



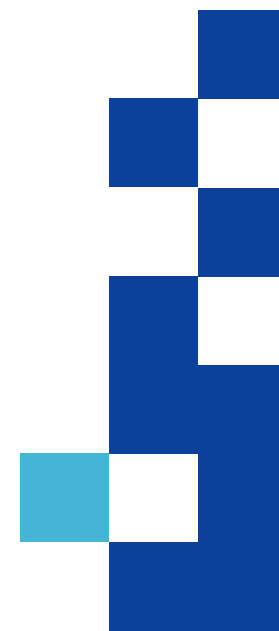
Increasing the use of PE pipe for large diameter water mains

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PE100+ Advisory Meeting

Nice, 9 June 2004



PE Pressure Pipes



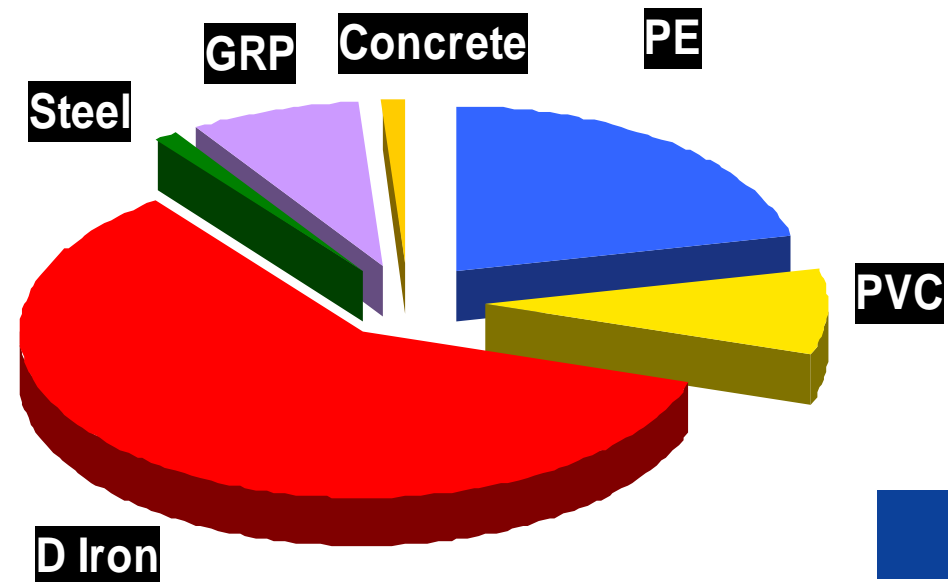
- Modern polyethylene is a highly engineered, high performance pipe material
- PE80 has now been in use since the mid 80s and PE100 since 1990
- PE pipeline systems are now the UK Water Industry standard for distribution size mains
- PE jointing systems obviate the need for anchorage, minimise leakage and make PE the ideal material for cost saving and environmentally friendly trenchless installation methods
- But what about large diameter use?



The Large Diameter Pipe Market

Water Pipe in UK 2001

- Data in km per annum for pipes of 300mm & larger
- Total length 646 km of which 138 km PE (21%)
- This means a potential growth of over 18,000 tonnes of PE pipe
- So what are the obstacles?



Source: AMI 2003





What are the factors affecting increased use of large diameter PE?

- Cost
- Conservatism
- Lack of knowledge/experience
- Confused/conservative design rules and guidance
- “Complicated” jointing methods – some thought poor
- “Complicated” and lengthy pressure test methods
- Poor product range



Cost



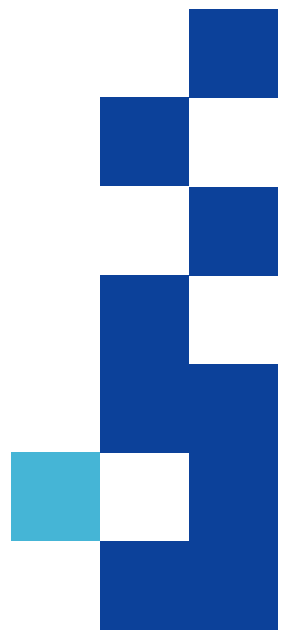
- Generally PE will lose out on materials cost
- Can improve comparison by using installed cost and correct hydraulic sizing and choice of pressure rating
- Really need a true 'whole life costing' model
- Need to correct the common fallacy that the life of PE pipe systems is 50 years whereas competing materials last longer



Conservatism



- PE has a limited track record compared with most of the other materials – and engineers therefore have limited experience
- Large diameter mains are treated as ‘one off’ engineering projects
 - Designers are not necessarily pipeline engineers
 - Designers lack operational experience
- DI and steel are familiar materials
- PE regarded as “plastic”, therefore not an engineering material



Guidance Documents



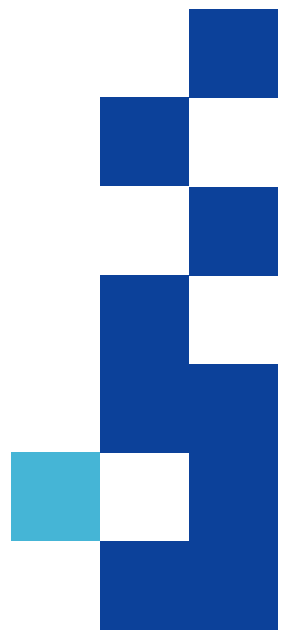
- Pipe Materials Selection Manual – 2 editions
- PE Pipelines Manual – 3 editions
- CP 312 / BS 8010
- PErseus software – structural and hydraulic design
- IGN 4-37-02 – design for surge and fatigue
- IGN 4-32-18 – design guidance for PE pipe systems
- IGN 4-?-? – guidance on the WIS/EN differences



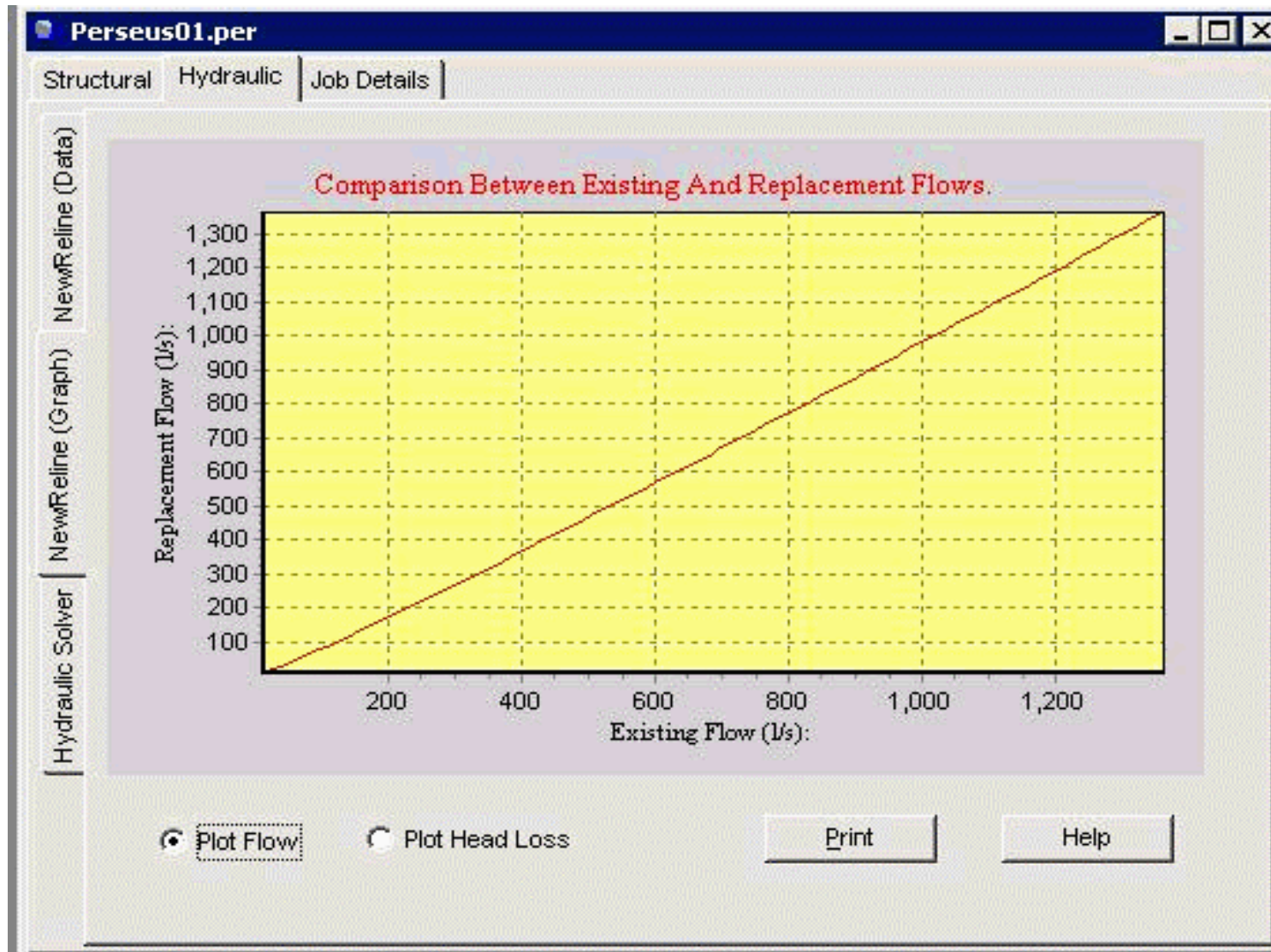
Confused Guidance/Design Rules



- Guidance documents available are not widely promoted
- Guidance has improved rapidly but old, outdated versions still in circulation
- Structural design methods still very conservative
- Confusion between WIS, CEN and ISO standards – many engineers don't know the differences!
- Few technical courses/training on the “new” materials



Hydraulic Design



Existing 30" (760mm) CI versus PE 710mm
SDR17



Surge and Fatigue



- PE slipline - 630mm into 720mm , 3km long
- Working pressure : 2.5 bar
- ' Surge ' envelope : 0 - 5 bar
- PMSM/CP 312 : $dp < 0.5^*$ static rating
- WIS 4-37-02 : $dp =$ static rating if surge less than 2^* PN
- 10 bar rating versus 4 bar rating
- Material cost difference : £115,000



Structural Design



- EN 1295 - 12 national annexes ! - None are appropriate for plastic pipes

Overall modulus of soil reaction $E' = E_2 C_L$

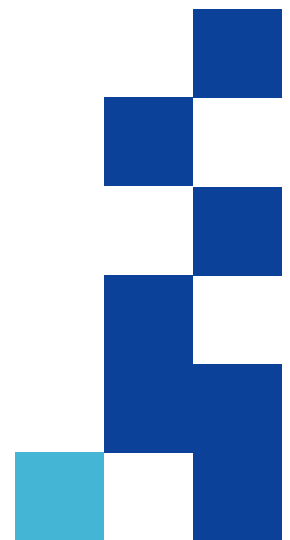
Note that if $b > 4.3 * d_e$, then $E' = E_3$

$$\text{Soil modulus adjustment factor } C_L = \frac{0.985 + 0.544 \frac{b}{d_e}}{\left(1.985 - 0.465 \frac{b}{d_e}\right) \frac{E_2'}{E_3'} - \left(1 - \frac{b}{d_e}\right)}$$

$$\text{Short-term critical pressure } P_{crs} = 0.6 \left(\frac{E_s I}{d_m^3} \right)^{0.33} (E')^{0.67}$$

$$\text{Long-term critical pressure } P_{crl} = 0.6 \left(\frac{E_1 I}{d_m^3} \right)^{0.33} (E')^{0.67}$$

$$\text{Rerounding of pressure pipes } \left(\frac{\Delta}{d_m} \right)_R = \left(1 - \frac{P_1}{40} \right) \left(\frac{\Delta}{d_m} \right)$$





Consult online at BPF or WRc websites



Free from websites



“Complicated” Jointing

- Needs special, expensive, hard to get equipment
- Takes much longer than DI etc – over 1 hour to make a 630mm SDR11 joint
- “Dual pressure” method seems complicated and difficult to achieve control of
- Different parameters for water and gas
- Large Diameter EF couplings expensive
- Large diameter EF couplings too prone to failure
- Need special trained staff





PE Jointing Machine
Single purpose



DI/GRP Jointing Machine
Multi-purpose



“Complicated” Pressure Testing

- Not straightforward for viscoelastic materials because:
 - Creep behaviour
 - Material dependent
 - Temperature dependent
 - Embedment condition dependent
 - Time dependent

- DI etc are only time dependent



EN 805 Method – Modified ‘Rebound’

■ Preliminary Test

- After filling, reduce pressure to atmospheric and allow to stand for at least 60 minutes
- Raise to test pressure in less than 10 minutes
- Maintain test pressure for a further period of 30 minutes
- Shut off and allow main to stand for 60 minutes without pumping
- If pressure is $> 70\%$ of test pressure continue to next phase
- If drop is greater consider if test conditions have changed, temp etc
- If test repeated allow a minimum 60 minutes relaxation period

■ Two further stages if this is successful!





Limited Product Range

- 16 bar rated pipe only available up to 630mm
- 10 bar rated pipe only available up to 1000mm
- EF couplings only available up to 710mm
- Many large diameter fittings are fabricated – concerns about mitred joints
- DI has a full product range of pressure ratings and fittings up to 1000mm and GRP/steel go above this.





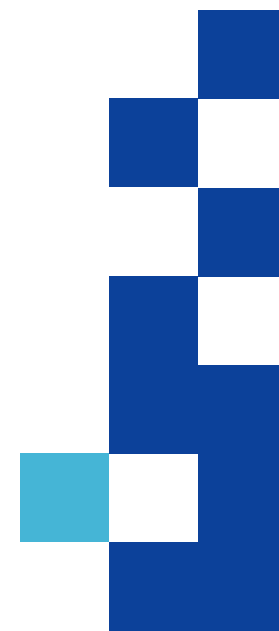
But on a more positive note...

- PE is **the** material for “Trenchless” Techniques
- These should be promoted by all for the refurbishment of trunk mains, especially in urban areas
- Cost savings should be available over conventional open cut
- Experience with PE in this field of application should promote wider use in new lay applications
- Engineers need to be given a better understanding of PE material properties and TT design



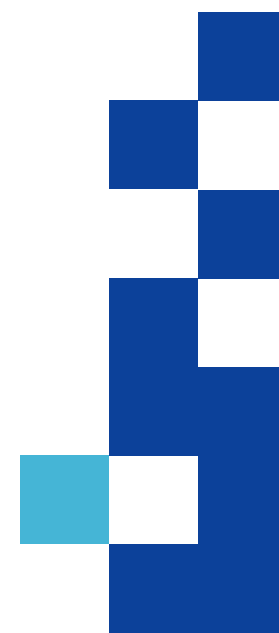


Conventional Sliplining



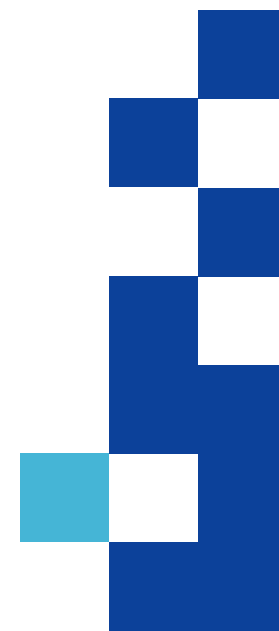


'Rolldown': Up to 500mm; SDR 11 to 33





'Subline': up to 1400mm; SDR26 to 80





Thank You

