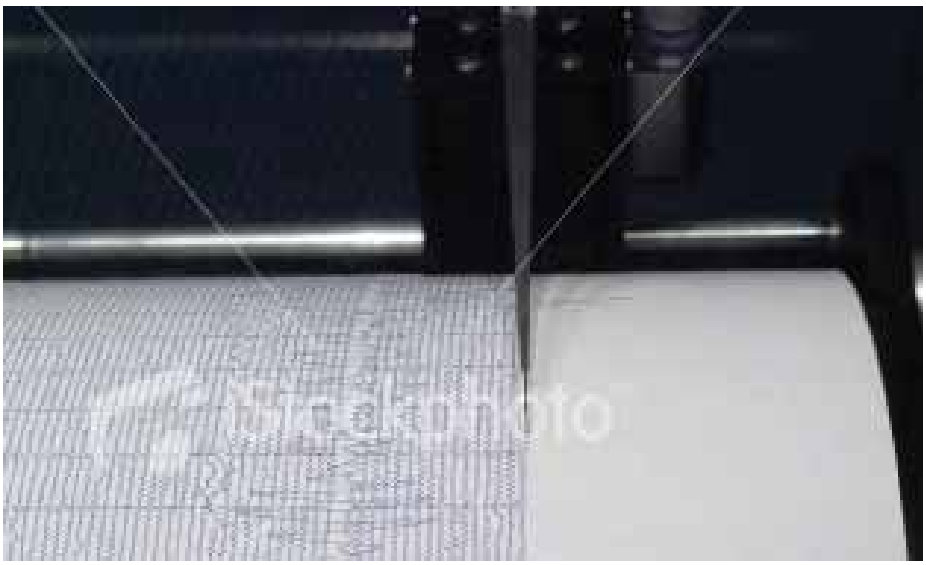
# Protecting pipes in moving soils

‘Reactive’ soils, which react to moisture by shrinking or swelling, can be just as damaging to pipes as a seismic tremor. However, as John Power reports, swivel and expansion pipe jointing systems can provide a long-term solution.



It doesn’t take an earthquake to fracture underground pipes – swelling and shrinking ‘reactive’ soils can be just as hazardous.

Every year fractured pipes cause millions of dollars worth of damage to homes and civic infrastructure throughout Australia. The culprit in most cases is ‘reactive’ soil, which swells in moist conditions and contracts during dry spells. Like an old ship trapped in sea ice, a rigid pipe network in severely reactive soil is doomed to fail under Mother Nature’s destructive forces.

Pipe damage frequently goes unnoticed by property owners until there is a major drainage failure or blockage, or above-ground signs such as structural cracking in walls.

Not only do cracked pipes ruin the effectiveness and sanitation of drainage systems, but leaked fluids can cause additional soil upheaval or subsidence leading to even greater fractures – the result is self-generating, escalating pipe damage.

Reactive soils are common in all Australian States, and with water restrictions now in place in most parts of the country, variations in soil moisture levels are now more extreme than ever.

Plastic pipes, in particular, are subject to additional problems due to the nature of PVC-U itself, which can expand at seven times the rate of steel and develop stress fractures.

### About reactive soils

Academic researchers have devoted a great deal of attention in recent years to the task of identifying reactive soil locations, types and behaviours, with a view to streamlining the roll-out of underground infrastructure like telecommunications cables.

Dr Rob Fitzpatrick, from CSIRO Land and Water in South Australia, has authored and co-authored a number of papers on the issue in a bid to demystify the complexity of reactive soils.

In an article entitled ‘Soil-related engineering problems: identification and remedial measures’[1], which Dr Fitzpatrick co-authored in 2001 with P. Slade and P.A. Hazelton, we learn that “It is known that expansive soils cause more damage to structures, particularly light buildings and pavements, than any other natural hazard, including earthquakes and floods (Jones & Holz 1973). Damage caused by expansive soils to residences in the USA alone [was] expected to total US $997 million in the year 2000.”

The article goes on to state that reactive soils, which are typically high in clay content, must be assessed according to depth; particle size; associated salt deposits; climatic conditions before, during and after installation works; vegetative conditions, including surrounding root growth; soil compaction during backfill; topographic conditions affecting water flows; and groundwater properties, particularly where freshwater may affect saline soils.

The most reactive soils are classified by type and their severity of reactivity to moisture (no reactivity scores a rating of 1; high reactivity peaks at 10). The worst offenders as far as pipes are concerned are Vertosols, such as grey clays and black earths, and clayey Sodosols. These types of soils carry the highest risk ratings of 8–10

and are responsible for costly pipe damage. Standard Sodosols and Chromosols such as red and yellow duplex clays carry moderate risk ratings of 6–7. Rudosols, sandy Tenosols or Podosols (sandy and loamy soils) have low shrink-swell risk ratings of 2–5. By contrast, solid rock – which absorbs minimal moisture and therefore does not display swelling or shrinking characteristics – is benign and scores a no-risk rating of 1. A map showing the main soil classifications, their locations across Australia, and soil reactivity risk ratings, is shown below.

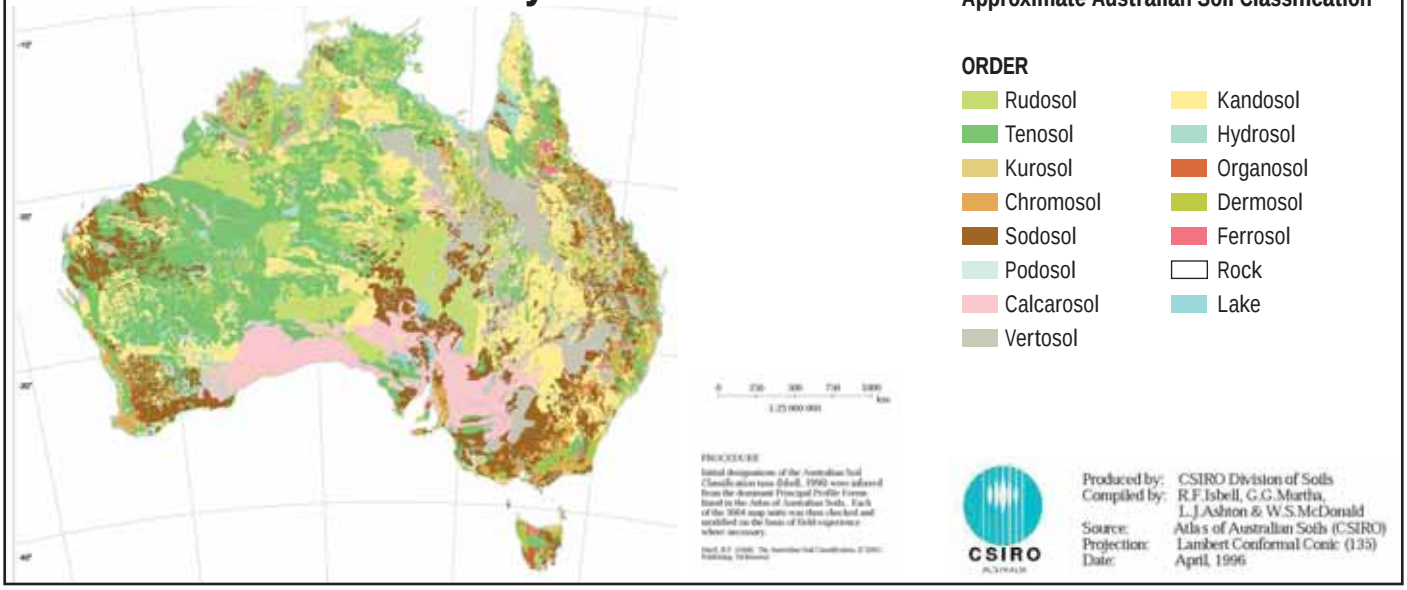
According to David Hallett, State manager (Victoria) at the building advisory organisation Archicentre, the problem of reactive soils is widespread throughout Australia.

"Sandier soils are better than clay soils for building stability," David says. "In Melbourne, for example, there are the beachside suburbs where soil is less reactive – water tends to percolate through sandy soils and not pose a problem – but if you go east all the way round to the west, and through the north-east in particular where the soils are more clayey, you have definite problems."

David says Archicentre conducts regular visual inspections of building damage, and while there are no data measuring the number of structural failures arising specifically from broken pipes, "from time to time we will see ponding where there shouldn't be ponding, such as underneath a house, and the water has to come from somewhere. We can't categorically say there is a lot of [pipe] fracturing, but we can say there is a lot of soil movement." ➤


Left: The 100mm Expanda joint can expand or contract like a telescope to compensate for reactive soils. Right: Swivel joints can rotate 360˚ and swivel 15˚ from a linear axis to help prevent fractures and breaks.

## How ‘rective’ are your soils?




Generalized soil map of Australia from the *Atlas of Australian Soils*[2] showing the approximate distribution of the various soil orders according to the Australian Soil Classification[3] (Isbell 1996). Map courtesy of Dr Rob Fitzpatrick, CSIRO Land and Water.

| SOIL SHRINK-SWELL RISK RATINGS | | |
|---|---|---|
| **SHRINK-SWELL RISK RATING GROUPS** | **INDEX RATING 1 (NO RISK) TO 10 (HIGH RISK** | **AUSTRALIAN SOIL CLASSIFICATION SOIL ORDER*** |
| High to very high | 8 to 10 | Vertosols, Clayey Sodosols |
| Moderate | 6 - 7 | Tenosols, Kurosols, Chromosols, Sodosols, Clayey Calcarosols, Hydrosols, Dermosols, Ferrosols |
| Minimal | 2-5 | Rudosols, Podosols, Calcarosols, Kandosols, Sandy Tenosols, Sandy Hydrosols, Organosols, |
| None | 1 | Rocks |

*The Australian Soil Classification is extremely useful in the development of a labelling system for soil landscape mapping units.

It is the normal practice to have soil sample test cores taken and assessed for every building site so that the soil type can be classified to determine construction design requirements.

Compliance in accordance with the Australian Standard (AS) 2870–1996 *Residential slabs and footings-Construction* has simplified the assessment of reactive soils for the building industry.

The current classification for the assessment of soils and their reactivity to moisture (water) is summarised as follows:

| SITE SOIL REACTIVITY CLASSIFICATIONS (IN BRIEF) AS 2870-1996 | | | |
|---|---|---|---|
| **CLASS A** | Little or no ground movement (Non-reactive). | | |
| **CLASS S** | Slightly Reactive. | | |
| **CLASS M** | Moderately Reactive | Extending to: | Class M – D |
| **CLASS H** | Highly reactive | ” | Class H – D |
| **CLASS E** | Extremely reactive | ” | Class E – D |
| **CLASS P** | Applies to ‘Problem sites’ (eg: filled soil or potential to collapse), special provisions apply. | | |

“ D ” means Deep clay soils

### Weathering the storm

Quality Assured South Australian company Storm Plastics (SA) Pty Ltd produces expanding and swivel pipe jointing systems designed specifically to combat the problem of repeatedly expanding or contracting soils. While the products have been around since the 1990s, most sales have been targeted at the Adelaide region, where reactive soils are amongst the most severe in the country. Nevertheless, these fittings are specified by architects and engineers nationally and are equally appropriate for original construction work or spot repairs.

There are two main categories of Storm Plastics assemblies: expansion joints and swivel joints.

‘Expanda’ DWV expansion joints are available in 100mm diameter size and, once installed, allow for permanent flexible longitudinal movement of up to 150mm (overall dimensions of fitting: 320mm closed to 470mm fully expanded). The range is supplemented by expandable 100mm 90˚ bend fittings. Expanda fittings are available in various sizes and are also

suitable for stormwater application.

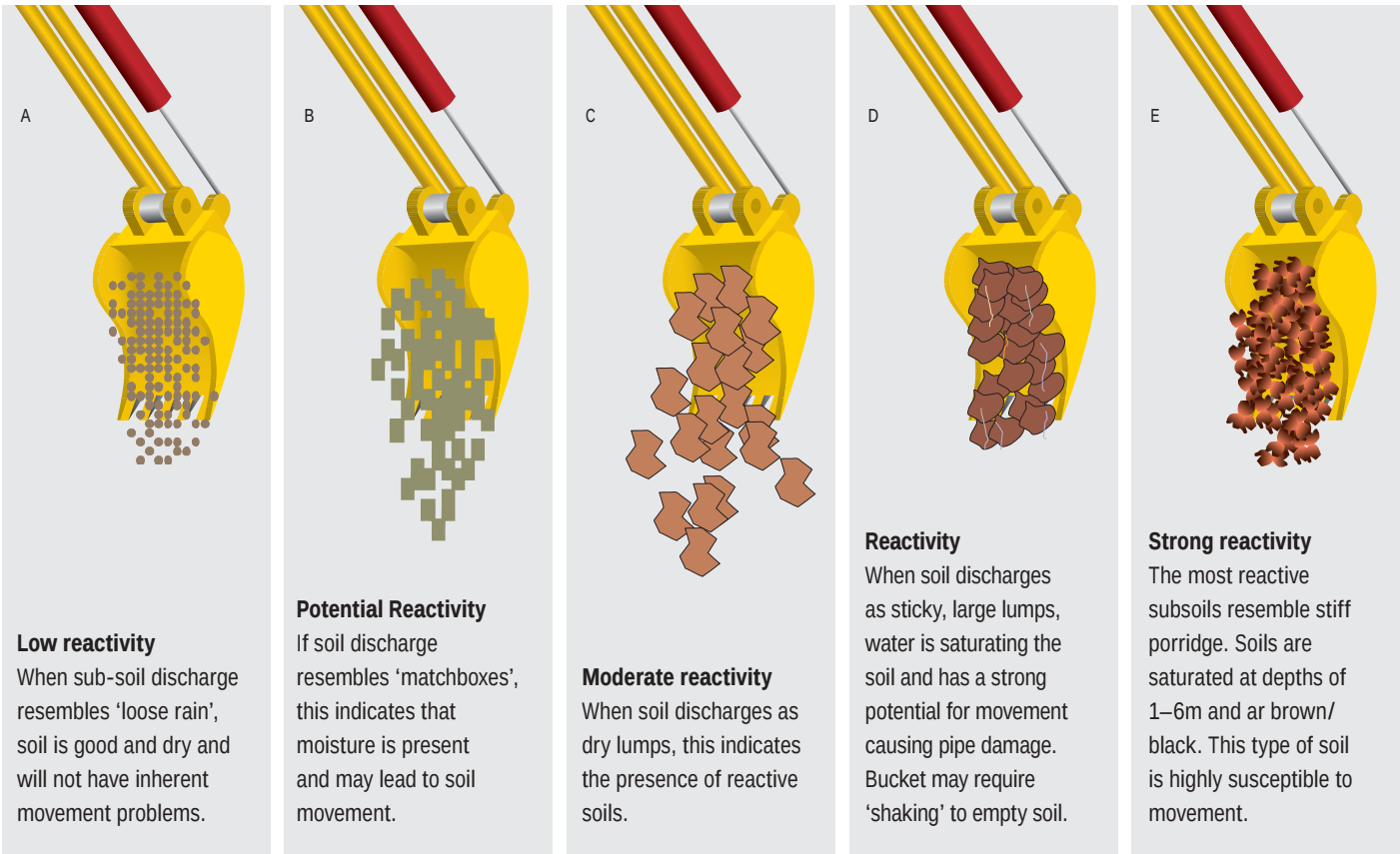
'Swivel' DWV combination expansion joints are available in 100mm and 150mm diameter sizes. The 100mm fitting allows for 50mm longitudinal movement (overall dimension of fitting: 275mm closed to 325mm expanded), while its 150mm cousin offers the benefits of 60mm longitudinal movement (overall dimension of fitting: 375mm closed to 435mm expanded). Both sizes can rotate 360˚ and swivel 15˚ from the linear axis, offering ongoing protection in underground settings where soil forces exert twisting, upward and/or downward forces. The joint area is covered in a plastic sheet membrane to prevent the intrusion of debris and the pipe beneath is coated in copper sulphate to impede tree root invasion.

The fittings, according to company manager Marco Elbe, were introduced to meet an urgent need from the community and building industry, in response to the structural damage (predominantly to domestic homes), caused by reactive soils – just as tree roots are able to bend and move depending on prevailing dry and wet conditions, pipes and jointing systems should also feature a high degree of flexibility.

Installation of Storm Plastics fittings is easy and can add many years to the life of pipes in reactive soils.

In recent months Storm Plastics has been petitioning the Standards Australia Committee WS–014 to modify the Australian-New Zealand (AS/NZS) Plumbing Standards relating to the use of flexible pipe fittings in circumstances where soils may be unstable or reactive.

During a presentation to the Committee in Melbourne last May, the company sought a tightening up of sections of AS/NZS 3500.2:2003 regarding underground drainage systems, and the inclusion of control mechanisms based on independent soil report assessments prior to installation. Such mechanisms, the company argued, would remove the need for installers to make subjective judgements about ➤




**Low reactivity**
When sub-soil discharge resembles 'loose rain', soil is good and dry and will not have inherent movement problems.

**Potential Reactivity**
If soil discharge resembles 'matchboxes', this indicates that moisture is present and may lead to soil movement.

**Moderate reactivity**
When soil discharges as dry lumps, this indicates the presence of reactive soils.

**Reactivity**
When soil discharges as sticky, large lumps, water is saturating the soil and has a strong potential for movement causing pipe damage. Bucket may require 'shaking' to empty soil.

**Strong reactivity**
The most reactive subsoils resemble stiff porridge. Soils are saturated at depths of 1–6m and ar brown/black. This type of soil is highly susceptible to movement.

the appropriateness of rigid or flexible pipework systems.

As the submission stated, "Expansion and contraction, primary issues for underground drainage pipework systems, are not adequately addressed in either AS/NZS 2032:2006 *Installation of PVC pipe systems* or AS/NZS 3500.2:2003. Hopefully provision will be provided to include reactive soils in the revision of AS/NZS 3500 Parts 2 and 5.

"Unless special provisions are enforced to support and accommodate [soil] movement, from any source (thermal or soil movement) – at the installation stage – pipework systems will continue to fail."

The submission continued: "It is of extreme importance to be aware that soil movement is not restricted to movement in one direction only; it could well be reacting in opposing directions at the same time – a wave action through the soil structure is not uncommon. Excluding earthquakes, natural phenomena and manmade interruptions to the course of nature, the extent of such soil movement is dependent on moisture (water) levels within the respective classes of soil on-site and the extent, if any, of pedoturbation."

It was also noted that installers should exercise a duty of care to select systems that meet the expectations of property owners, preferably with the aim of providing a realistic 50-year lifespan for PVC-U drainage installations.

Furthermore, Storm Plastics has questioned the process of encasing pipe assemblies in concrete within reactive soils, as the settlement of concrete masses can easily cause breaks where pipework meets the concrete encasement.

Regardless of the processes by which we identify and classify problematic soils and install pipes, it is clear that ongoing research is welcome and should be examined carefully by all professionals dealing with pipe laying and repair operations, particularly non-pressure underground drainage pipework systems. ■

1. Fitzpatrick, Dr R.W.; Slade, P.; Hazelton, P.A. "Soil-related engineering problems: identification and remedial measures". *Geological Society of Australia Special Publication 21, 2001, pp 27–36.*

Readers can obtain a pdf copy of this paper by emailing the editor, *Plumbing Connection*, at johnpower@build.com.au

2. Northcote, K.H. et al., *Atlas of Australian Soils*, CSIRO, 1960–68.

3. Isbell, R.F. *The Australian Soil Classification*, CSIRO Publishing, Melbourne, 1996.

**CONTACT**

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