ABSTRACT

“An onslaught of construction defect litigation over the last two decades has pummeled the construction insurance industry. Coverage disputes between contractors and their insurers, and between insurance companies are, unfortunately, as common as the construction defect claims themselves...” – taken from the description of the course “Construction Defect Trends and Developments” offered at the Insurance Risk Management Institute’s Construction Risk Management Conference, November 2003.

In this paper we will propose a method to minimize insurance claims and to improve the performance of geomembrane and GCL-based lining systems thereby making geosynthetics more acceptable to facility owners, engineers, and regulators.

INTRODUCTION

The insurance industry, as many others, has changed significantly since 11 September 2001. Previously, the market was very “soft” with the business emphasis on gaining market share. As in much of the geosynthetics industry pricing was on a commodity basis. As a result, insufficient emphasis was placed on meaningful risk assessment. In concert with this philosophy there was inadequate insistence on effective construction quality control (CQC) and construction quality assurance (CQA) resulting in many construction failures and large claims settlements. The events of 9/11 were an awakening call to all of us.

As a result of 9/11 many reinsurers went out of business and the rest have become very concerned. The industry became very “hard”. Risks were better assessed and premiums increased, as clearly evident in our professional, health, and residential policies. There is perhaps little doubt that the pendulum is swinging too far the other way. In some cases it is not possible to get insurance at all. In a few cases this extreme “hardness” is now being replaced with more efficiency, to the benefit of the insured, the insurers, and the reinsurers. Here is where a careful review of projects to be insured, the experience of associated professionals and companies, and realistic risk assessment play a
significant role. Increasingly risk specialists are being used to analyze all aspects of a construction project.

Most construction projects are analyzed by the risk specialist for the insurer. Meanwhile, the insured generally assumes that the project engineer has performed an adequate job. Clearly, in geosynthetic containment systems this assumption is not justified, particularly outside landfill containment systems. In addition to the risk specialist, a qualified loss adjuster, typically jointly appointed by the insurer and the insured, is also involved with evaluating project quality. With such a team and system, the insurer is more likely to find willing reinsurers, and the reinsurers are more confident in what they are purchasing. Thus, at all levels, risks should more properly evaluated, apportioned, and more realistic coverage provided at reasonable cost. But, note that the objective of risk assessment is not necessarily to improve the quality of installations (although this is desirable and ultimately will occur), it is simply to realistically assess the actual project quality. Thus, poor projects will receive poor coverage at high cost while high quality projects will be better covered at lower cost. Hopefully this will ultimately drive up the quality of the average project and balance the higher initial cost of a quality installation with lower insurance and operating costs and broader coverage.

However, and not surprisingly, it is apparent that civil and geotechnical design engineers are not adequately familiar with engineering plastics, just as plastics engineers are not familiar with soil and concrete. It is also probable that the insurer’s risk specialist is not a specialist in lining systems. Thus, lining systems are not properly evaluated and much still falls between the cracks, primarily the contents of the containment system! We will propose how to prevent the propagation of, and how to seal, these cracks.

Most major construction projects do have a risk analysis performed before the insurance coverage is written. Generally, the points and levels of risk associated with various aspects of a project are based on the statistics of experience. In addition, the forecasted potentials for additional risks are developed to completely evaluate the financial risk associated with the project. If, through data, it can be shown that a project is low risk or that measures are being taken to reduce risk these factors will result in an improved policy and reduced policy cost. With this approach if a problem occurs it is an accident and not a predictable or foreseeable risk. Unfortunately, the statistics of geosynthetic liner failures have not been adequately generated, nor are forecasts of potential problems reasonably made.

Increasingly, loss adjusters play an important role in the execution of insurance policies. Now, often assigned at the beginning of the policy development and selected by both the insurer and the insured, the loss adjuster is responsible for evaluating costs associated with any claim against the insurance policy. Loss adjustment today is approached very technically with experienced assessors using experienced consultants. When a claim is made obviously insurers and reinsurers want to know why they have to pay; adjusters
determine what really caused the damage, and by analyzing the terms of the policy determine whether coverage is provided. This is where appropriate records and data collection during the construction process are very important. When the adjuster can be proactive in working with the insurer and the insured to implement appropriate QC and QA programs, an environment is created which makes any claims process clean and direct (cost-effective) for the parties involved. If there is an incident associated parties know where to look for the cause of the damage, relevant data exist, appropriate investigative procedures can be followed and cause and coverage are bound together so claims can be handled properly. Claims can be handled very effectively, and at minimum cost, since the cause of the problem can most quickly be defined and the extent of coverage, or whether the incident is covered at all, are known. With these steps in place the reports have more basis and background, insurers and reinsurers can understand how the damage happened and everybody can be confident that the situation is being handled fairly and correctly.

This information can be especially valuable when both the insurer and the primary insured are not locally available to the project. We have seen that many purported experts design projects which are less than viable from a geosynthetics perspective, something for which there is no clear cut “acid-test”. Many multi-national companies who own and build overseas projects, often in developing countries, have little first hand information on which to rely. Good data collection and comprehensive QA/QC programs and records can be invaluable should a crisis occur in this situation.

**CASE HISTORIES**

A GCL is designed as the sole leakage barrier for a decorative pond. A monolayer of pebbles is placed on top of the GCL to make the bottom of the pond look natural. Rough limestone rocks are placed on the GCL around the periphery of the pond and it is expected that soil in planters behind the rocks will provide confining pressure to the back of (and between?) the rocks. The subgrade is changed from sand to 25 mm minus angular aggregate. The only allowable leakage specification is a loss of water level when there are 3 m of water over the subgrade (not the GCL), but the design depth of water in the pond is about 1 m. Not surprisingly the pond leaked – many thousands of liters per day.

An owner thought he had saved $15,000 by contracting a local installer, rather than a nationally recognized installer, to “just install me a liner in this pond” with essentially no specifications. When filled the 2 ha geomembrane-lined pond in this major international development project had 12 whales. On emptying, a great deal of water was found under the liner. The subgrade was relatively impermeable. A light geotextile was under the geomembrane, but not everywhere. There were no means of removing leaked water. In 0.5 ha of liner there were over 100 leaks ranging from pinholes to unwelded patches 600 mm long, the vast majority on fusion and extrusion seams. There was little
evidence of seam air pressure and vacuum box testing having been done. If it had been done most leaks would have been found. Development stopped because there was no irrigation water. The investigation, remediation, and associated costs probably exceeded $600,000.

HDPE was specified to line many concrete basins containing solutions of organics, aromatics, and sulfuric acid at up to 70°C. Severe absorption buckling between fixed points caused weld peel separation and ultimate cracking. Weld cap and repair material had much lower carbon content, lower oxidative induction time, and lower stress cracking resistance than the primary lining material. Initially a chemical resistance test had been recommended by the liner contractor but the $10,000 expenditure was not thought necessary by the engineer. The engineers claimed that HDPE had worked well in previous installations so it should be satisfactory. The engineers did not recognize the significance of the aromatics and much higher temperatures that were not present in the previous applications. The contractor and installer were faulted. Replacement of all liners was necessary and years of legal wrangling ensued. A $10,000 saving quickly turned into several millions of dollars of costs!

A GCL was used as the only barrier component in several ponds at a wastewater treatment plant. During filling to perform the required full-scale hydrotest the water level could not be increased above 60% of the design depth – water was leaking out as fast as it was entering the pond. The GCL had been placed on a subgrade with less than 20% fines (>80% recommended by the manufacturer) and stone sizes to 100 mm (<25 mm recommended). The cover soil contained rocks up to 250 mm (<25 mm recommended). In a 0.6 ha pond there were at least 55 groups of holes in the GCL, the largest individual hole being about 40 mm diameter. Despite written protestations about the quality of the soils, both the contractor/installer and the GCL manufacturer were faulted for inferior installation and product. Litigation ensued.

There is no question that insurance companies are paying inordinate settlements that are not necessary. Clearly, the financial situations of all parties would be improved with a system of preliminary meaningful risk assessment. Then insurance policies can be set at appropriate levels of premiums, deductibles, and breadth of coverage, such that:

- owners would have a financial incentive to implement good designs and to use experienced contractors.

- experienced contractors (designers, manufacturers, fabricators, installers, CQA firms, testing laboratories) could distinguish themselves from others, providing an opportunity to charge appropriately for value added services and materials.

- insurance companies would expose themselves to lower financial risk.
The general philosophy of such a system is simple. Its implementation will be a little more difficult, but far from impossible.

**REVIEW PROCESS**

The mandate for change will start with the insurance companies. They have the power (and the incentive) to require effective review of the qualifications of all parties to the project, the project specifications, and the design. We recommend the assembly of a review team that will consist of a core group of independent industry technical experts who are familiar with best practice and procedure. They will also be familiar with the state of the art as well as the state of practice. They would not necessarily do all the reviews themselves but would know of the relevant experts capable of performing qualified reviews.

We must make the insurance industry aware that several components of liner projects will need to be reviewed to evaluate and limit risk. Examples and suggestions for such an evaluation follow. Clearly there is much work yet to do to create a comprehensive evaluation process. Such a process can clearly be applied to other non-liner applications of geosynthetics.

**Design Engineer**

Our experience is that the cause of 70% of liner failures is inadequate design due to a lack of familiarity with polymeric material performance, lining systems themselves, and practical field construction activities and capabilities. For instance, it is easy to show intimate contact between geomembrane and subgrade with two parallel lines on a drawing, but it is very difficult to achieve intimate contact in the field. It is easier to attach geomembrane to a rectangular concrete structure than a circular structure, and it is difficult to spread a thin soil layer over a geomembrane. In many instances while it appears that the liner material has failed the primary problem is that it was incorrectly specified; it never could have succeeded.

The previous liner experience of the contracted engineering company and the individual engineer should be reviewed, including the performance of systems he/she has designed.

**Project Specifications**

Review of the project specifications should include: the selection of liner materials, the completeness of their specifications, calculations, drawing details, pre-specification testing, pre-project submittals, proposed testing in lab and field, test methods, record requirements, and final report requirements. In other words, a comprehensive review by a panel of integrated peers, not just a single peer review. Reviewers should be selected based on the requirements of the specific project.
For instance, if an electrical integrity survey of the primary geomembrane is required as the final stage of CQA several boundary conditions must be included in the project specifications and drawings, otherwise it will not be possible to perform an adequately sensitive survey. If a survey is not done it must be recognized that the primary liner of a double lining system, and all single liners, will probably leak. Surveys show there to be between 2 and 15 holes per hectare (1 and 6 per acre) depending on the size and complexity of the lining system. Consequently, a maximum allowable leakage rate or action leakage rate (ALR) should be specified for all primary and single lining systems, noting that zero is not achievable since diffusion occurs through a non-perforated geomembrane.

Recently a CQA firm was sued because the leakage detection system of a double lining system containing low level radioactive waste water was dripping water. No ALR had been identified in the project specifications – absolute zero was assumed by the owner to be guaranteed and the owner felt it was the CQA firm’s responsibility to assure zero leakage for the lifetime of the system. This was also a typical instance of the owner assuming that CQA would result in a perfect installation, not simply assuring that what was designed was built. CQA will not turn a sow’s ear into a silk purse.

If we provide insurance companies with knowledge of ALR and other vital design issues the insurer can insist that these issues be addressed in the design, thereby reducing the risk of a frivolous dispute over ambiguous or undefined aspects of the design.

**Geosynthetics Manufacturers**

This program will have to provide a means to evaluate the manufacturers and their materials. The experience of the manufacturer with the specified materials will be reviewed, including the manufacturing QC and QA programs. QC is performed on a party’s own actions and products, while QA is performed on the products and services of others. Thus manufacturing QA will identify whether incoming raw materials (the products of others) are acceptable or might adversely affect the manufactured geomembrane or associated products. For instance the question should be asked, are QC certificates required for incoming raw resin and is the resin tested before use? Is adequate manufacturing QC being performed on the manufactured geomembrane?

The insurance company must be confident that the form of the product proposed for the project will be assessed for its appropriateness and that the product provided meets all specifications. For instance, is the GCL structure correct? Is the upper geotextile of a high enough mass to protect the underwater GCL against damage from the overlying rocks that will be dumped onto it from a barge? Is natural sodium bentonite used rather than calcium bentonite or activated calcium bentonite? In a recent project a 0.5 mm HDPE geomembrane was specified. An HDPE slit-film woven with a thin coating of
LDPE on each side was provided. It leaked profusely and the project ended up in litigation.

Fabricator/Installer

The experience of the installer (company and individuals) with the project specific materials and products must be reviewed. International Association of Geosynthetics Installers (IAGI) certified welders and site superintendents should be required. Both the fabrication and installation QC programs will be reviewed including the plant and field records/logs to be used.

The number and experience of employees and local laborers proposed for the project will be identified. On a project several years ago a schoolteacher employed during the summer was the installer’s only “employee” sent to site to install prefabricated liners in six ponds. He hired local laborers. All installed liners leaked badly. Features for repair were marked but repairs were not made.

Construction Quality Assurance

It is necessary for the insurance companies, and all project parties, to understand the value of CQA. One of the objectives of reviewing the quality programs of all parties is to ensure that all are integrated with one another and that there are no gaps and potentially conflicting overlaps. The project CQA plan is the document that should tie all other documents together.

The experience of the CQA firm and proposed personnel with the specific liner material will be reviewed. The number of people proposed for the project in relation to the number of seaming, testing, and repair crews proposed by the installer will be evaluated. Many years ago there was one CQA monitor for each installation activity crew, but now there is typically only one person to monitor all installation activities. Many times this is a person that has to ask the installer to explain what he/she needs to do! If the CQA monitor does not know at least as much as the welder then his efforts are to no avail and simply a waste of time and money – except that regulations requiring that a “body” be on site to do “CQA” are met. In fact, a demanding unknowledgeable CQA monitor is likely to so frustrate the installer that the liner quality will be lower than if the installer had been left to its own devices.

The review will include CQA field logs and the format and completeness of final reports.

Laboratory

The geosynthetics testing laboratory must be currently accredited by the Geosynthetic Accreditation Institute’s Laboratory Accreditation Program (GAI-LAP). But note that it
is not sufficient for the laboratory to claim GAI-LAP accreditation; they must be accredited for the specific tests that are to be performed. They must have adequate turnaround times and their period for retaining samples and specimens must match the requirements of the project. The participation of their staff in ASTM committee D35 (Geosynthetics) and other standards and professional institutions will be considered.

**Owner/Operations**

The experience of the owner in operating lined facilities will be evaluated together with plans for the specific installation making sure that the facility design and planned operations are compatible, or identifying incompatibilities. For instance, will the facility be filled immediately or will some of the geosynthetics remain exposed for some time? How will filling progress – from the bottom upwards, from the slope at one end, from the bottom of the slope to the top, or from the top down? What are temperature and wind conditions? Will the contents vary? Is periodic sludge removal required and how will cleaning be done?

**PROJECT ASSESSMENT REPORT**

The results of these individual reviews will be assessed a rating on an appropriate scale. Both itemized and overall ratings will be presented to the insurance risk specialist. Appropriate policy details will then be established.

**SUBSEQUENT PROGRAM DEVELOPMENT**

Initially this program will be implemented as insurance coverage is sought, when construction of an already designed facility is about to start. The next development would be for the insurance company to be involved at the design stage so that appropriate suggestions for improvement can be made to the owner and design engineer as design is progressing. Ideally however, this process will be replaced by a third stage in which owners would submit their projects directly to the independent review board so that positive modifications can be made to increase a project’s ratings prior to review for the insurance company. In fact, an insurance review should not be necessary if a preliminary owner’s review has been done. Hopefully an owner’s preliminary review will result in appropriate modifications being made to achieve the highest rating.

In summary, the independent review board would be initially established on behalf of the insurance industry at their expense. Subsequently, a proportion of the review board’s activities would be performed directly for the facility owners at their cost while the balance remains funded by the insurance industry for those owners who are not then familiar with the review procedure. Thus some of the initial costs would shift from the insurance industry to the facility owners. Alternatively, the insurance industry could
require that all projects be initially assessed by the review board at the owners’ direct cost or at a cost that is incorporated in the insurance premiums.

INDUSTRY CERTIFICATION, ACCREDITATION, AND STANDARDIZATION

These programs will encourage, and will be supported by the development of improved material and installation specifications, certifications of engineers, materials, installers, CQA personnel, and accreditation of testing laboratories as instituted and proposed by GRI.

As a result geosynthetics will become more attractive to more engineers as they can acquire support that will better assure a quality installation. Installations will be of a higher quality and provide better performance with fewer failures thereby increasing the acceptance of geosynthetics and increasing the market. Accredited and certified products and services will provide an opportunity to charge increased prices.

Both the insurance and geosynthetics industries will benefit.