

Technical Note 176

Vinyl Sheet Piles

September 2018

Copyright

© The State of Queensland (Department of Transport and Main Roads) 2018.

Licence



This work is licensed by the State of Queensland (Department of Transport and Main Roads) under a Creative Commons Attribution (CC BY) 4.0 International licence.

CC BY licence summary statement

In essence, you are free to copy, communicate and adapt this work, as long as you attribute the work to the State of Queensland (Department of Transport and Main Roads). To view a copy of this licence, visit: <https://creativecommons.org/licenses/by/4.0/>

Translating and interpreting assistance



The Queensland Government is committed to providing accessible services to Queenslanders from all cultural and linguistic backgrounds. If you have difficulty understanding this publication and need a translator, please call the Translating and Interpreting Service (TIS National) on 13 14 50 and ask them to telephone the Queensland Department of Transport and Main Roads on 13 74 68.

Disclaimer

While every care has been taken in preparing this publication, the State of Queensland accepts no responsibility for decisions or actions taken as a result of any data, information, statement or advice, expressed or implied, contained within. To the best of our knowledge, the content was correct at the time of publishing.

Feedback

Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

1 Purpose

The purpose of this technical note is to specify the design criteria for vinyl sheet piles to Transport and Main Roads requirements.

2 Referenced documents

Table 2 below lists referenced documents in this Technical note.

Reference	Title
AS 5100.3	Bridge Design: Part 3: Foundation and soil-supporting structures
ASTM D256	Standard test methods for determination of Izod pendulum impact resistance of plastics
ASTM D638M	Test method for tensile properties of plastics
ASTM D648	Test method for deflection temperature of plastics under flexural loads
ASTM D696	Test method for coefficient of linear thermal expansion of plastics
ASTM D4216	Standard specification for rigid poly (Vinyl Chloride) (PVC) and related PVC and chlorinated poly (Vinyl Chloride) (CPVC) building products compounds
ASTM D4226	Standard test methods for impact resistance of rigid poly (Vinyl Chloride) (PVC) building products
ISO 179-1	Plastics - Determination of Charpy impact properties – Part 1: Non-instrumented impact test
ISO 306	Plastics - Thermoplastic materials - Determination of Vicat Softening Temperature (VST)
US Army Corps of Engineers Report	A study of the long-term application of vinyl sheet piles by US Army Corps of Engineers, Engineer Research and Development Centre, August 2003

3 Applications

Use of vinyl sheet piles in Transport and Main Roads projects shall be limited to short term emergency applications only. For retaining wall applications, the maximum height of the sheet pile wall shall be limited to 1.5 m regardless of material and section properties of the vinyl sheet piles used.

Vinyl sheet piles can be considered for short term emergency applications such as:

- to control water in flood prone areas
- to prevent soil erosion
- retaining walls for securing shallow excavations
- sites with limitation on access for heavy machinery which exclude the use of heavier steel sheet piles, and
- cut off walls to control scour in culvert structures / aprons.

4 Material

Vinyl sheet piles are made using recycled, post-industrial or virgin PVC. If recycled PVC substrate is used to manufacture sheet piles, there shall be a high quality virgin PVC exterior portion (“capstock”) for resistance against weather and UV degradation. The virgin PVC “capstock” thickness shall not be less than 0.381 mm (0.015 inches).

The full composite product of the substrate and “capstock” material shall be in accordance with testing requirements as specified in ASTM D 4216 and shall meet the minimum mechanical property requirements as specified in Table 4.

Table 4: PVC sheet pile mechanical properties

Mechanical Properties	Value
Type of resin	Poly (vinyl chloride) (PVC)
Izod notch impact test ¹ (ASTM D256)	> 267 J/m
Drop dart impact test (ASTM D4226 – Procedure A)	> 6.67 kJ/m
Drop dart impact test (ASTM D4226 – Procedure B)	> 13.35 kJ/m
Tensile strength (ASTM D638)	> 40 MPa
Modulus of elasticity (ASTM D638)	> 2600 MPa
Deflection temperature under load ² at 1.82 MPa (ASTM D648)	> 70°C
Coefficient of linear expansion (ASTM D696)	< $8.0 \times 10^{-5} \text{ C}^{-1}$

Notes:

1. Alternatively, material impact resistance may be tested to ISO 179-1 and meet a minimum Charpy notched Impact strength of 291 J/m (35 KJ/m²).
2. Alternatively, material may be tested in accordance with ISO 306 and meet a minimum Vicat softening temperature of 80°C.

The supplier shall prove the material properties by NATA accredited laboratory test reports.

5 Design loads

Design loads and load combinations shall be in accordance with AS 5100.3.

6 Structural design

A criterion based on the maximum allowable deflection whilst meeting the maximum allowable stress and strength requirements shall be considered for designs using vinyl sheet piles. The Registered Professional Engineer of Queensland (RPEQ) designer shall limit the deflection of the wall to meet the functional and serviceability requirements, strength and design life for the specific project application.

Manufacturers of vinyl sheet pile shall provide the creep modulus degradation data to facilitate an appropriate design. With a predictable creep modulus “as a function of time” with time and a known load, the deformation shall be calculated over the lifetime of the sheet pile. The allowable bending stress shall be limited to ensure the induced stress will remain well below the creep deformation limit for the life of the structure.

A RPEQ certified geotechnical interpretative report is required for the design of vinyl sheet pile walls. Minimum pile embedment shall be provided in the Geotechnical Report. The ground level in front of the wall shall be assumed to be lowered by a minimum of 0.5 m for the purpose of determining the maximum bending moment of the wall.

The following criteria shall be used for the design of vinyl sheet piles walls:

- Elastic modulus for deflection calculation shall not be greater than 2600 MPa.
- Allowable serviceability limit state bending stress shall be limited to 20 MPa.
- Strength of vinyl pile wall shall meet the requirement of $\Phi_s M_u \geq M^*$.

Where M_u is the ultimate bending strength calculated from tensile strength of the vinyl material and the section modulus. Strength reduction factor Φ_s for vinyl piles shall be taken as 0.5. Design ultimate bending moment M^* shall be calculated as 1.5 times the maximum bending moment with load factor of 1.0 for earth pressure imposed loading.

For designing vinyl sheet piling (PVC) it is necessary to consider the failure criteria that is appropriate for the design. PVC fails only after a very large deformation. Vinyl sheet pile material has low tensile modulus (about one eightieth of steel). For a given load and shape of a beam PVC deflects about eighty times more than the steel.

Because of the visco-elastic nature of the PVC, degradation of the elastic modulus occurs over time. As a result, excessive deformation will occur over the long term under a given load without any failure. Such excessive deformation is not unacceptable. At low applied loads creep is hardly a problem because it takes an extremely long time to deform; however at a higher applied load PVC creep and a higher temperature may accelerate the creep deformation.

7 Proprietary vinyl sheet pile products and designs

Proprietary vinyl sheet pile products shall be a Transport and Main Roads approved product. Design shall be RPEQ certified. Product approvals for proprietary vinyl sheet piles shall be considered outside of a contract due to the time required to evaluate products.

Designs using Proprietary vinyl sheet pile products shall be in accordance with this Technical Note and sheet pile manufactures specifications.

The design shall be submitted to tmr.structural_reviews@tmr.qld.gov.au for review and acceptance by the Director (Structures Design Review and Standards).

If the submission is not suitable for email submission, please mail to:

Department of Transport and Main Roads
Engineering & Technology
Structures (Structures Design Review and Standards)
GPO Box 1412
Brisbane City Qld 4000

