

Butt-fusion Harmonisation Project for the Welding of Large Diameter Polyethylene Pipe

Steering Group Project Manager appointed by PE 100+ Association

Steve Beech

SHB Consulting

beechs@blueyonder.co.uk

May 08

Buttfusion Harmonisation

OBJECTIVE

- Ideally to have one or two ISO standardised fusion procedures
- Confirmed by accepted ISO standardised tests

Buttfusion Harmonisation

How to achieve objective?

- Review of test methods for butt welds
- Assess short and long term tests using medium to thick walled pipe
- Confirm suitability of tests
- Assess procedures
- Revise standards – test methods/procedures

Buttfusion Harmonisation

- Steering Group membership
 - PE 100+ Association members
 - Marcogas, GdF, GasTec
 - Becetel, Hesseltechnic, Bodycote PDL
-
- Finance – PE 100+ Association
 - Support – GdF
 - Reinert Ritz
 - Egeplast
 - Widos
 - McElroy

Buttfusion Harmonisation

The general situation

- 3 principal methods – European single pressure, US single pressure, UK dual pressure – and ‘variations’
- ISO standard being developed to incorporate the 3 procedures (ISO DIS 21307)
- Testing – ISO, DVS, WIS, ASTM, JIS, GdF etc
- Tensile, bending, creep, pressure test etc

Available test methods?

- Countries/organisations contacted include:-

Marcogas, UK Water/PDL, Germany DVS and DVGW, Becetel, GasTec and NEN, INSTA Scandinavia , PPI, Japan – Prime Polymers & Mitsui, PIPA Australia, Italy, manufacturers

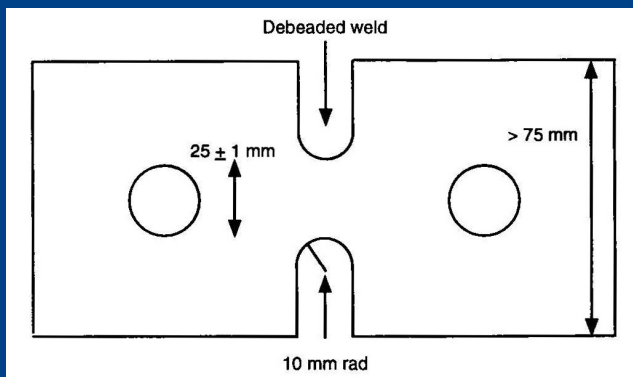
Short term tests

- Tensile tests – small specimens
- Parallel sided – plane strain geometry issue
- Pipe assembly test – increased thickness at weld, biaxial stress distribution

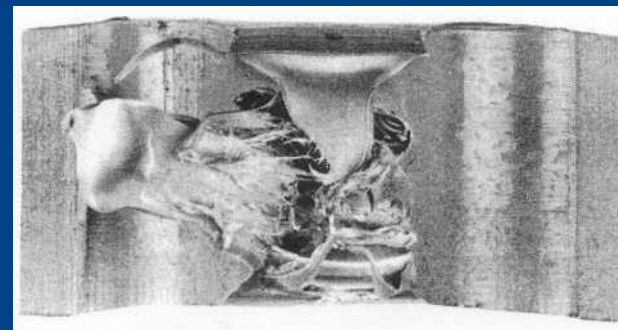
Conclusion – Tests for evaluation at extended geometry

- WIS type drilled specimen better especially with energy measurement
- DVS EN 12814 bend test, little experience outside Germany but of interest

WIS 4-32-08 Test Specimen



Mixed mode

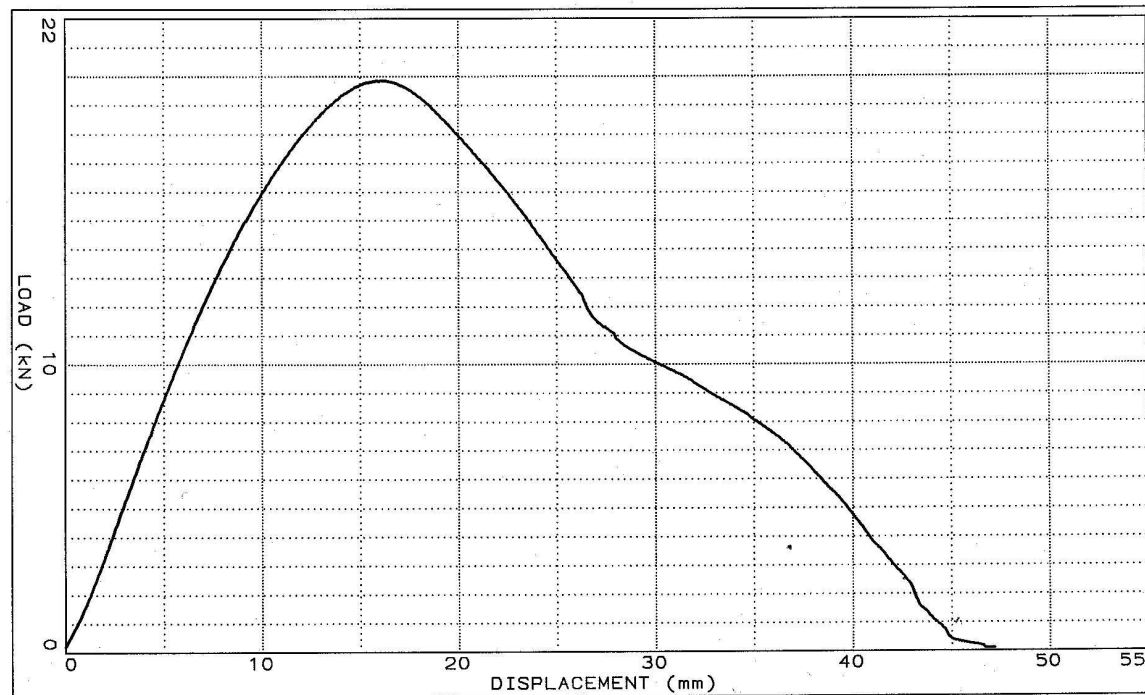


Ductile



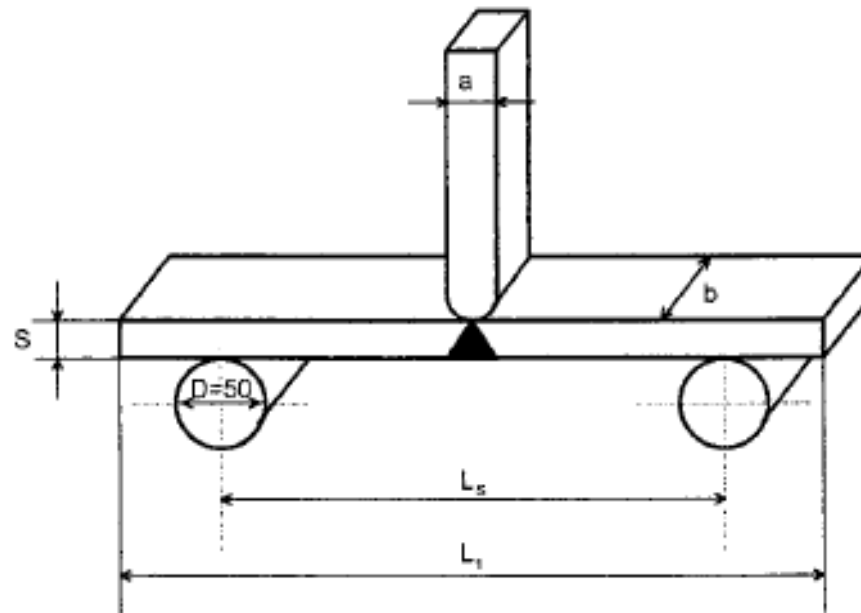
Brittle

WIS Test



Energy trace for ductile behaviour

DVS Bend Test



- | | | | |
|-------|----------------------------------|----------|-------------------------------|
| s | thickness of test specimen | f | ram displacement |
| b | width of test specimen | α | bend angle |
| L_1 | total length of specimen | a | diameter of ram |
| L_s | distance between axes of rollers | D | Diameter of the rollers in mm |

Figure 1. Sketch of the test arrangement.

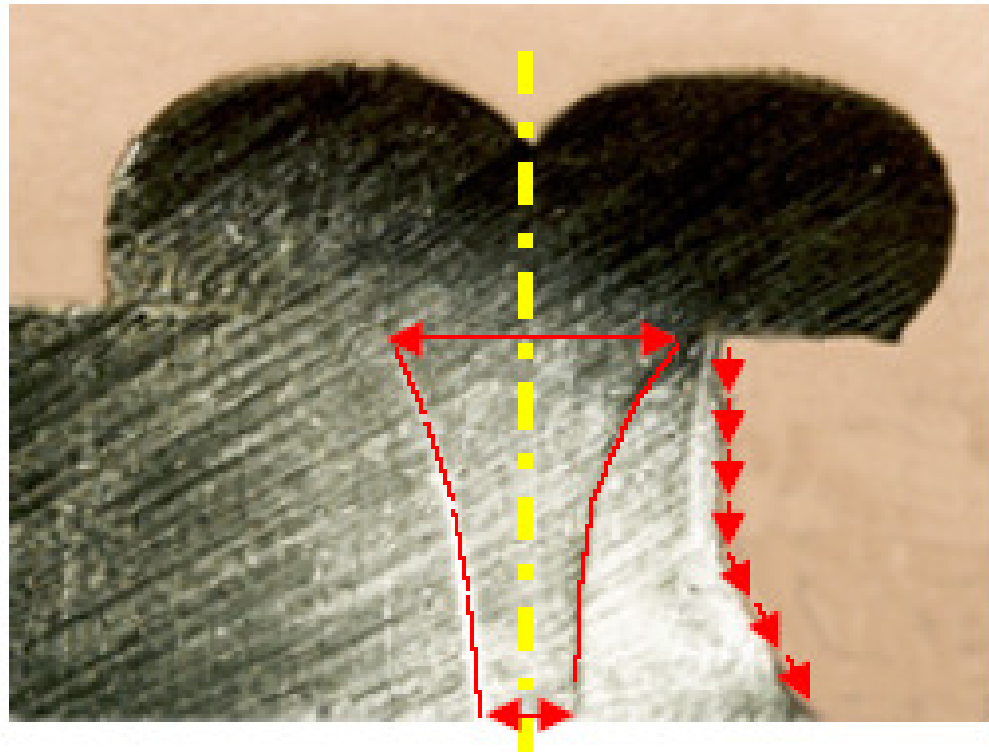
Failure criteria
– achieve a
minimum bend
angle without
cracking

**Test inner and
outer weld
beads**

Buttfusion Harmonisation

- Potential long term failure mode in service?
- SCG from notch created by weld beads
- Whilst material dependent, may be affected by welding procedure also.

SCG Failure at weld



Typical crack path at butt welded PE-joints.

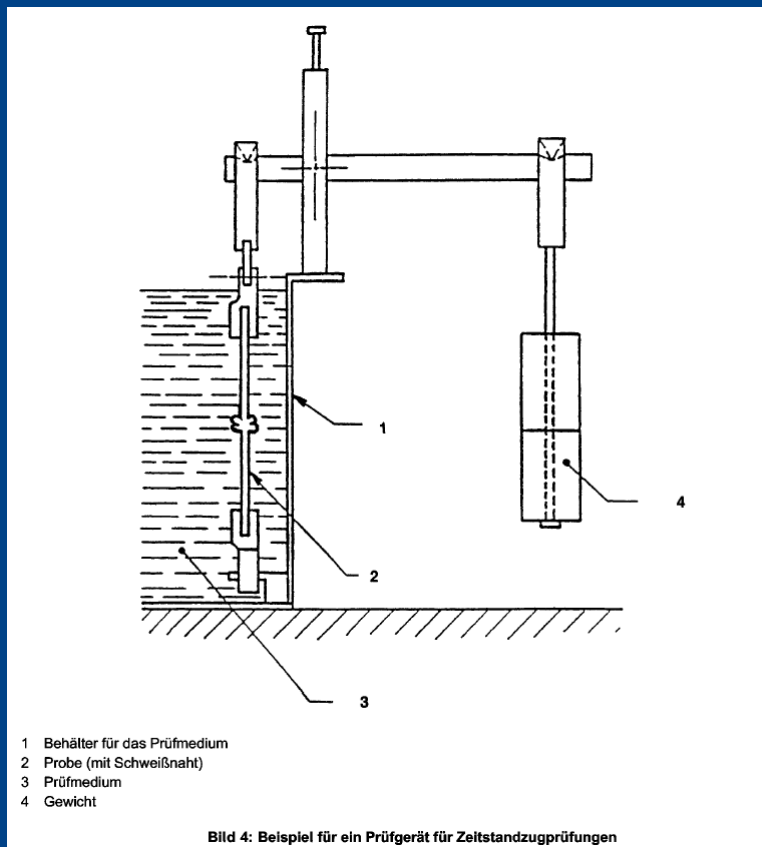
Long term tests

- DVS EN 12814 Creep test, full thickness, failure mode observed as SCG in service
- FNCT small specimen, centre weld zone
- GdF cylindrical 'FNCT'
- Longer term assembly pressure test – discounted

Conclusion - Tests for evaluation

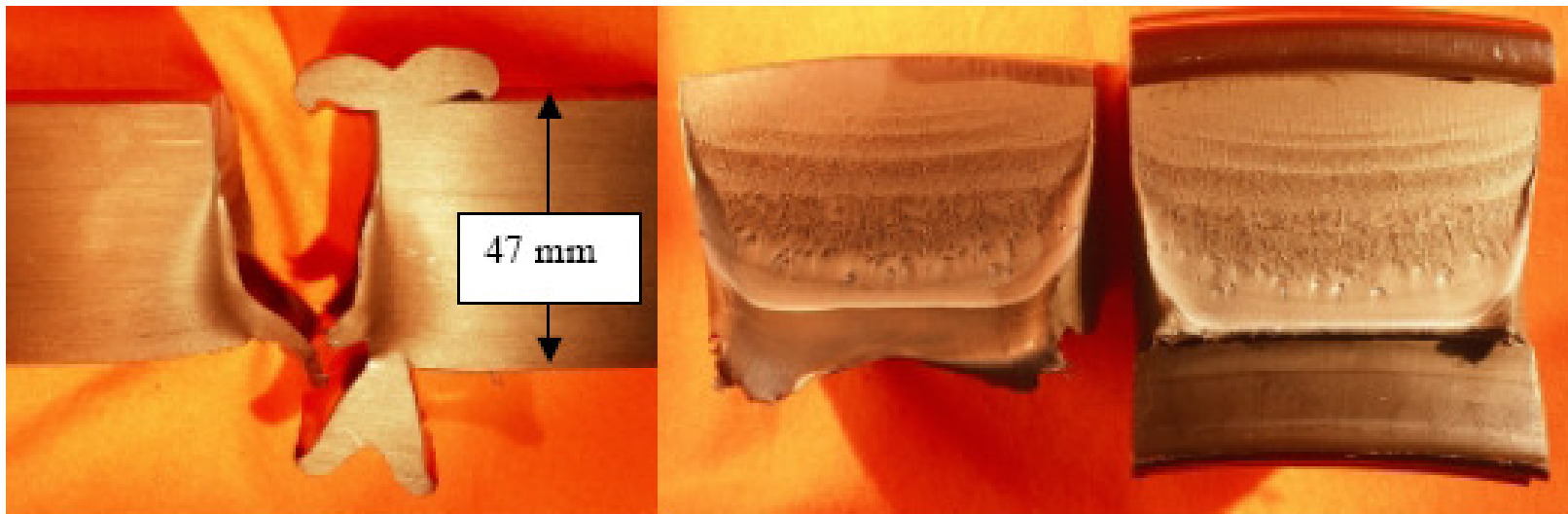
- DVS Creep test
- GdF FNCT test

Long term creep test



*Evaluate crack path and
time to failure*

Long term creep test

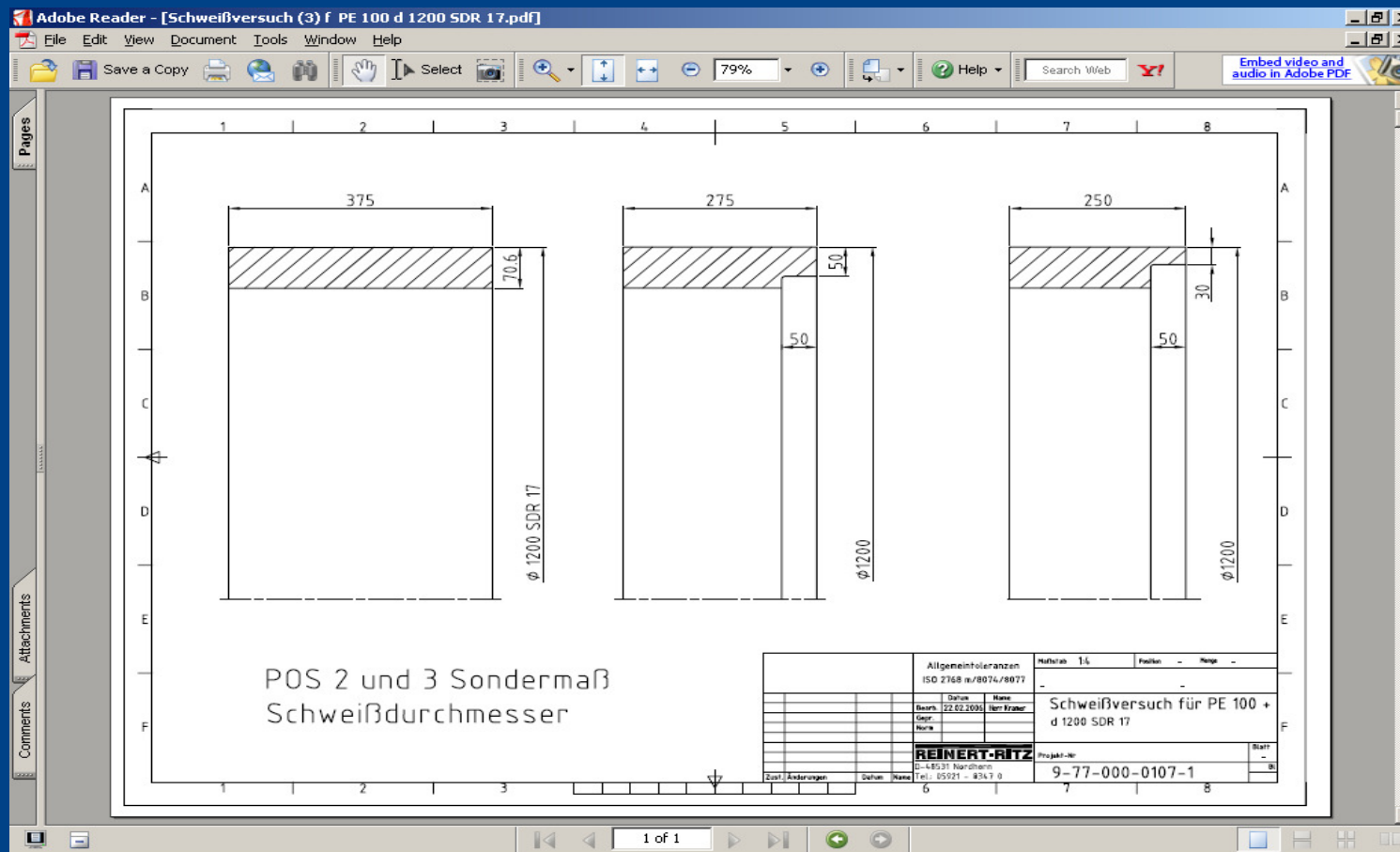


Crack behaviour at butt welded heavy wall pipe (500 x 47 mm)

Pipe

- Supplied by Egeplast, DE
- 1200 mm SDR 17, nominal 70.6 mm thick
- PE 100+ Black
- To be machined 30mm/50mm/Full wall
- Advantage – same extrusion/material
- Preparation by Reinert Ritz

Machining of the pipe



Welding

- **European single pressure - Widos**
- **UK Dual pressure - Widos**
- **USA Single pressure - McElroy UK**
- **‘Poor’ condition weld for comparison**

Testing

- WIS testing – Bodycote PDL UK
- Bend testing – Becetel BE
- Creep testing - Hesseltechnic DE
- Cylindrical FNCT - GdF
- Samples available for other evaluations

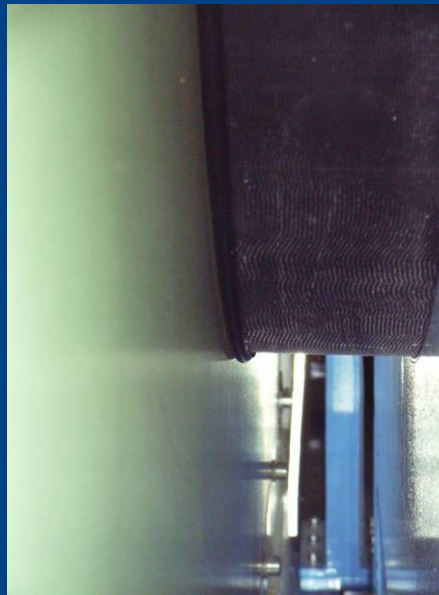
Timing of test programme

- Dependent on completion of welding
- Preparation of test specimens
- Creep testing may require > 5000 h
- Results late 08 to mid 09

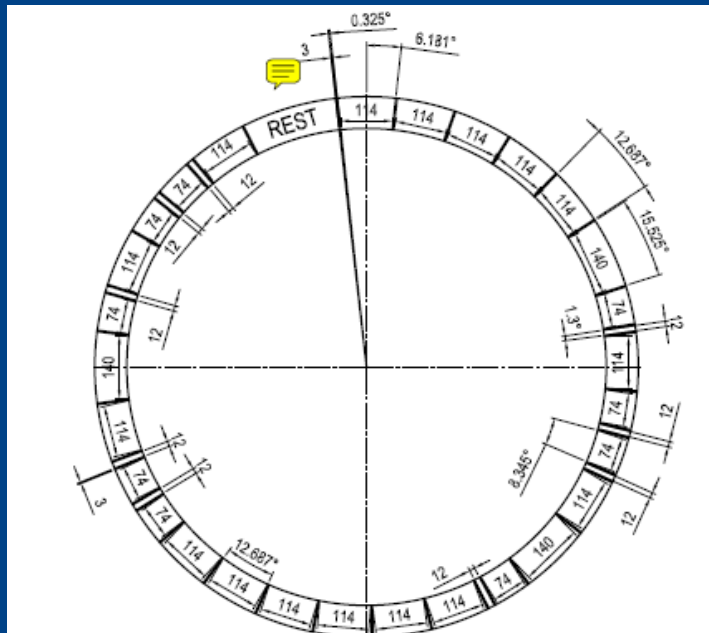
Next stage

- Harmonise tests in ISO and re-evaluate ISO butt-fusion procedures standard
- Test methods – SC5/WG12 Polyolefin Assemblies (P.Vanspeybroeck)
- Revise ISO 13953 or develop new standard
- Procedures ISO/TC 138/SC4 AHG/Buttfusion harmonisation (E.Striplin) ISO 21307

Welding



Samples and tests



- Welded pipe rings @ 30mm, 50 mm, full wall x 3 procedures
- Each assembly to be cut
- WIS, Bend, Creep, GdF FNCT samples

Cutting of test samples



Not an easy job!

***Cutting of the
samples was clearly
underestimated !!!***

*Many thanks to Michael Ritz,
Reinert Ritz!!*



*Development of
cutting process*