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Jetting and Floating Help to Put Cable Underground

Willem Griffioen

Non-Pole Expo, Maintenance & Resilience, Tokyo, 19-21 July 2017

VISION & PERFORMANCE

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Introduction

- Japan by far worldwide leader FttH roll out
- Network almost ready?
- No: No Pole Policy
  - Need to be able to restore service (lifeline) asap
  - Prevent traffic congestion and rescue team blocking due to collapsed poles during disaster (earthquakes, typhoons)
  - No aerial cables spoiling world heritage landscapes
- Demand for new (underground) structures

Introduction

- Collapsed poles

Introduction
Source MLIT

○無電柱化は、「①防災」、「②安全・快適」、「③景観」の観点から推進

道路の
防災性能の向上

通行空間の
安全性・快適性の確保

良好な景観形成

Introduction

- Ducted solution logical underground choice
  - No damage during typhoons
  - Limited damage during earthquakes
  - Cables can be quickly replaced
- Pre-cabled duct (prefab)
  - Might be advantageous in rural areas, in some cases
- Cables installed in duct in the field
  - Advantageous in urban areas
  - Trenches open over short length and time

Introduction

- Pulling in/out now considered in Japan
- And jetting (blowing) and floating (water)?
  - Blown fibre used in Japan in the eighties
  - Mainly abandoned now for the aerial network
- May be reconsidered for underground network
  - Jetting worldwide used today
  - Many advantages over pulling
  - Works for all kind of cables (no need to be flexible)
  - For long lengths floating becomes popular too

Installation Techniques

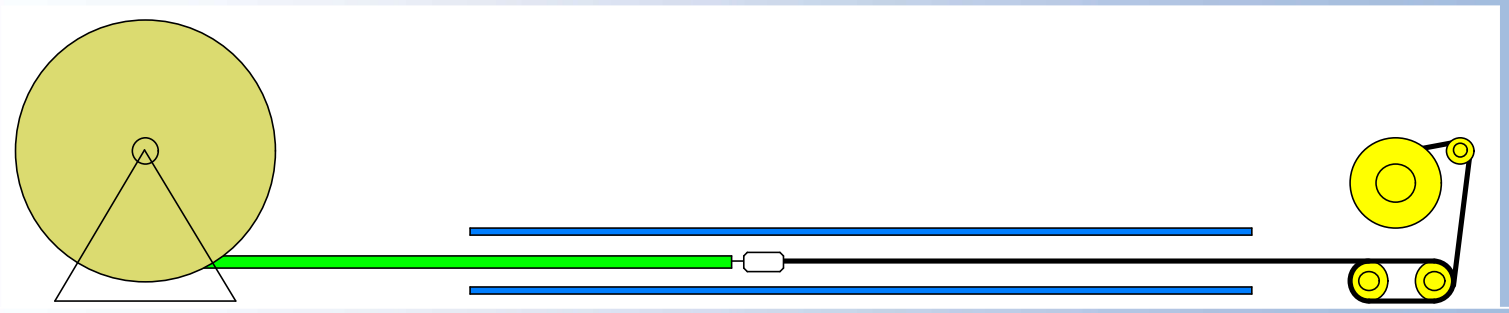
- **Techniques to install cables into ducts:**
  - **Winch pulling**

    Need to install winch line first

    Labour and equipment at both sides duct

    Synchronisation problems

    Length limited by capstan effect

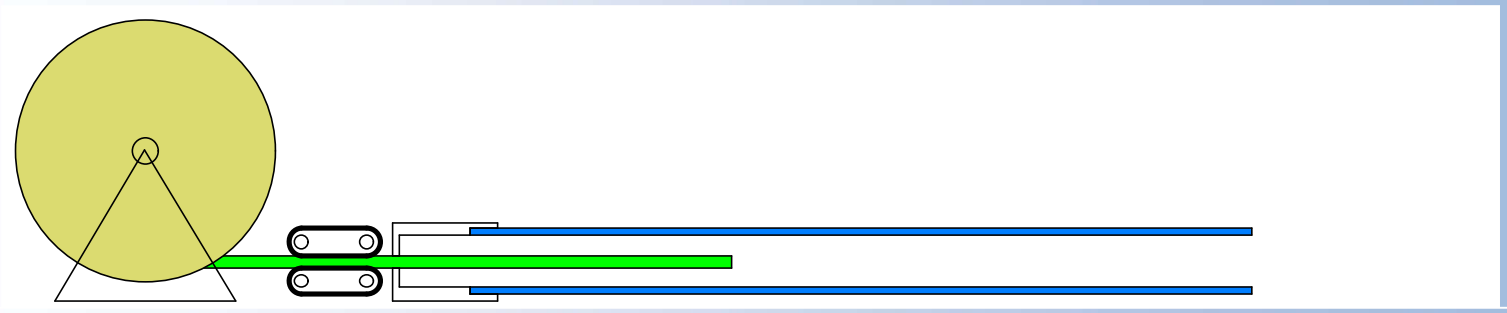


Installation Techniques

- **Techniques to install cables into ducts:**
  - **Winch pulling**
  - **Pushing (rodding)**

    Disadvantages of winch pulling eliminated

    But distance which can be reached further limited



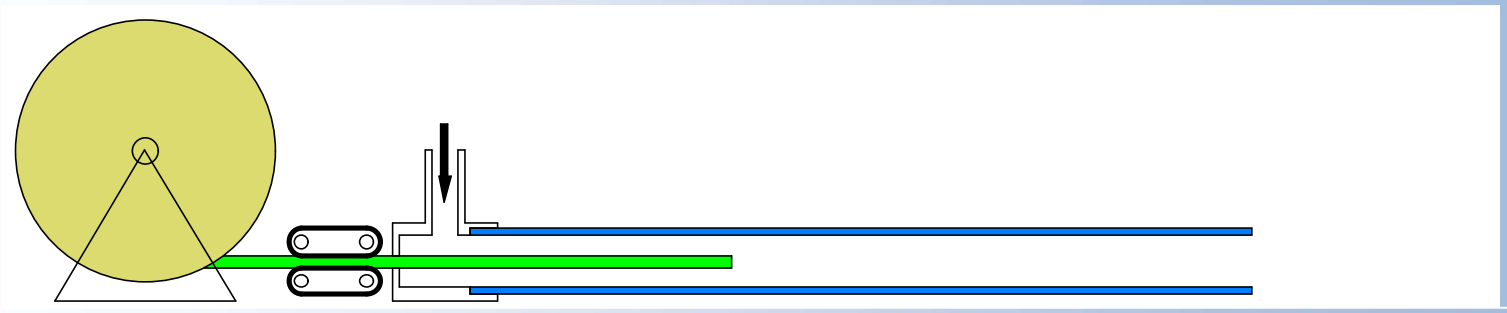
Installation Techniques

- **Techniques to install cables into ducts:**
  - Winch pulling
  - Pushing (rodding)
  - Jetting (blowing)

    The additionally injected airflow does miracles

    Low forces, but distributed, so capstan effect liminated: long lengths!

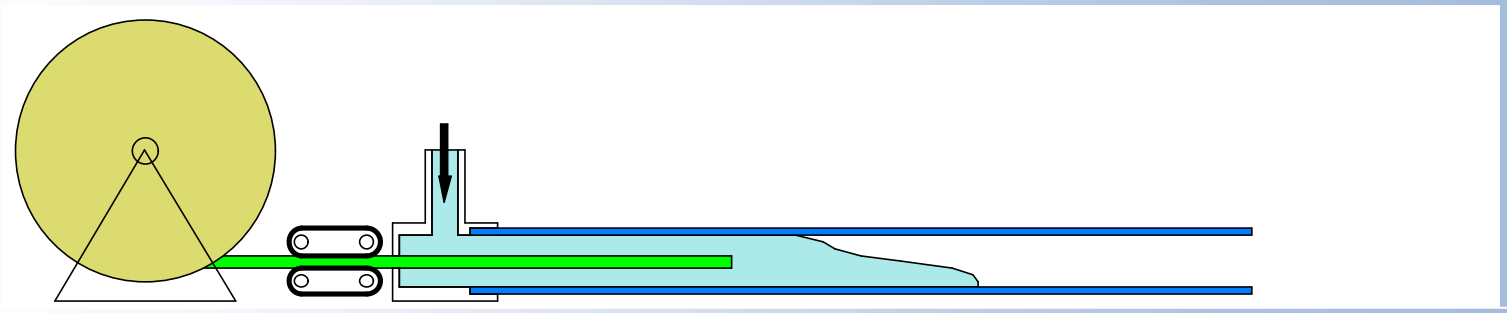
    Bends hardly limit installation length



Installation Techniques

- **Techniques to install cables into ducts:**
  - Winch pulling
  - Pushing (rodding)
  - Jetting (blowing)
  - Floating

    Same trick as jetting, extra help from buoyancy, record lengths!
    Allows larger ducts (less flow because of higher viscosity)



Jetting Practice

- **Netherlands 1987 (KPN):**
  - Pulling length 10 mm cable in 32/25 mm duct 175 m
  - Invention of Jetting made length increase to 700 m
  - Exclusive licence to Plumettaz
- **Worldwide, today (Plumettaz equipment):**
  - Jetting lengths up to 3.7 km reached
  - Cable/duct filling rate increased to 80%
- **Improvements last ¼ century by:**
  - Improved cable, duct and equipment quality
  - Last but not least: lubrication

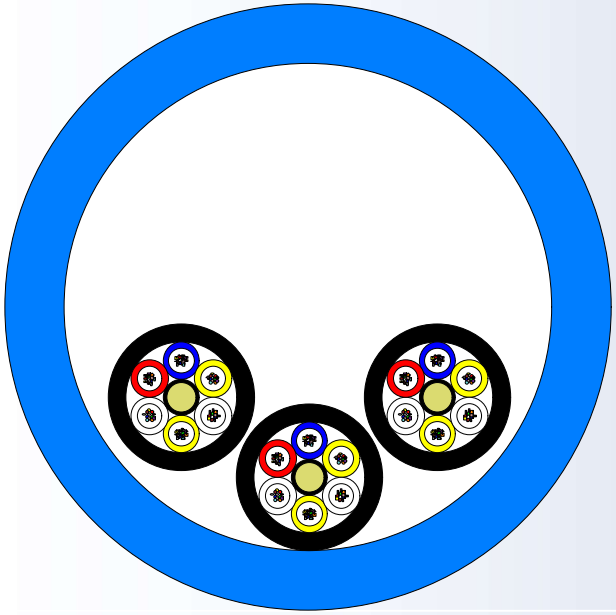
Jetting Practice

- **Used for Telecom cables (almost all cables!)**

Developed in NL in 1987

For 10 mm cable in 32/26 mm duct

Used until max duct size 63/50 mm



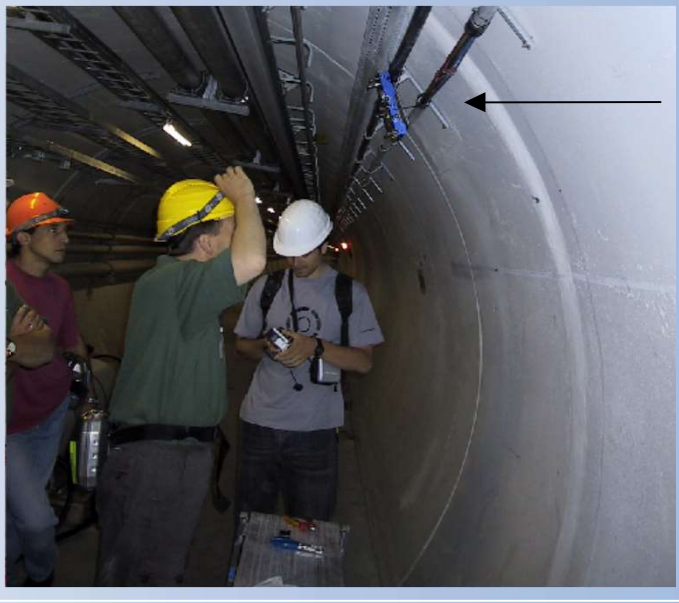
Microduct technology

Also microducts can be jetted in

Cables 1-8 mm, microducts 4-16 mm

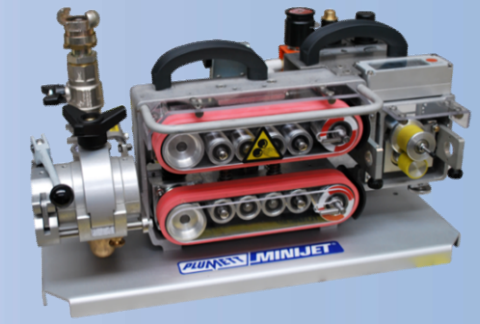
Jetting Practice

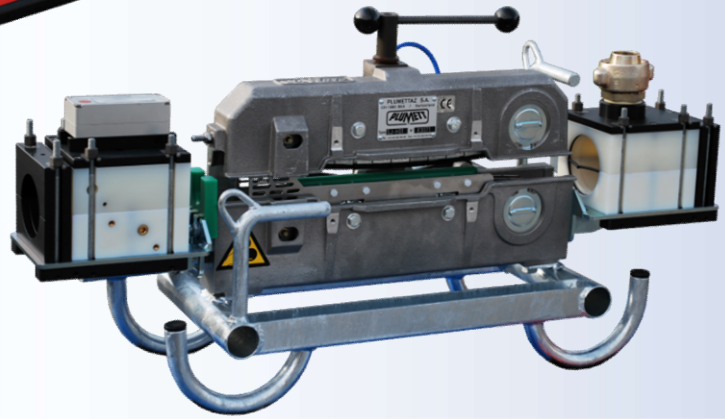
- Example: CERN (Higgs particle)
  - Golden Hadron award 2006, Nobel price 2013
- 1500 km cable, 2500 km microducts
- Jetting record: 3.7 km

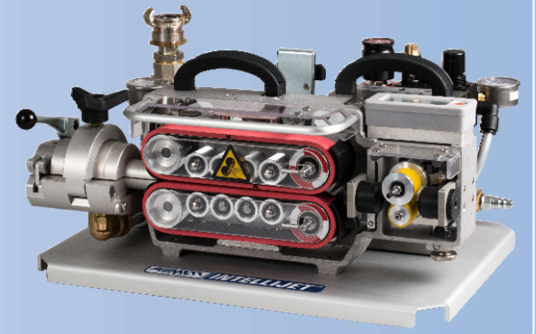


Jetting Practice

Trunk, feeder and distribution cables

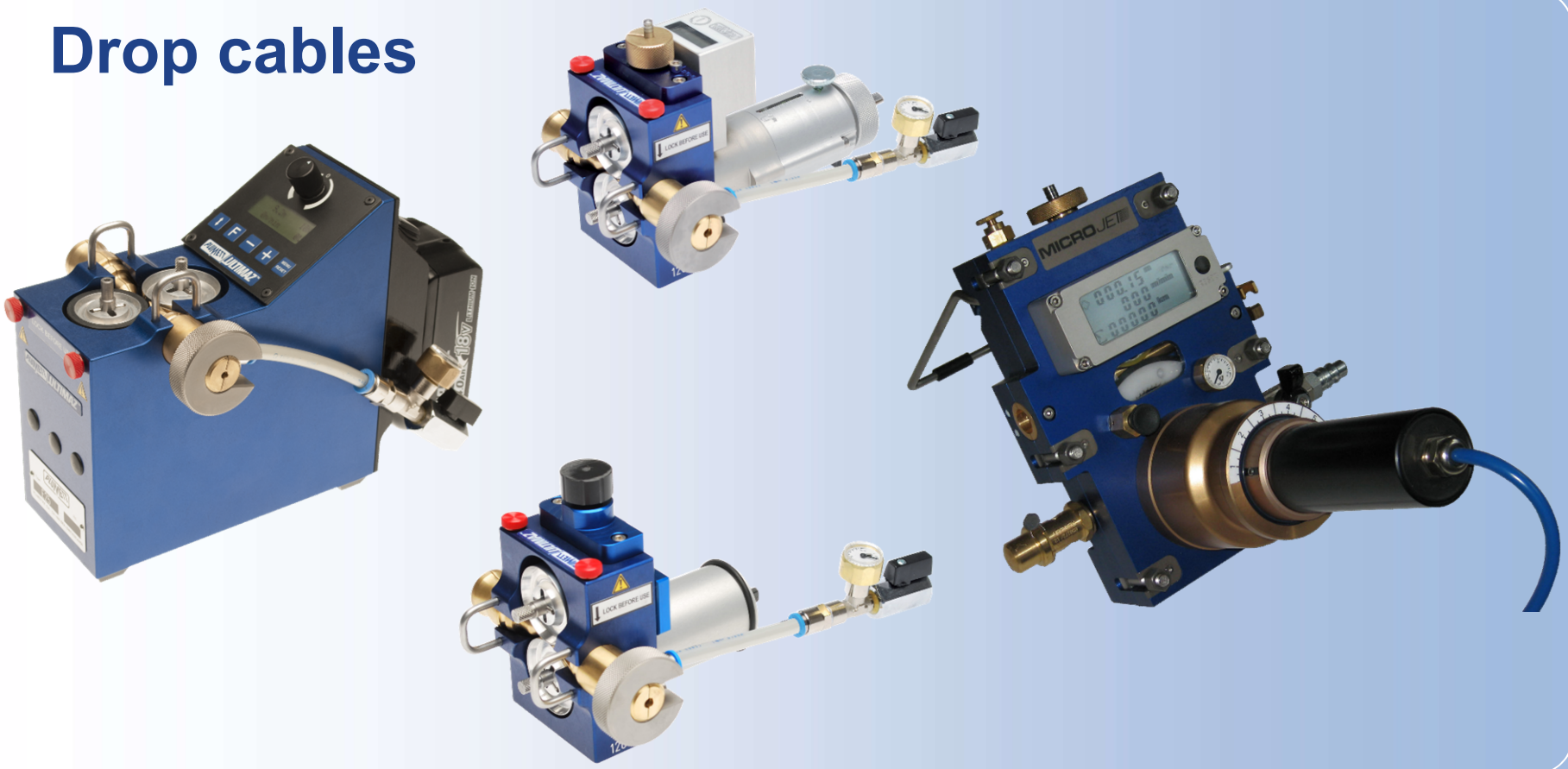






Jetting Practice

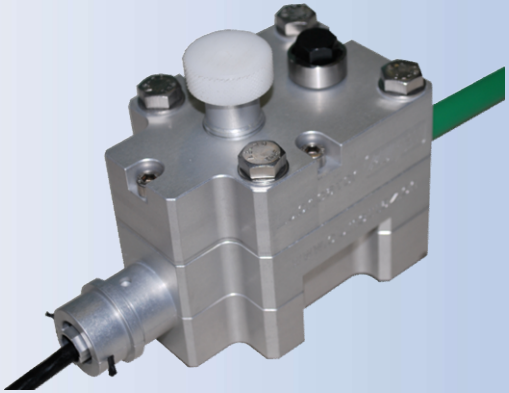
Drop cables

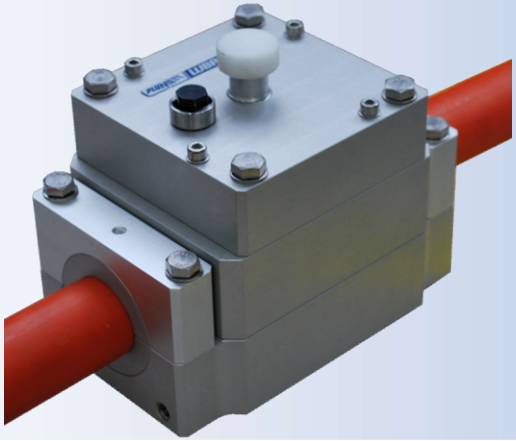


Jetting Practice

Accessories

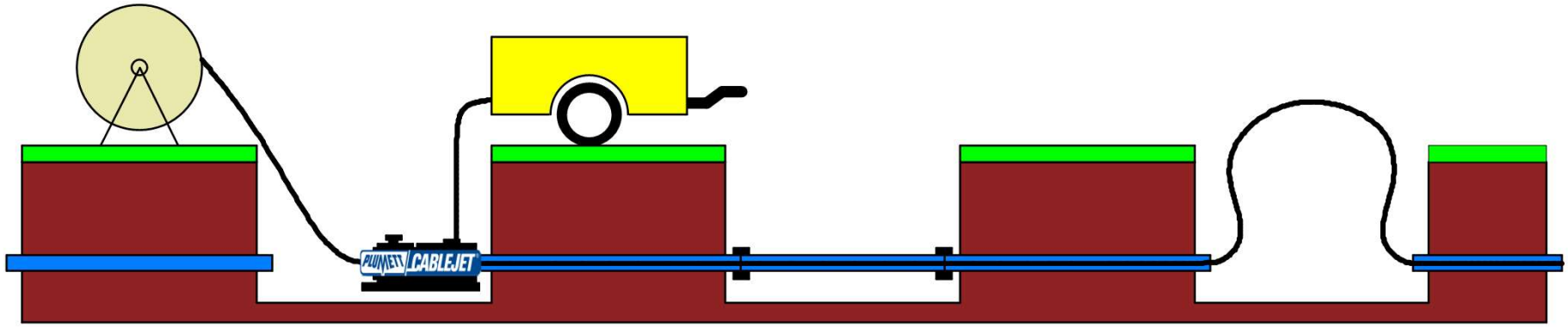
- Cable lubricators
- Cable buffering
- Sonic head





Jetting Practice

- Easy to jet cable overlength
- No pulling needed at open duct end!



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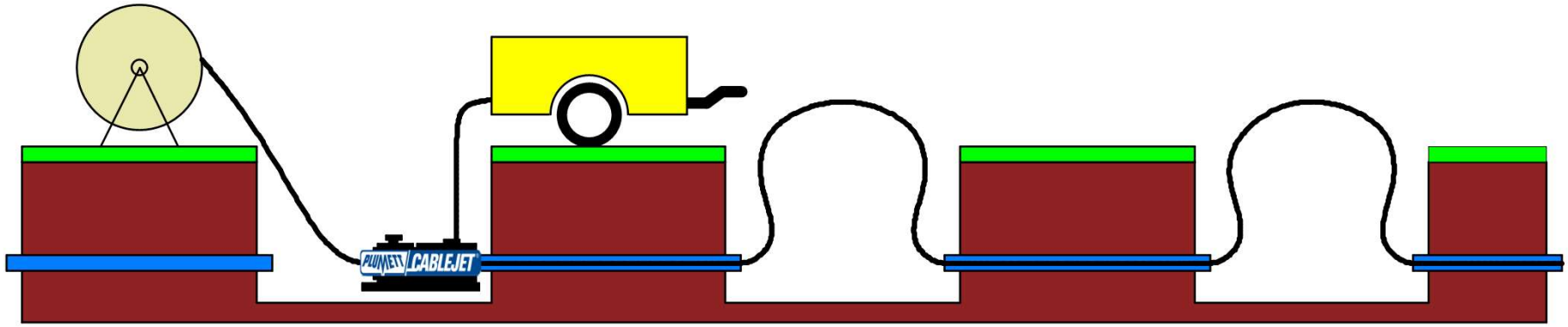
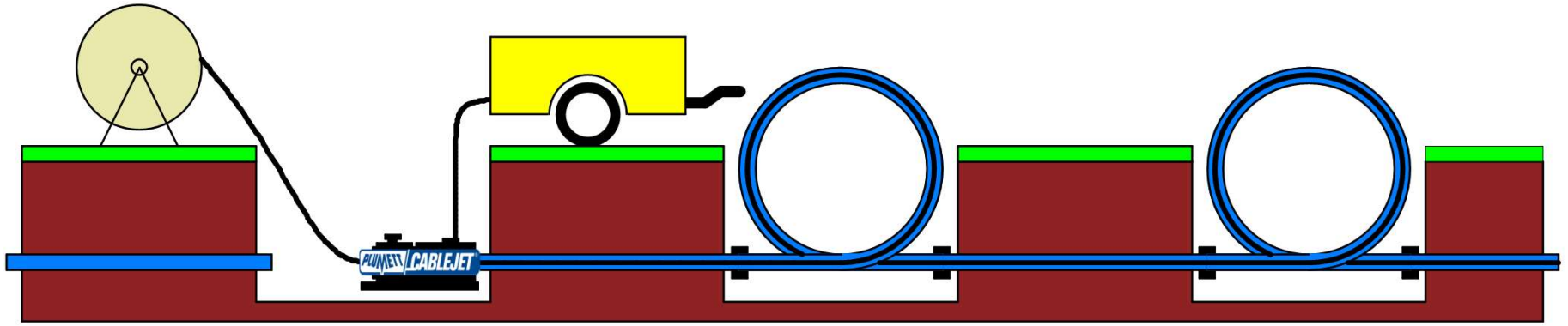


Jetting Practice

- Overlength also possible with duct
- No problems with bends, no capstan effect!

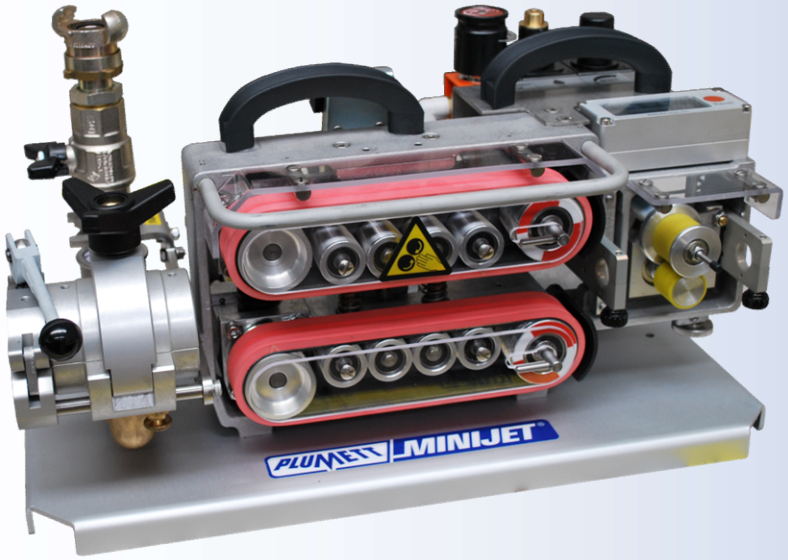


Floating Practice

- A logical follow up after jetting
- Used for Telecom and Energy cables
- Extremely long lengths possible for Floating
  - Limited speed for microducts
  - May require large pump for large energy ducts
  - But for duct sizes 25mm to 63 mm almost no limits
    - Strangely not much used yet for latter application!
    - 10 km already reached for LV cable in 50/40 mm duct

Floating

Equipment for microducts (hydraulics + water)



Floating

Netherlands

- 7 mm 96 OF cable
- 10/8 mm microduct (narrow fit!)
- 2310 m floated
- 22-25 bar water
- End speed 9 m/min

Floating

- Germany (world record for microducts)
  - 5 km of 6.1 mm 96 OF cable in 10/8 mm microduct
- Myanmar
  - 7.2 mm 96 OF cable
  - 14/10 mm microduct
  - 3 to 4 km floated in one go
  - 22-23 bar
  - Average speed 40-50 m/min
  - 8-12 km per day

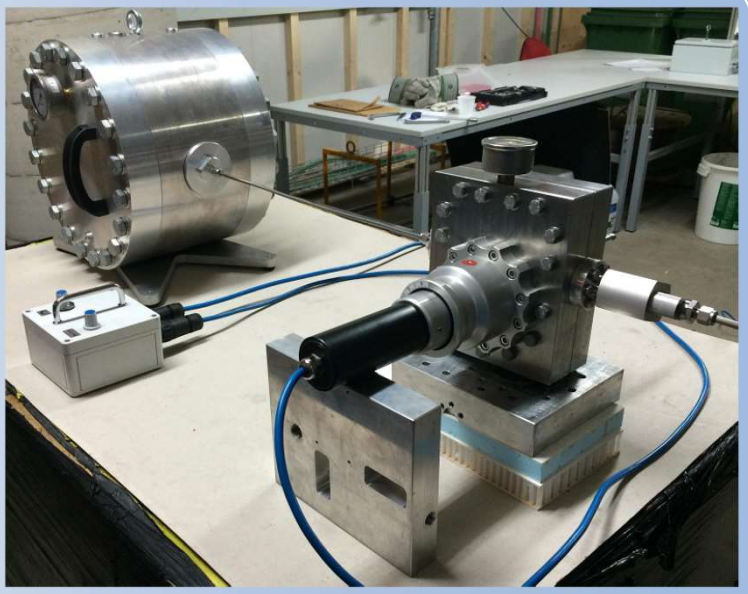
Floating

Extremely large (Energy cables)

- 82 mm power cable, in 125/102.2 mm pipe
  - 680 m test loop in sea
  - On land 1037 m reached with 19 bends
- 160 mm cable possible, over 20 km or more
  - Mass tuning
  - When too large, use pig (Water PushPull)

Floating, SensoJet

- **Extremely small**
  - In steeltube or glass tube
  - Helical shape (often)
  - Tube ID: 0.4 - 5 mm
  - Cables (fibres): 0.16 – 2 mm
  - 10 km possible with 100 bar
  - Application for sensing:
    - Oil & gas (flex pipes, umbiligals)
    - Energy (power cables, steam pipes in plants)
    - Large mould products

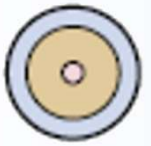


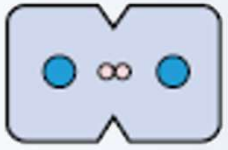
Intelligent Tool

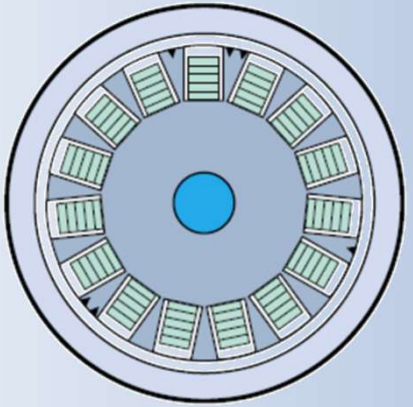
- **Monitors and records:**
  - Pushing force
  - Slip belts – cable
  - Cable velocity
  - Distance
  - Air pressure
  - Air temperature
- **Half automated:**
  - Shuts off when needed
- **Fully automated:**
  - Future target

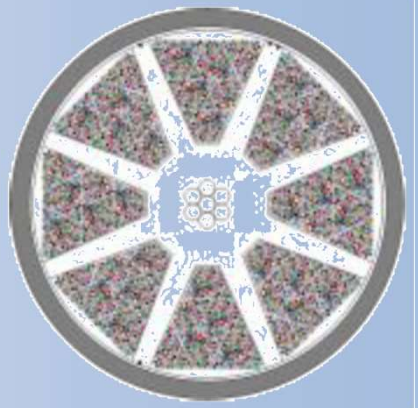
Japan Options

- Wide range of cables
- Most of them suitable for jetting and floating
- FttH drop cables





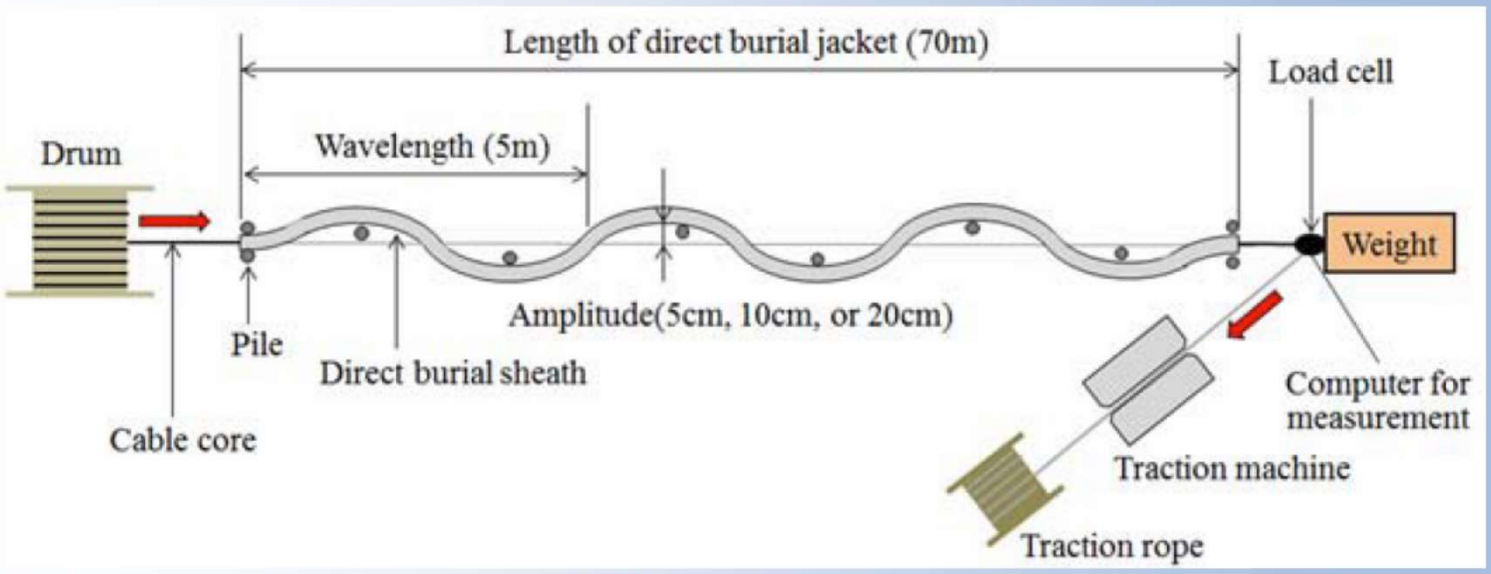




- Trunk, feeder and distribution cables
  - Example, 1728 OF cable with pliable ribbons

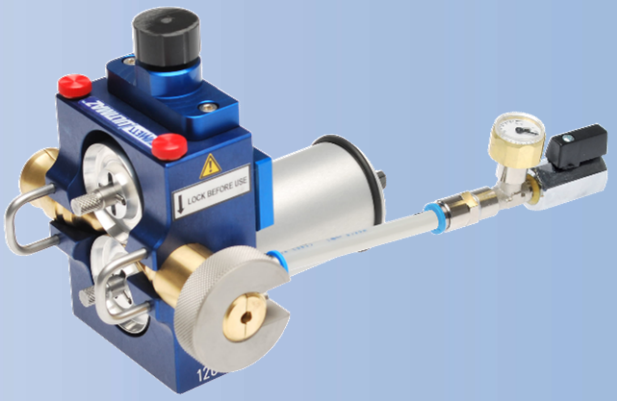
Japan Options

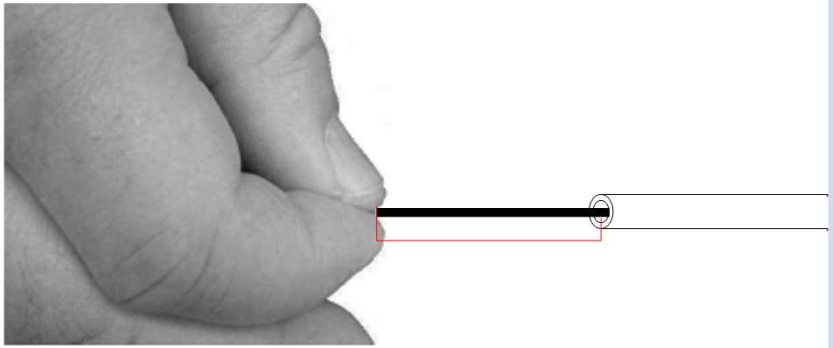
- **Prefab cable in duct (or installed in field)**
  - **For pulling undulations critical for replacement**
  - **For blowing in or out less critical**

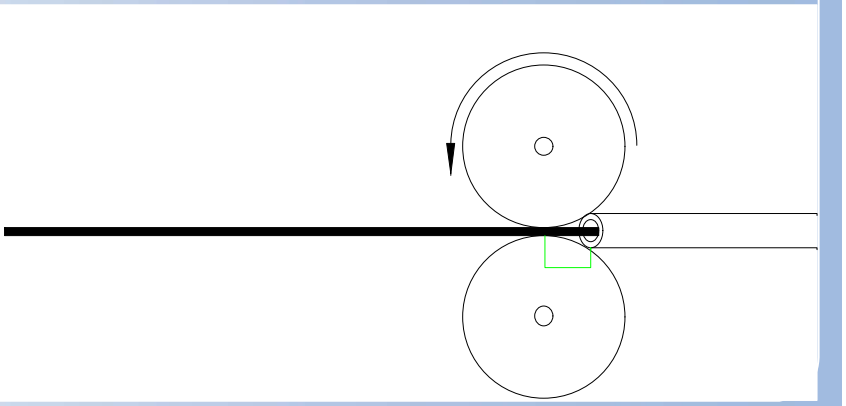


Japan Options

- Drop cables
- P2P pusher (air option)
- Free Stroke
  - Wheel more efficient
  - No risk of damaging the cable







Software

- JetPlanner
- Pulling, Pushing, Jetting, Floating
- Cable parameters (also cable stiffness!)
- Duct parameters
- Trajectory parameters (besides bends and slopes also undulations!)
- Example: 1728 OF cable, 26 mm, 8 N/m, 18 Nm^2 duct 40/35 mm, many bends, 200 m long

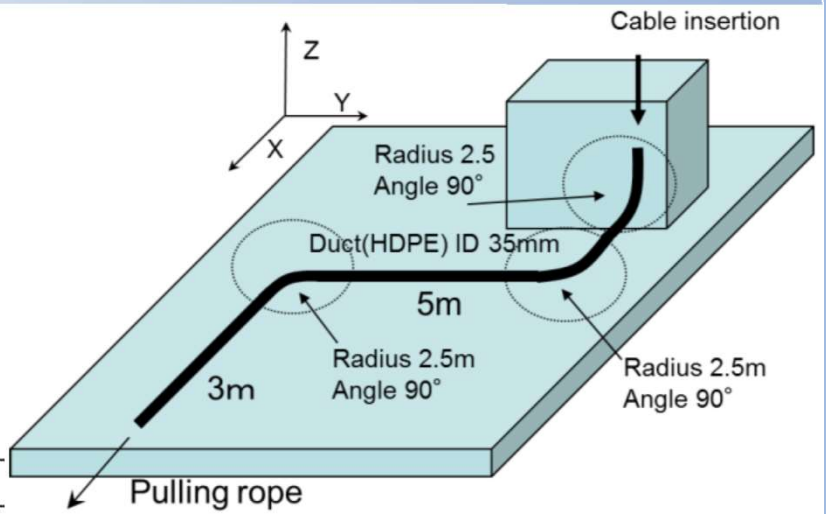
Software

Example: Jetting in 2x Japanese pull trajectory, elongated to 200 m and return loop

```
Cable diameter (mm). . . . . =   26.00
Cable weight (N/m) . . . . . =    8.00
Cable stiffness (N*m2) . . . =   18.00
Intrinsic cable curvature. . =      No
Duct inner diameter (mm) . . =   35.00
Coefficient of friction. . . =    0.20
Undulation amplitude (mm). . =   50.00
Undulation period (m). . . . =    8.00
Installation method. . . . . = Jetting
Compressor pressure (1000hPa). =  5.00
Compressor capacity (m3/min) . =  9.00
Pushing unit . . . . . = SuperJet H
Pulling support. . . . . =        -
Number of curves . . . . . =      9
Number of slopes . . . . . =      5
Bundle . . . . . =       No
Resident cables in conduit . . =  No
```

Result:

Maximal installation length: 218 m



Curves on (m): (curve radius(m)/curve angle(deg) in parenthesis)

5(2.5/90)	14(2.5/90)	18(2.5/90)	22(2.5/90)
100(2.5/180)			
178(2.5/90)	182(2.5/90)	186(2.5/90)	195(2.5/90)

Slope	from (m)	to (m)	incl. (deg)	Slope	from (m)	to (m)	incl. (deg)	Slope	from (m)	to (m)	incl. (deg)
1	0	18	0.0	3	22	178	-0.0	5	182	20000	0.0
2	18	22	90.0	4	178	182	-90.0				

Conclusions

- Japanese no pole policy opens the way to new cable installation technologies
- Ducted solution: easy to replace cable
- Jetting technique suitable for Japanese cables
  - High count trunk, feeder and distribution cables
  - Prefab cable in duct or installed in the field
  - Drop cables to the homes (also pushing)
  - Advanced software to calculate installation length
- Floating technique? Next step after jetting?

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Thanks for your attention

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Distributor Japan: ATECH CO., LTD

本社
PLUMETTAZ S.A.
Route de la Gribannaz 12
1880 Bex, Switzerland

エイテック株式会社

〒328-0061
栃木県栃木市新井町1024-7
TEL:0282-20-742