Third International Conference on Geotextiles, 1986, Vienna, Austria

FINN, N.B., Chemie Linz AG, Brisbane, Australia
SADLIER, M. A., Chemie Linz AG, Melbourne, Australia

A STUDY OF GEOTEXTILE USE IN AUSTRALIA

ETUDE SUR L'EMPLOI DE GEOTEXTILES EN AUSTRALIE

DER EINSATZ VON GEOTEXTILIEN IN AUSTRALIEN

This paper presents a commentary on the historical development of geotextiles and explores the current state of geotextile use in Australia. It discusses the early days when only heat bonded and light woven fabrics were available and the period after the Paris Conference when non-woven needled fabrics became more widely used. It discusses some of the problems of this period. It discusses the period after Las Vegas which saw the introduction of more direct marketing practices by some major manufacturers. This period saw the promotion of fabrics for reinforcement functions in road pavements and the subsequent debate about reinforcement and separation in road construction. A Standards Association of Australia Committee was established to prepare geotextile standards. It also provides information regarding testing and evaluation by a number of authorities in Australia.

Dieser Vortrag kommentiert die historische Entwicklung von Geotextilien und erforscht den momentanen Stand der Verwendung von Geotextilien in Australien. Er behandelt die Anfaenge, als nur thermisch verfestigte und leichte Gewebe verfuegbar waren, und die Zeit nach der Pariser Konferenz, als Endlosfaservliese in immer groesserem Ausmass Verwendung fanden, sowie einige Probleme aus dieser Zeit. Dieser Vortrag behandelt die Zeit nach Las Vegas, in der direktere Marketingpraktiken von einigen grossen Erzeugern eingefuehrt wurden. Diese Zeit brachte eine gesteigerte Anwendung von Vliesen zur Bewehrung im Strassenbau sowie die daraus resultierende Debatte hinsichtlich Bewehrungs- und Trennfunktion im Strassenbau mit sich. In Australien wurde eine Vereinigung zur Erstellung von Normen fuer Geotextilien gegruendet. Diese Vereinigung gibt auch Informationen hinsichtlich Pruefungen und Bewertungen von zahlreichen Institutionen in Australien.

1 INTRODUCTION

This study of the development of geotextile use in Australia is based on information provided by various geotextile users and researchers as well as the experience of the authors. It is essentially a compilation and an examination of the effects of geotextile education and research, particularly with respect to practical use of geotextiles in construction work.

Some background of the Australian context will be useful. Australia is a country of some 7,682,000 square kilometres, with a population of some 15 million. This population is concentrated on the fertile coastal strips, particularly in the south east. There is very little development of the arid central regions with the exception of isolated resource extraction projects.

Climate on the east coast varies from tropical in the north with large silty river basins, which must be traversed to provide access to mining developments, to a temperate climate in the south.

Choice of sites for development have often allowed many options and in many cases sites with potential geotechnical problems have been rejected in favour of sites with less geotechnical expense, and less interest to geotechnicians. However, particularly in urban areas the choice of sites is now more limited and this provides greater scope for newer geotechnical techniques including the use of geotextiles.

In many locations, convential materials of sand and crushed rock are available in abundance and the potential benefits of geotextile use are not so obvious in these areas. The technical professions in Australia have often found that new products and methods introduced from America and Europe are often unsuitable and require considerable modification for successful use in Australian conditions. This has led to a healthy scepticism and desire to see field trials and evaluation before putting new concepts or techniques into general use.

2 EARLY EXPERIENCE WITH GEOTEXTILES IN AUSTRALIA

The development of geotextiles in Australia occured during the early 1970's. This development was rapid with the introduction of a number of types of geotextiles from various parts of the world. With the first recorded use of a fabric in geotechnical engineering dating back to 1926 and the major development extending to the development of non-wovens in Europe in the 1960's major manufacturers were well established, with the technical requirements and various end uses for their own products clearly defined.

The products first available in Australia included heat bonded and light split film wovens. These products were used in various applications during this period. The usage of geotextiles was further developed with the introduction of non-woven needle punched fabric during the mid 1970's. With the annual world wide consumption of geotextiles increasing very rapidly during this period of early development in Australia, local agents and distributors were encouraged to promote various products with a great deal of enthusiasm.

This enthusiasm lead to intense promotion of geotextiles leaving specifiers and end users interested but somewhat confused by the extent and sometimes conflicting data presented to them by suppliers.

The 1977 First International Conference on the Use of Fabrics in Geotechnics in Paris France provided further evidence that good research and progress was being experienced overseas.

3 AFTER FIRST INTERNATIONAL CONFERENCE IN PARIS

With this new influx of information from the Paris Conference papers and additional reports becoming available through the suppliers, many authorities became more interested in geotextiles. At this stage however local experience and knowledge was still very limited. A number of authorities felt at this time that local trials were warranted in light of their potential usage of geotextiles in the future.

Discussion of these field trials and evaluations may be found in the appendices, however due to the limits of this paper we can only deal with a small number of examples. The cases mentioned are those that had significant influence on the development of geotextiles in Australia during this period.

This period saw a number of geotextiles introduced to Australia by general suppliers of civil engineering materials and existing agents of manufacturing chemical companies with limited knowledge and experience of geotextiles in civil engineering. A situation rapidly developed when many suppliers were pursuing a still relatively small demand.

Prices however remained quite high and, fuelled by uncertainty, a conservative approach to a choice of geotextile grading was common. This situation meant that geotextiles were not as commercially attractive as they may have been with confidence in lighter grades at more attractive prices.

4 AFTER SECOND INTERNATIONAL CONFERENCE IN LAS VEGAS

The period after the Las Vegas Geotextile Conference saw a number of changes in the development of geotextile usage and distribution in Australia. One significant change was the establishment of geotextile supply organisations with geotextiles as their primary intent and with experienced staff, often with technical training.

Many of these organisations had direct links to manufacturers and manufacturer based technical support. This led to a better understanding of geotextile users difficulties and problems at the distributor level which in time led to manufacturers understanding and reacting to some specific problems associated with Australian conditions. The most important example of this was in the field of stability under prolonged exposure to U.V. radiation, some details of which are mentioned in Appendix 7.1.

This improvement in the technical and practical support available to geotextile users improved the level of confidence in geotextiles as a whole. Further development of the users confidence was still being hampered by distributors sometimes unfortunate and unconstructive criticism of opposing product types,and occasional misuse or abuse of geotextile fabrics with resulting unsatisfactory performance.

The authors are, for instance, aware of projects which were suspended due to lack of funding with geotextile left uncovered for several months with significant deterioration as a result. Fortunately such incidents are becoming more and more rare.

The Las Vegas Conference initiated a great deal of discussion regarding the use of geotextiles as reinforcing elements in road pavement construction. It coincided with the introduction of several of the light weight slit film type of woven products to the Australian geotextile market. At this time monofilament woven fabrics were not very common and this situation still applies today. This led to a situation with geotextile users considering and experimenting with the use of these light weight, high modulus woven fabrics with relatively shallow cover of base course materials for roads which were often intended to have a sealed pavement surface.

A degree of confusion resulted and geotextile users were forced to evaluate in practical terms the relative merits of reinforcement with light weight, high modulus fabrics as against separation using high permeability, low modulus fabrics.

On some projects both techniques were considered and tried. One example is the tourist link road from Strahan to Zeehan on the west coast of Tasmania which had to cover several kilometres of peaty swamp near Strahan in an area with about one metre of annual rainfall. A variety of fabrics were trialled and the major portion of the work was carried out using polyester and polypropylene needle punched non-woven with various amounts of locally available sand fill.

Another example was the secondary pavement embankments using sand fill over estuarine silts at Brisbane Airport, which have at various times been constructed using light weight woven, light weight non-woven and has now returned to using medium weight needle punched non-wovens.

Some of the geotextile users have taken the view that the reinforcement technique was complicated by the need for anchorage and controlled rut development which detract from its advantages. The use of geotextile separators as a construction expedient, often in conjunction with relatively porous fill material, offers practical advantages and the opportunity to use construction techniques that result in significant cost reduction, particularly in wet conditions (Waters 1984 Ref 1).

This period also saw a growth in user confidence for the use of geotextiles under various forms of armour for hydraulic works and as filters protecting drainage structures in fill dams. Most applications of geotextile under armour entailed the use of primary and secondary armour. This was borne out of a desire to provide a protection layer against U.V. radiation which may penetrate the primary armour. Some practicioners argue that it is not necessary to construct the two armour layers in separate operations; that the desired result may be achieved by suitable grading of armour material to be placed in a single operation in order that the secondary armour sized material may penetrate the interstices to rest on the geotextile fabric. Examples of this include the Redcliffe Seawall (Qld) and the Heron Island shore protection (W.A.). (See Figure 1).

The use of needled non-woven geotextile under rail ballast became common place, particularly in Queensland and New South Wales, and railway authority use of geotextile filters also increased. As these uses developed the rail authorities conducted in-house trials and evaluations which sometimes resulted in production of reports to provide guidelines for rational geotextile use.

(eg. Public Transport Commission of New South Wales, Interim Report, August 1982 - Ref 3).

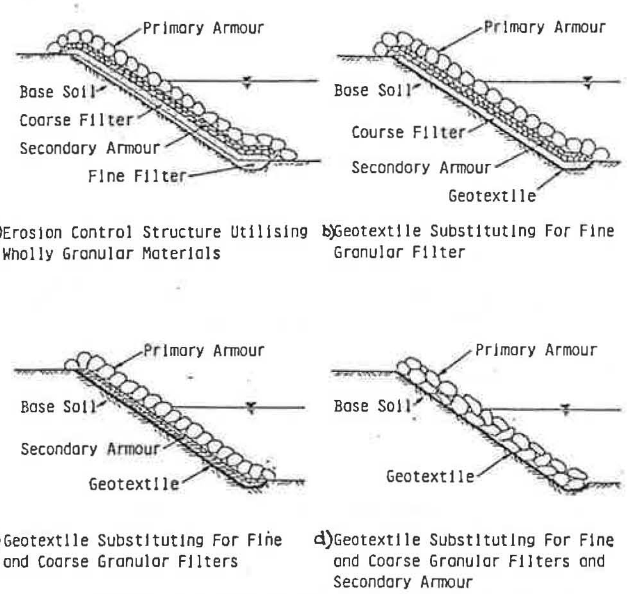

Figure 1: Revetment Using Wholly Granular Materials and Equivalent Structures Utilising Geotextiles. (Source: Lawson et al Ref 2)

5 CURRENT SITUATION

As we draw to an end of 1985 we have just seen a number of initial standards for geotextile testing published in draft form and public comments on the drafts have just closed. These drafts are for test procedures for properties relating to strength, hydraulics, filtration and durability and are intended to relieve some of the confusion caused by the wide variety of test procedures currently in use. Some details of the drafts are set out in the Appendices.

The committee preparing these standards represents a wide cross section of interests and they have had to grapple with a number of conflicting points of view. The ultimate aim is to produce a very broad ranging standard code of practice for the use of geotextiles which will be a reference source for all geotextile users, familiar or not.

Current geotextile use is growing in diversity and quantity with armour protected revetments using heavy needle punched non-woven geotextile filters being constructed at Stansbury and Port Lincoln in South Australia, Bega and Tweed Heads in New South Wales, Hope Island, Townsville and Fisherman's Island in Queensland. Ongoing research by Lawson et al (Ref 2) has led to the development of design criteria which provide a working relationship between revetment characteristics such as slopes, roughness, deformation rock size and mass and geotextile laboratory test properties. These criteria provide a useful guide and can be reinforced by references to successful projects with similar circumstances.

The Main Roads Department in Queensland have developed the philosophy of non-woven fabrics for separation with porous fill materials to the point where this technique is being used on almost all of the 35 km long Gateway Arterial Road which is mainly traversing estuarine silts in the Brisbane River basin. Other road construction authorities are continuing to use and specify geotextile fabrics for sub-grade works and for filtration for sub-soil drainage. The greater part of this fabric is non-woven with some tape woven products being used in low permeability applications in Victoria and Queensland and access works in the Northern Territory.

Authorities involved with dam construction have now experienced geotextiles in less critical or short term filtration applications. Confidence is now growing and serious consideration is being given to the use of geotextile filters and separators in major zoned dam construction.

Interest is also growing in the potential for geotextiles as reinforcement and planar drainage elements in soil/fabric wall structures, and a number of composite type products have also appeared, combining geotextile with various cores for use as planar drainage elements, vertical drains or other applications.

6 THE FUTURE

The use of geotextiles in Australia has now matured and is ready for further development and growth. Users of geotextiles are no longer innovators; Civil Engineering courses are mentioning geotextiles alongside traditional materials such as cement and crushed rock, although most engineers are still more familiar with cement and concrete technology than they are with geotextile technology.

This maturity and improved level of understanding has been assisted by, and has helped to develop, a new constructive and co-operative attitude amongst geotextile suppliers. We, and others, believe that a steady share of a growing market is more desirable than an improved share of a static market. Competition remains very strong with some thirty seven different geotextile products available and knowledgable users, soon to be armed with standard test methods, able to ensure that commercial comparisons are made on a sound technical basis.

7 APPENDICES

7.1 Accelerated U.V. Tests

The U.V. stability of geotextiles was under examination by a number authorities during the early 1980's. It was generally considered that a high degree of U.V. stability was necessary particularly in hydraulic works. The general concensus was that polypropylene geotextiles were highly susceptable to loss of strength once exposed to U.V. light and some doubt was expressed concerning the effeciency of stabilisers added to the polymer during manufacture. Polyester products were accepted as suitable due to their inherent resistance to U.V. light.

A number of comparitive tests were conducted eg: Queensland Water Resources Commission. In response to requests from Consulting Engineers a test program was initiated in 1982 to evaluate the U.V. stability of the polypropylene product, Polyfelt TS.

Tests were conducted to compare the relative performance between the U.V. stabilised polypropylene needle bonded non-woven Polyfelt TS700 and polyester needle bonded non-woven Bidim U34. Samples of each product were obtained from their respective supplier for testing.

Initially the testing consisted of pegging out a large sample of Polyfelt TS in an area close to the site near Melbourne where it was exposed to direct sunlight. After a period of approximately 3 months it was confirmed that the U.V. stabilised Polyfelt geotextile did not show any evidence of deterioration after conducting Grab Tensile strength tests on samples recovered from the site. The test continued with a series of accelerated U.V. stability tests at the Australian Wool Testing Authority Textile Testing Division in Melbourne. The exposure method used is described by Fincher et al (Ref 4).

Samples of both Polyfelt TS700 and Bidim U34 were exposed at a distance of 180 mm from a phosphor incandiscent lamp (MBTF) light source. This light was used to continually expose the samples to a high degree of U.V. light for periods up to 8 weeks. Control samples were taken and tested for their mass and grab tensile strength. Exposed samples were taken from the apparatus for testing in the same laboratory after periods of continuous exposure of 1 week, 2 weeks, 4 weeks, 6 weeks and 8 weeks and the results were recorded. (See Figure 2).

In the description of the test procedure the correlation is made that 4 weeks of this accelerated exposure is approximately equal to 6 months under extreme sunlight conditions prevailing during summer in Central Queensland, Australia, at a latitude of 23° (ie: on the Tropic of Capricorn). Once a full set of test results were available a comparison was made between the polyester and U.V. stabilised polypropylene non-woven geotextiles residual strength. The test result confirmed that this U.V. stabilised polypropylene geotextile displayed similar U.V. stability to the polyester product and has since been accepted for general use under Australian conditions.

However, in Australia as well as other parts of the world it is still understood that geotextiles in general are not suitable for prolonged direct exposure to U.V. light.

7.2 Draft Australian Standards Geotextile Test Methods

The draft standards which were released for comment in July 1985 are the first phase of a long term plan to provide standard test methods and application guidelines for the geotextile industry in Australia. At this stage the plan has four major elements.

a) Standard test methods for laboratory testing for properties relating to strength, filtration, hydraulic behaviour and durability. (July 1985 drafts).

b) Standard test methods for additional index tests, particularly an abrasion test.

c) Standard test methods for soil-geotextile interaction tests, such as the determination of soil-fabric friction.

d) Establishment of guidelines for geotextile design, application and performance evaluation.

Listed below are the titles of each of the draft standards and a synopsis of their contents.

DR-85230 - Geotextile - Glossary of Terms.

DR-85231 - Geotextiles - Identification, Marking and General Data.

DR-85232 - Geotextiles - Methods of testing.
- Introduction and List of Standards.

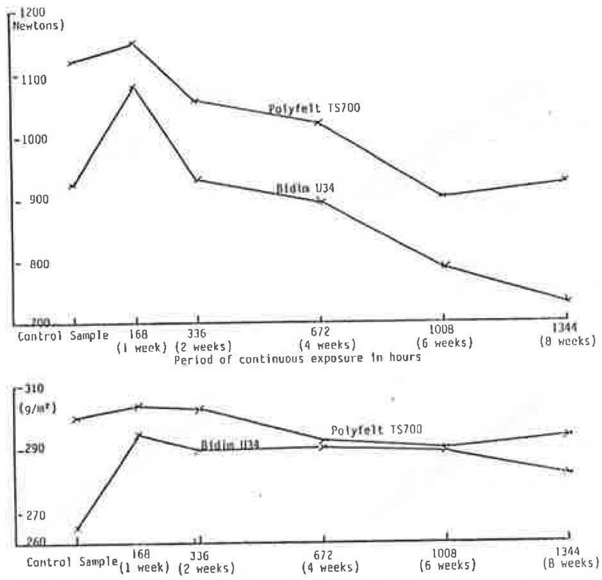

FIGURE 2: Accelerated Continuous U.V. Light Exposure Test Results.

a) Residual Grab Tensile Strength (AS 2001.2.3 -1981)

b) Average Sample Mass. (AS 1587-1973)

DR-58233 - General Requirements, Sampling, Conditioning and basic Physical Properties.

This draft sets out requirements for the testing of fabrics intended for use as geotextiles. It gives the sampling and conditioning procedures to be used, the methods for the determination of basic physical properties such as length and mass per unit area, and the principles of statistical analysis to be applied to the other standards in this series, as appropriate.

DR-85234 - Determination of Tensile Properties Wide-strip Method.

This draft sets out a method for determining the tensile properties of geotextiles in both the dry and wet conditions using a wide strip specimen. It recommends a 200 mm wide sample and a constant rate of extension test machine.

DR-85235 - Determination of Tearing Strength Trapezoidal Method.

This draft sets out a method for determining the tearing strength of geotextiles to in-plane loading, using the trapezoidal method.

DR-85236 - Determination of Indirect Biaxial Tensile Strength
- CBR Plunger Method.

This draft sets out a method for determining the indirect biaxial tensile strength and deformation properties of geotextile fabrics using CBR (California Bearing Ratio) test apparatus, for both atmospheric - conditioned and wet-conditioned specimens.

DR-85237 - Determination of Puncture-resistance Drop Cone Method.

This draft sets out a method for determining the puncture resistance of geotextile fabrics by the drop cone method using a CBR mould and clamp with a 50 mm diameter, 1 kg, 45° angle cone.

DR-85238 - Determination of Seam Strength

This draft sets out a method for determining the seam strength of geotextiles as a proportion of the unseamed tensile strength.

DR-85239 - Determination of Pore-size Distribution Dry-sieving.

This draft sets out a method for determining the pore-size distribution and apparent opening sizes (AOS) of a geotextile using the dry sieving method; and, from those results, the equivalent opening size (EOS).

DR-85240 - Determination of Pore-size Distribution Wet-sieving Method.

This draft sets out a method for determining the filtration diameter of a geotextile, using a wet sieving method with repetitive immersion of the geotextile and test soil.

DR-85241 - Determination of Permittivity

This draft sets out a method for determining the permittivity of geotextiles by measuring the flow of water through the fabric normal to its surface under a constant head.

DR-85242 - Determination of Transmissivity

This draft sets out a method for determining the permittivity of geotextiles by measuring the flow of water in the plane of the fabric under a constant head.

DR-85243 - Determination of Durability General Requirements.

This draft sets out general requirements applicable to the determination of the durability of geotextiles.

DR-85244 - Determination of Durability Resistance to Degradation by Ultraviolet Light and Heat.

This draft sets out a method for assessing the durability of geotextiles when subjected to degradation by ultraviolet light and heat.

DR-85245 - Determination of Durability Resistance to Degradation by Hydrocarbons or Chemical Reagents.

This draft sets out a method for determining the durability of geotextiles when subject to testing by hydrocarbons or chemical reagents.

DR-85246 - Determination of Durability Resistance to Biological Agents.

This draft sets out a method for determining the resistance of geotextiles to biological agents.

The period for comment on the drafts concluded on 30th September, 1985 and, after review in the light of public comment they will be issued as standards, probably early in 1986.

7.3 Railway Authority Geotextile Evaluation

Development in this area was particularly significant as the geotextiles finally approved for use in this field, under ballast particularly, required excellent resistance to most agressive conditions and their good performance gave confidence to other users.

Two railway authorities in particular took a great deal of interest in the employment of geotextiles to overcome maintenance and construction problems. In 1980 the introduction of a wider range of geotextiles to railway authorities enabled them to test and identify the most appropriate geotextiles for their applications. Up until this time heat bonded non-woven and woven products had been installed in a number of trial applications directly under ballast by various railway authorities in Australia. Due to the poor performance of these fabrics in this application some doubt was cast on the suitability of all geotextiles.

During 1981 the Queensland Government Railways researched the use of geotextiles in this application further and decided to conduct full scale trials on a number of types of geotextiles available in Australia. These included heat-bonded non-wovens, wovens, needle punched non-wovens and some composite products. This test program was initiated by the Queensland Railways to determine the type of geotextile best suited for use directly below ballast on the railway formation to prevent the mixing of fines due to constant pumping action by passing trains.

These actual infield trials provided the Queensland Railways with an indication of the performance of geotextiles in this application and more specifically the type of geotextile most suitable. Their acceptance of needle punched non-wovens lead to a general increase in demand for geotextiles and as these trials were conducted locally they provided the increased confidence lacking previously.

During the same period the State Rail Authority of New South Wales were also investigating information obtained from various sources on the use of geotextiles overseas as well as conducting their own in field trials. As a result of this the Concrete and Soils Laboratory of the State Rail Authority issued a report with recommendations during 1981. (Ref 3). This report was sent to all of the SRA divisional engineers to enable them to overcome confusion caused by the diversity and quantity of geotextiles available at that time.

The significance of this report in terms of the development of geotextiles at that time was the number of applications for geotextiles suggested. These applications included under ballast separation, roadworks, drainage, retaining walls and erosion control. Nine brands of geotextiles were identified in the report and the problem related to comparisions between different products was obviously very difficult at this time.

7.4 Road Construction Authority

A survey of the use of geotextiles by State Road Authorities carried out by the Department of Housing and Construction in 1980, (Ref 5) indicated that a number of these authorities were using geotextiles. The Department of Main Roads in New South Wales reported the largest use of geotextiles. Their applications included subgrade separation, filters in sub soil drains and filter blankets. Considerable testing of geotextiles have now been carried out and a report is currently being prepared for publication.

The Victorian Country Roads Board reported using geotextiles in subgrade separation, reflective cracking restraints for asphalt concrete overlays, drainage blankets and filter socks.

The Queensland Main Roads Department issued a report on the evaluation of engineering fabrics in 1981. (Ref 6). This report indicated that they were using geotextiles as separators, filters,reinforcements and drainage blankets. They identified that in view of the number of types available, their relative costs and the claims of suppliers a need existed to provide their engineers with guidelines for the selection of appropriate products for particular applications.

The Main Roads Department continued to identify and conduct tests on various products and as a result they issued a further report on the evaluation of geotextiles in 1983. (Ref 7). The tests were carried out by the Materials Branch and included the CBR strength test, the drop cone test, the perpendicular flow test and pore size test.

In addition to these tests, relatively straight forward tests were conducted to determine the porosity of the geotextile under light and medium loads. These tests included the determination of the mass per unit area and the thickness under light and medium loads. The Queensland Main Roads Department have now established a means fo specifying geotextiles according to their own test procedures. This test procedure also allows for testing of products actually delivered to site to provide for quality control.

7.5 Queensland Water Resources Commission

In 1982 the Queensland Water Resources Commission developed a test procedure which enabled them to measure the strength of various geotextiles as well as make comparisons between them to identify products with similar properties

A test was developed which consisted of a large diameter rubber diaphram burst test. As they are involved in hydraulic engineering the most significant mechanical properties were identified as flexibility and bursting/puncture strength. Another important consideration was the effect of U.V. light on geotextiles which may become exposed due to washing out of rip rap for example, as a result of major flooding. They conducted U.V. stability tests at Rocklea in Brisbane and Claredale in North Queensland. Claredale is approximately 1800 km north of Brisbane and 1000 km north of the Tropic of Capricorn on the east coast of Queensland.

Small samples were taken and tested for their mass, burst strength and penetration resistance. These tests were conducted by the Queensland Water Resources Commission materials laboratory at Rocklea in Brisbane. Samples were recovered from the test sites after exposure intervals of 12 weeks, 24 weeks and 48 weeks. Mechanical test results were compared with tests on control samples to identify any loss of strength.

Test results are made available to Water Resources engineers to enable them to identify products with sufficient U.V. stability and more easily identify products with similar properties. No overall report of the studies has been published. Various geotextile suppliers have been given information regarding test results on their own particular products.

8 REFERENCES

1. WATERS T.J. Evaluation of geotexile for drainage and reinforcement applications.
   ARRB Conference August 1984 Vol 12, Part 2.
2. LAWSON C.R. & CURISKIS J.I. Geotextiles including manufacture, properties and use in pavements, embankments, subsurface drainage and erosion control.
   Sydney August 1985.
3. Public Transport Commission of New South Wales Interim Report on Geofabrics for Railway Use.
   Sydney August 1981.
4. FINCHER K.W., CEEDER J.D., SINCLAIR J.F., WHITE M.A. An economical method for accelerated sunlight exposure testing. Journal of Textile Institute 1975 no 7 pp 268.
5. ROGERS J. 1980 - PIARC. - Testing of Road Materials Technical Committee - Artificial Fabrics - Minutes of Department of Housing and Construction Meeting ref 80/1661.
6. Queensland Main Roads Department Materials Branch Report on Evaluation of Engineering Fabrics Ref RP 705 tt 70 October 1981.
7. Queensland Main Roads Department, Materials Branch Report R1324. Evaluation of Geotextiles, September 1983.