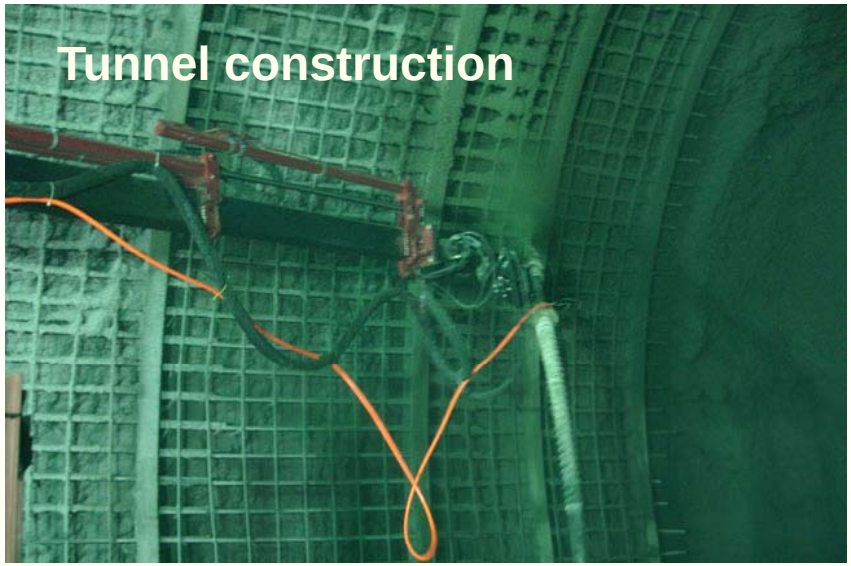
1. dry mix hopper
2. rotary feeder wheel
3. feeder pocket
4. dry mix conveying by compressed air







Shotcrete (Gunite) applications



Shotcrete (Gunite) applications

Retaining wall construction (permanent or temporary), paving, landscaping

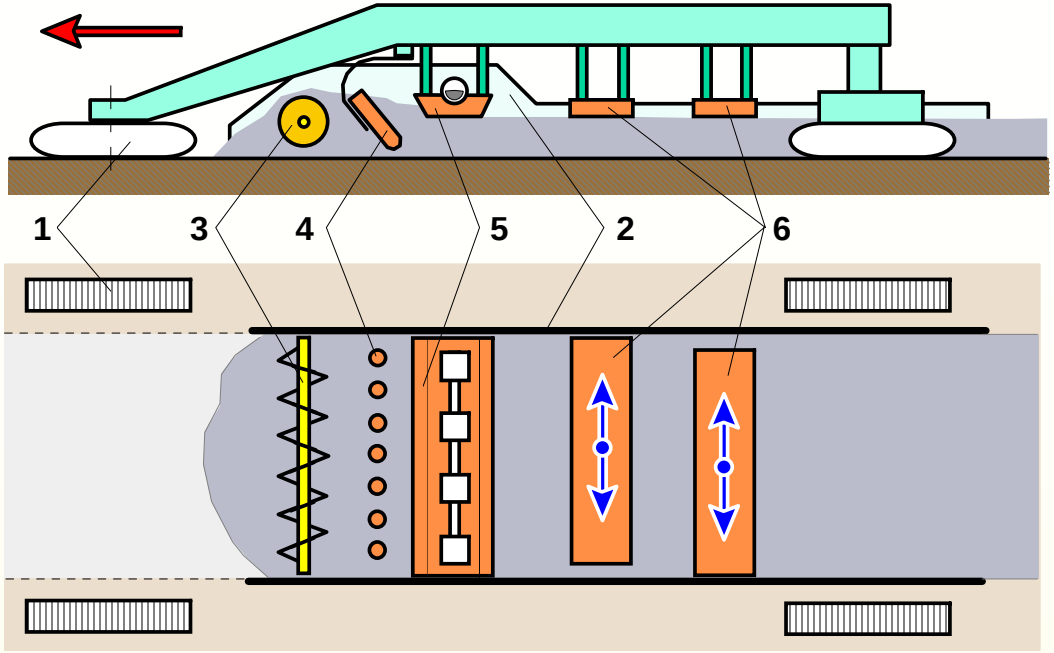
Power trowels (finishers)

Ride-on typed
double rotor
power trowel

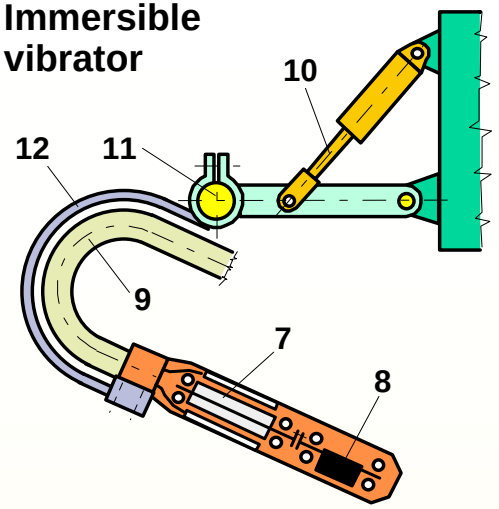
Power trowels in action

Walk-by typed
single rotor
power trowel

Concrete paver (finisher)



Immersible vibrator



1. bogie track
2. mould
3. distributor screw
4. Immersible vibrator
5. surface vibrator
6. floating trowel
7. motor
8. exciter mass
9. power cable
10. hydraulic cylinder
11. tip shaft
12. plate spring

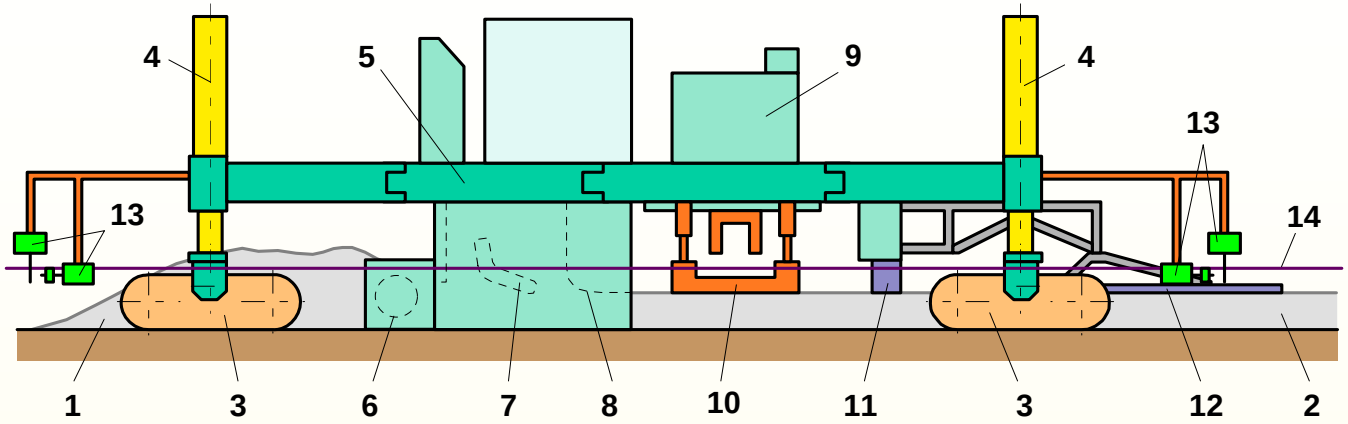
Course spreading

Kerb (curb) construction by concrete finisher

Concrete paver (finisher) with joint-bar inserter

Joint-bars: bond breaker coated steel bars inserted across the extension joints

Functions: retaining vertical dislocation of adjoining concrete panels



1. loose concrete mix
2. compacted concrete layer
3. bogie track
4. elevation control
5. main frame
6. distributor screw
7. immersible vibrators
8. screed (mould)
9. joint-bar inserter
10. joint-bar vibrator
11. transversal screed
12. longitudinal screed
13. level detectors
14. guide wire

Longitudinal joint-bar inserter

Transversal joint-bars inserted (for joining parallel lanes)

Effect of weather conditions on concrete works

Hardening time of concrete is effected by the temperature of the environment:

- ⇨ Final hardness of concrete is attained in 28 days at about +20 ^{o}C
- ⇨ At +5 ^{o}C to attain final hardness of concrete takes 35-50 days
- ⇨ If water content of concrete mixture froze at beginning of hardening process, before attaining it's final hardness, it can not resist pressure of solidifying (extending) water (ice), it cracks and never reaches the intended (designed) final strength (hardness)

At about freezing-point:

- ⇨ „Hot concrete" production (delivery temperature: 40 - 45 ^{o}C)
- ⇨ Admixing „anti-freeze" agent (additive)

} Limited applicability at road construction

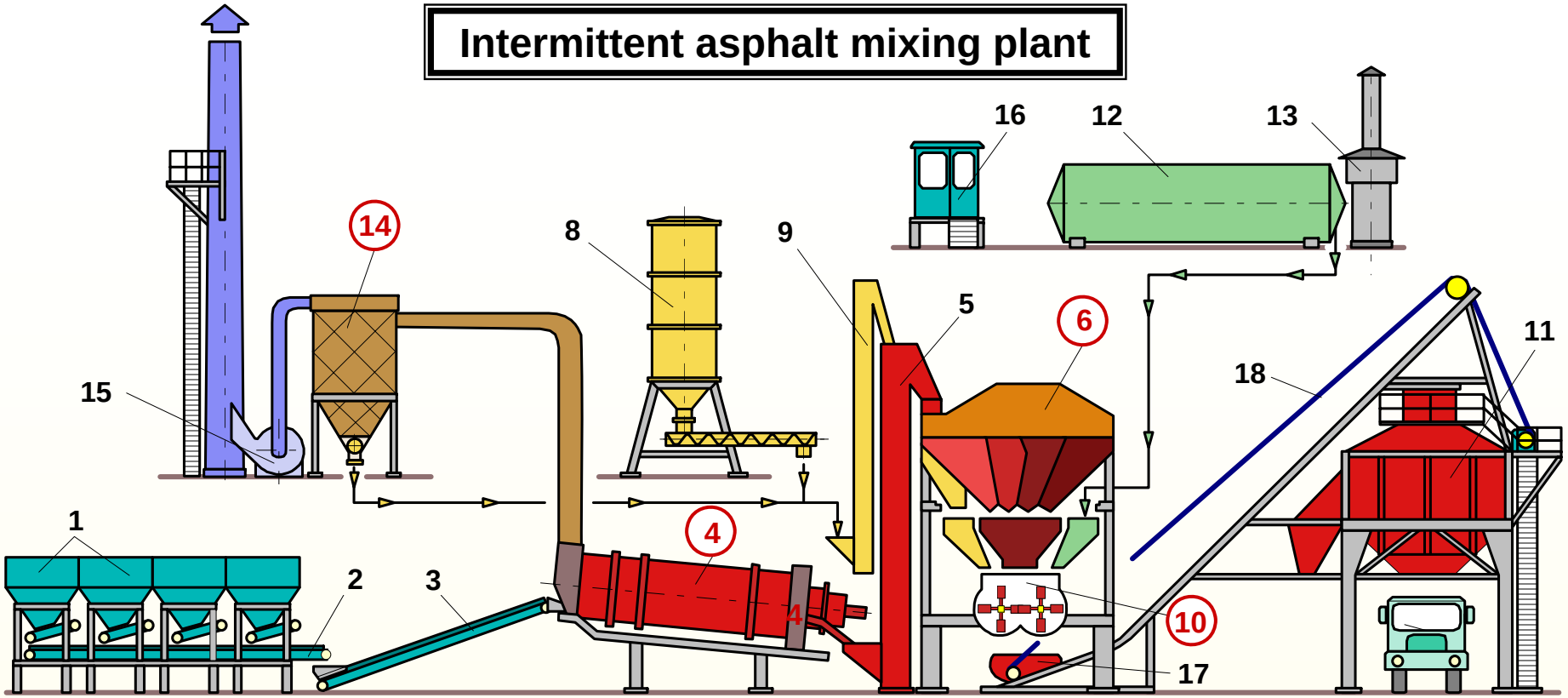
Hot summer:

Problem is the intensive evaporation of water (at the surface)

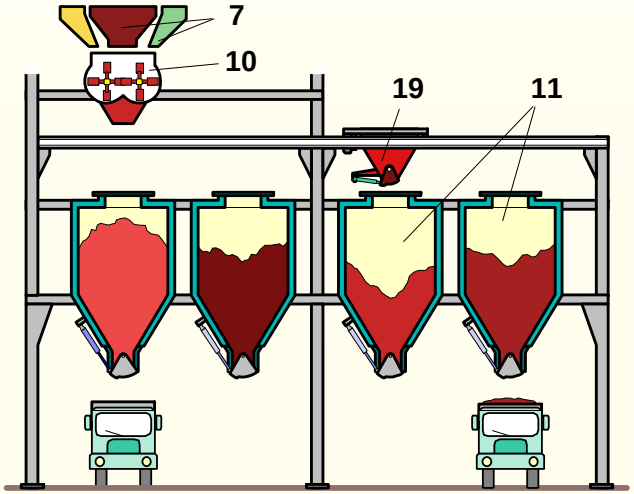
Counter-action:
- ⇨ Using low heat-producing cements
- ⇨ Reducing mixing temperature (pre-cooling the aggregate)
- ⇨ Reducing evaporation (covering fresh concrete, vapour-tight coating)
- ⇨ Using retarding admixtures or reducing water content (with admixtures)

Precipitation:
- ⇨ Can change water content of the fresh concrete
- ⇨ Can corrupt the surface of the fresh concrete structure

Intermittent asphalt mixing plant



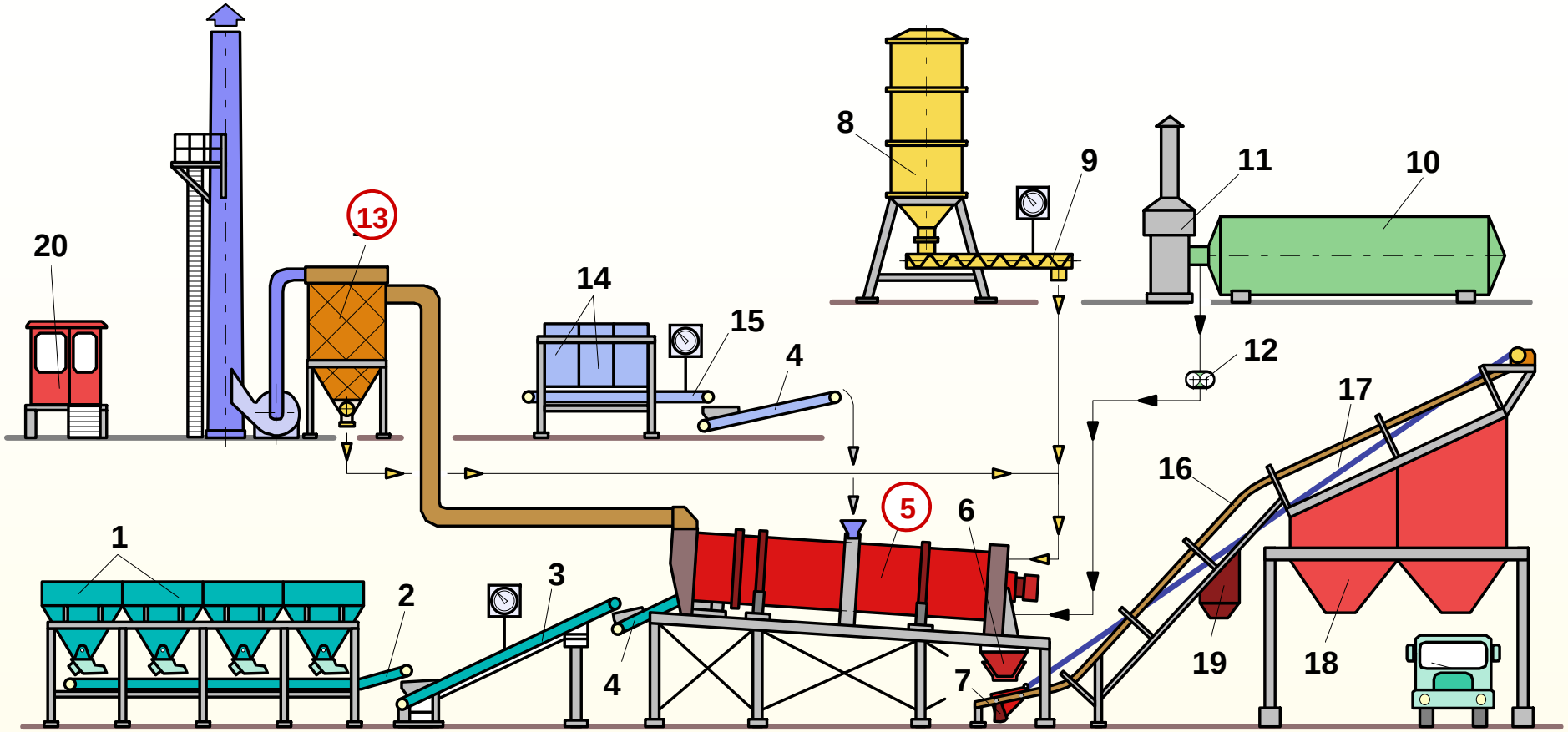
Horizontal system



Chambered ready-mix container

1. feeder bunkers
2. conveyor belt scale
3. conveyor belt
4. rotary dryer
5. hot elevator
6. separator
7. scales
8. limestone dust silo
9. fines elevator
10. mixer
11. ready-mix container
12. bitumen tank
13. bitumen heater
14. dust collector
15. exhaust ventilator
16. control room
17. elevator bucket
18. wire rope
19. transporter truck

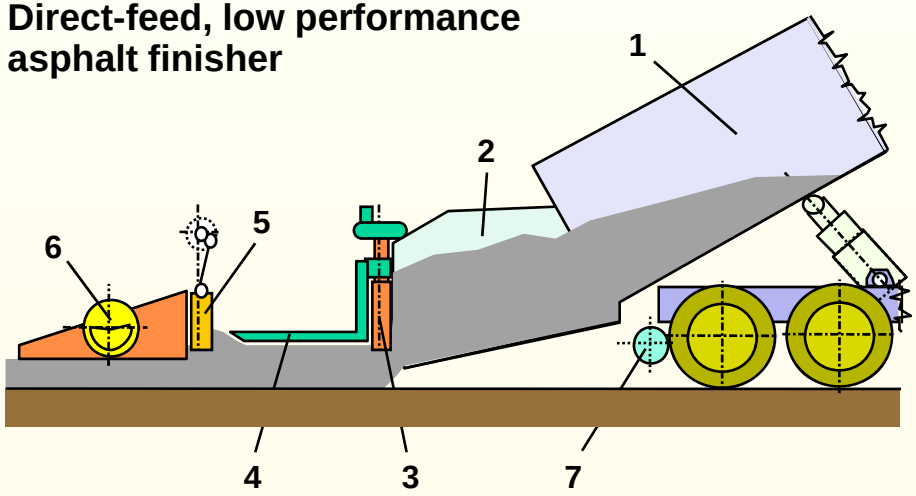
Continuous asphalt mixing plant



1. feeder bunkers
2. collector conveyor
3. conveyor belt scale
4. batching conveyor
5. rotary dryer
6. pre-store basin
7. elevator bucket
8. limestone dust silo
9. feeder screw scale
10. bitumen tank
11. bitumen heater
12. bitumen batcher pump
13. dust collector
14. chambered asphalt bunkers
15. belt scale (for recycled asphalt)
16. elevator line
17. lifting rope (of hoist)
18. ready-mix bunker
19. waste material bunker
20. control room

	Pavers (Finishers)	
	Asphalt	**Concrete**
Course thickness	30 - 300 mm, more layers, spread in layers	180 - 600 mm, single layer
Compacting	preliminary ⇩ by the finisher final ⇩ by rollers	both preliminary and final by finisher (higher output vibrators)
Auxiliary units	mechanical parts in direct contact with the asphalt can be heated	roughening and curing equipments can be attached behind the finisher

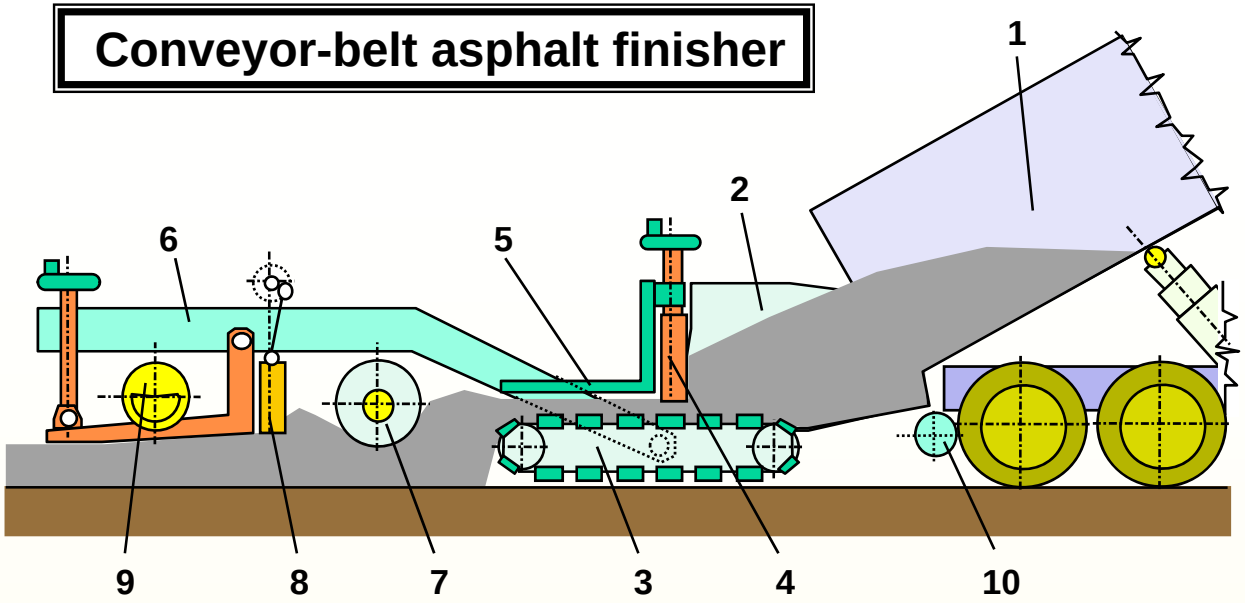
Direct-feed, low performance asphalt finisher



1. dumper truck
2. feeder bunker
3. screed
4. level mould
5. tamper beam
6. vibro plate
7. push idler

Asphalt finisher in action

Conveyor-belt asphalt finisher

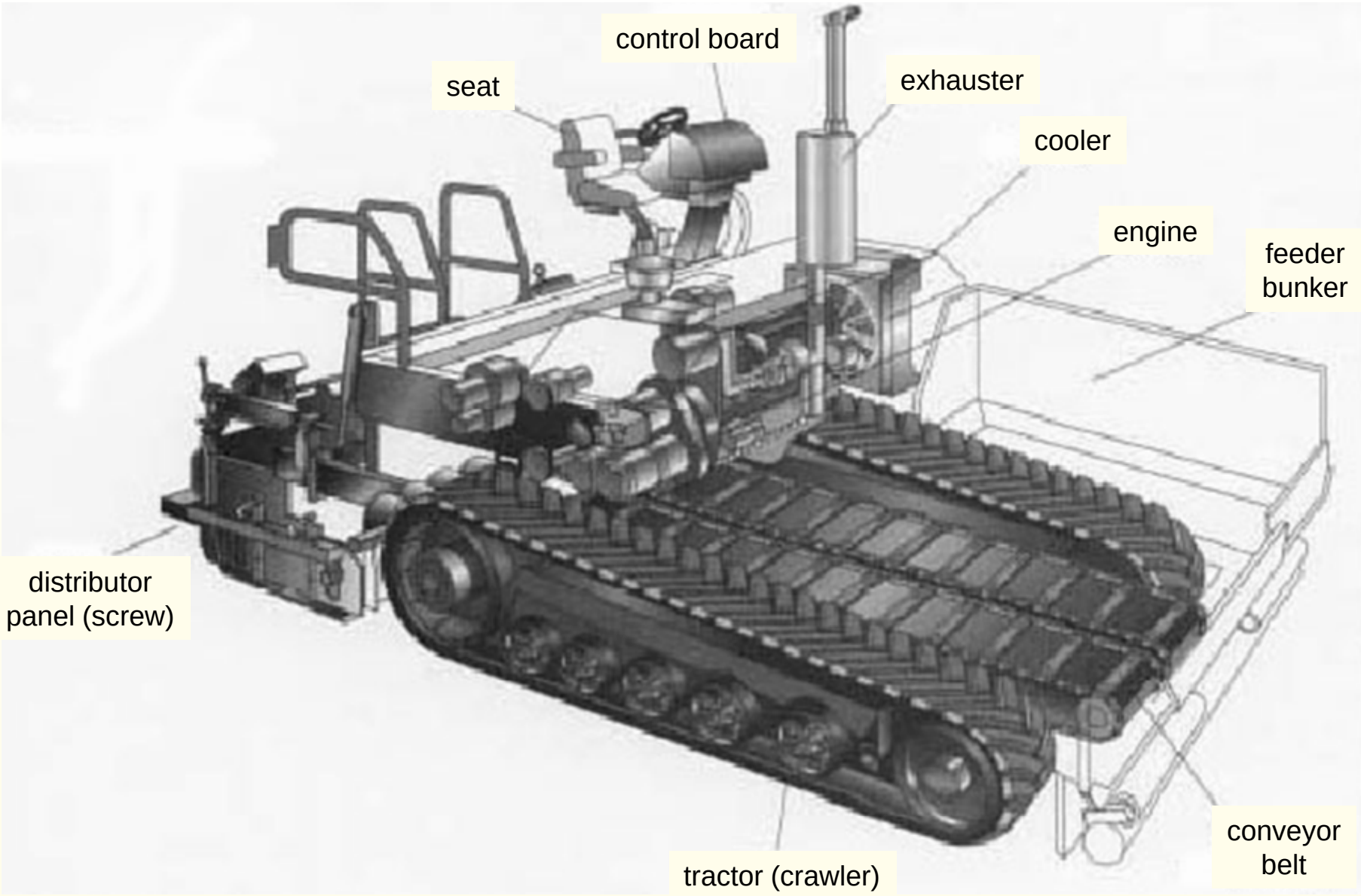


1. delivery dumper truck
2. feeder bunker
3. conveyor belt
4. screed
5. level mould
6. main frame
7. distributor screw
8. tamper beam
9. vibro plate
10. push idler

Feeding the finisher

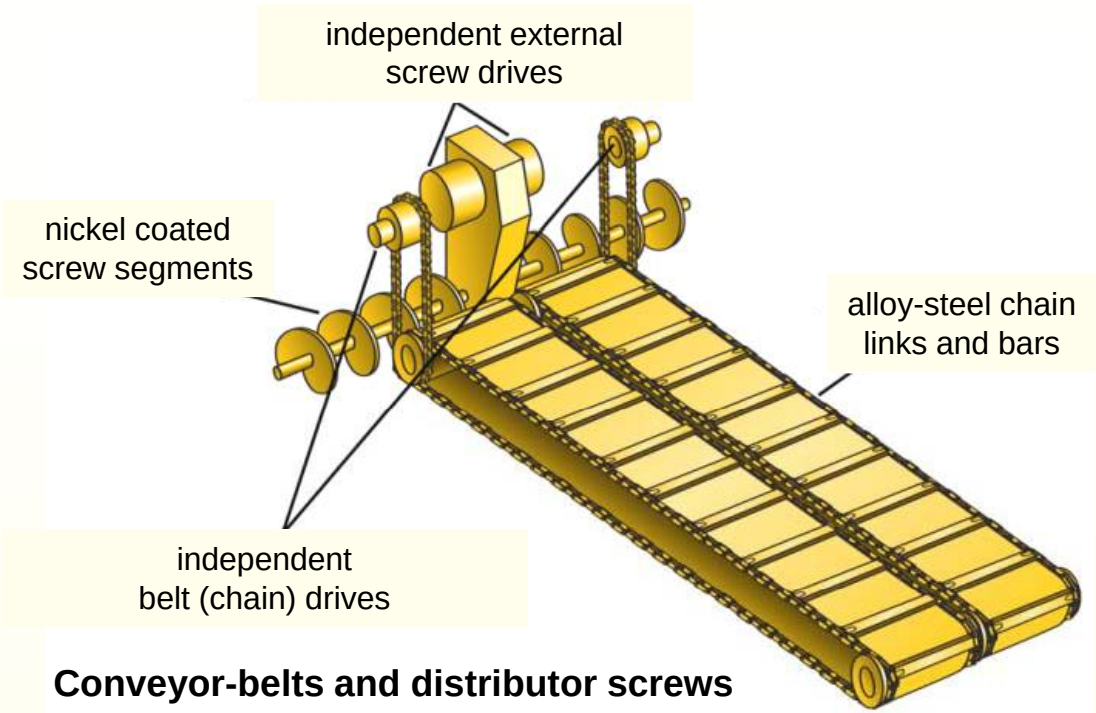
Finishers applied in groups

Conveyor-belt (scraper-chain) asphalt finisher



Main parts of a conveyor-belt (scraper-chain) asphalt finisher

Feeder (bunker)



Conveyor-belts and distributor screws

Bogie types:

- Track (caterpillar)
- Rubber wheel
- Rubber belt (track)

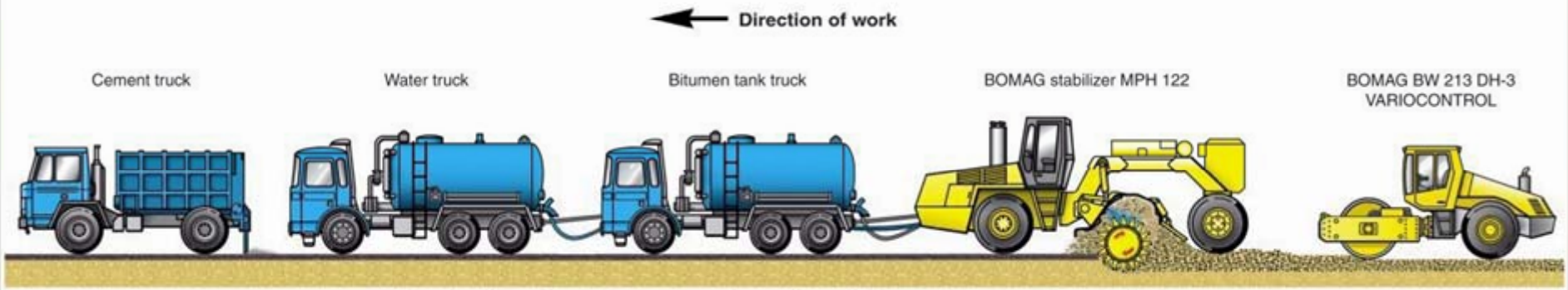
Track (crawler) bogie

Rubber wheel bogie

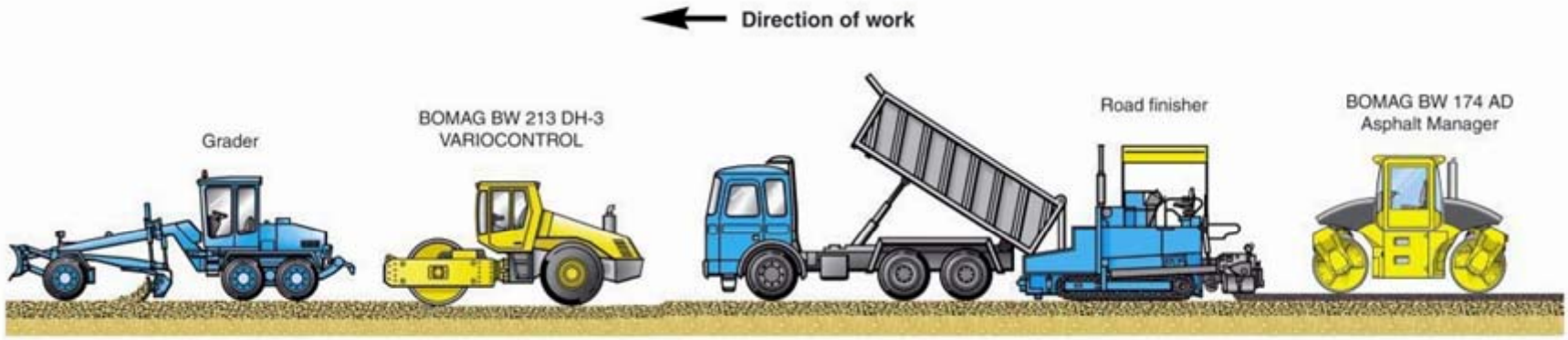
BOMAG

Mix-in-place Recycling

Methods and equipment for the reconstruction of low trafficed roads and road reinforcements



Construction of a new base course by reusing existing road construction materials and adding cement and/or foam bitumen or bitumen emulsion



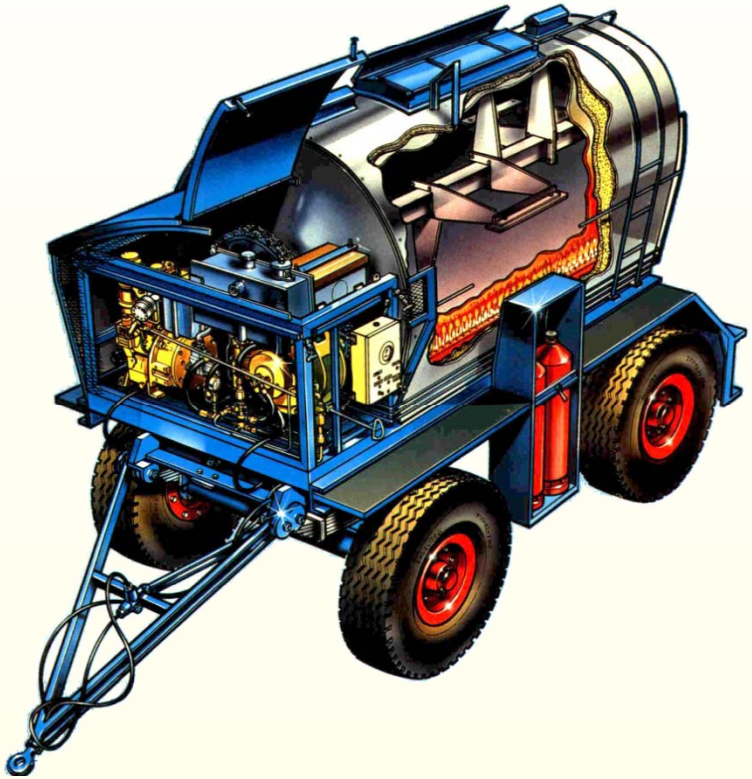
Laying of a new surface layer

gravel-sand asphalt Gravel-sand/old asphalt with new binding agent

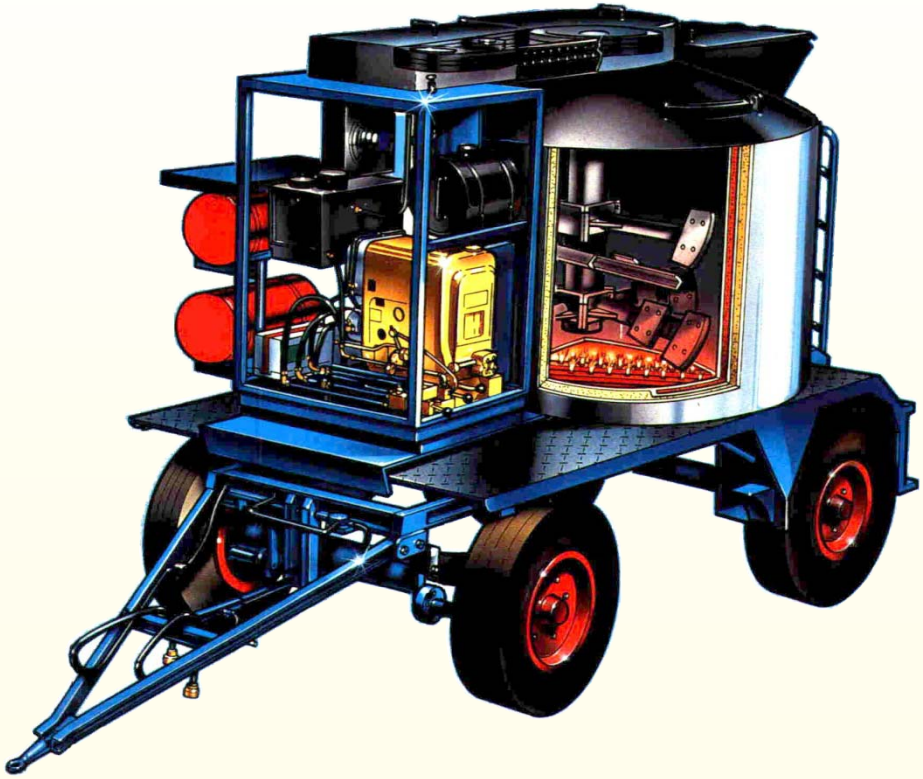
BAO1e-31/03

Mastic asphalt mixers (boilers)

- Fix (batching plant)
- Mobile (masticator)
  - Horizontal shaft
  - Vertical shaft



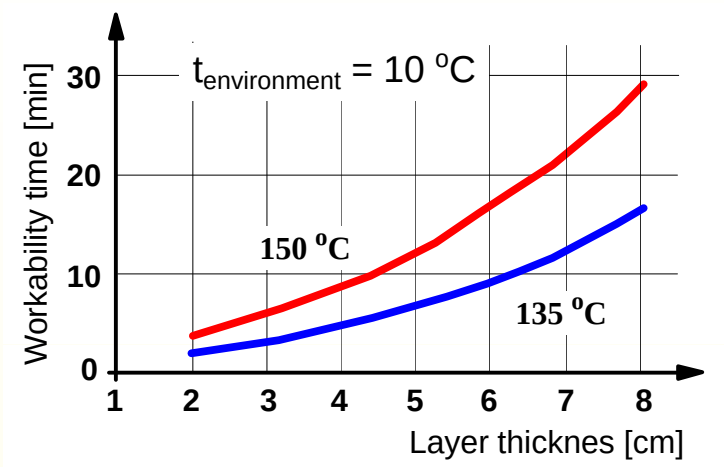
Horizontal shaft mastic asphalt mixer



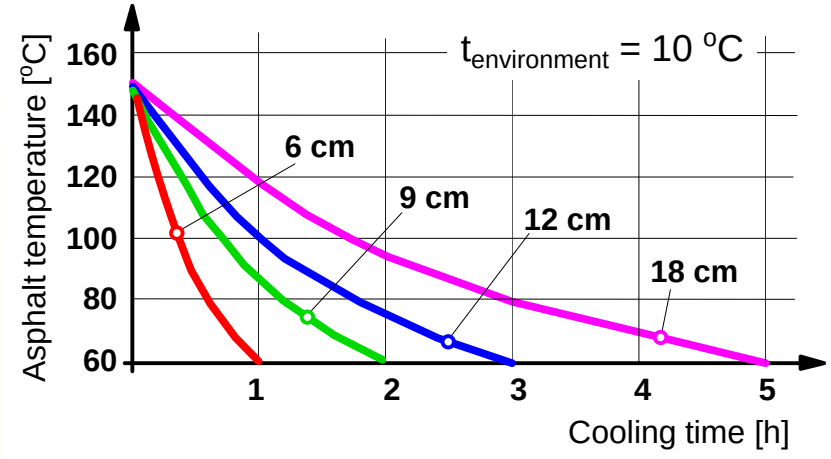
Vertical shaft mastic asphalt mixer

Effect of delivery time of mixtures on workability

Workability time of asphalt in function of mix temperature and of layer thickness



Asphalt temperature in function of layer thickness and of cooling time



Maximum holding time of concrete in function of means of transport and of temperature of the environment

Transporter	Temperature [°C]	Transport [h]	Casting [h]
Mixer truck	30 - 20 19 - 10 9 - 5	1,0 1,5 1,5	0,5 0,5 0,5
Dumper truck	30 - 20 19 - 10 9 - 5	0,50 0,75 0,75	0,5 0,5 0,5

Effect of weather conditions on asphalt works

Temperature close to freezing-point:

⇨ Asphalt must not be laid on frozen base!

Acceptable air temperature when spreading regarding the type of course			
Course	**Base course**	**Bond course**	**Wearing course**
Temperature	> - 3 °C	> 0 °C	> (3 … 6) °C according to thickness

⇨ Snow and ice must be removed from the surface before spreading any aphalt course on it.

⇨ Roller compactors must work immediately after (behind) the finisher.

Hot summer:

⇨ Delivery temperature must be optimized regarding the temperature of the environment.

⇨ Rubber-wheel rollers should not be favoured (due to segregation).

⇨ Handover to traffic is allowed when asphalt temperature got less than 40 °C.

Rainy weather:

⇨ Top (wearing) course must not be spread on wet base or in rainy weather .

⇨ Rain-water collected on the surface must be removed after rainfall before going on.

Managerial tasks of asphalt surfacing

⇨ **When ordering asphalt expectations must be set clearly regarding:**

– quality and composition of mixture (grain-size number, temperature, etc..),

– quantity of mixture, location of use, transport route,

– schedule of delivery broken down to days and to hours.

⇨ **When delivering** unbroken telecommunication is essential between the place of use and the mixing plant

⇨ **Before working in** quality control is evident (sampling regularly, measuring temperature, visual inspection)

Visual inspection of asphalt mixture

Feature	Proper	Cooled	Burnt
Colour	black, weakly sparkling		browny, mat
Steaming	greyish	not steaming	tawny
Castability	easily castable	lumpy	scattering
Adhesion	adheres properly	crust on the surface	low or no any

⇨ **When working in:**

– advancing of the finisher must be adjusted to schedule of delivery and to performance capacity of roller-compactors.

– wearther and temperature of the environment must be also regarded

Sources of B&W pictures and drawings:

- Bacher Károly, Dr. Lánczos Pál, Dr. Soós László, Építésgépesítés I., Tankönyvkiadó, Budapest, 1985
- Dr. Nagy Pál, Építéstechnológia I, Alaptechnológiák, Tankönyvkiadó, Budapest, 1990
- Soós László, Építőoipari gépek I., Tervezési segédlet, Tankönyvkiadó, Budapest, 1987
- Soós László, Építőipari gépek II, Tervezési segédlet, Tankönyvkiadó, Budapest, 1987