GEOSYNTHETIC ENGINEERING CONCERNS FROM A MANUFACTURER'S PERSPECTIVE

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To achieve a successful project; that is one which is completed on-time, on-budget and performs all of the functions which the owner and customer expects, several parties must be involved. Each participant, the owner, the design engineer, the purchasing authority, the general contractor, the materials supplier, the installer, the third party auditors and laboratories and the Manufacturing, Construction, Installation and Quality Assurance firms must work cooperatively with each other. One of the keys of effectively working cooperatively is a shared set of expectations which each party has regarding who will complete which tasks and who is responsible for certain decisions, requirements and performance. When these expectations are not in agreement one of two things occur; either two or more of the parties argue about "who will do what" or two or more of the parties assume that others are responsible for doing certain things and thus do not do them themselves. The former is usually unpleasant, but is seldom damaging; the latter can be catastrophic to a projects success.

The goal of this paper is to outline expectations from the geosynthetic manufacturer's perspective. To communicate what items and areas the manufacturers accept responsibility for and where manufacturers defer responsibility to others involved in the process. Further, to outline how these decisions are communicated and to point out, based on past experience, where errors and "catastrophe" have occurred and how problems may be avoided in the future. Manufacturing quality control and assurance frequencies, scheduling and methodologies for long term testing, (geomembrane stress crack resistance, geonet and geocomposite transmissivity and geosynthetic clay liner permeability), as well as friction angle and direct shear performance for all geosynthetic varieties are critical items where everyone involved should have agreed and shared expectations and understanding.

[A brief note regarding references: In this paper I have combined the typical list of references with a numbered footnote type system. Regrettably, very little of what I am saying in this paper is new. As far back as the late 1980's several noteworthy authors who are still involved in our industry were publishing articles that either focused on, or contained instructions for, successfully managing the geosynthetic portion of a construction project. Anyone interested in this topic would be well served by reading and following the suggestions contained in the papers referenced here.]

The following text outlines the optimal situation from the perspective of all of the stakeholders in a geosynthetic installation project.

The <u>owner</u> is the final beneficiary and the ultimate authority in most cases. Critical tasks for the owner are to make everyone (direct hires and subcontractors) work together. The owner should take great care to only hire competent people/firms, both engineering , contractors and inspectors. The most important person the owner hires is the design engineer (1); a bad design is extremely difficult to overcome and cause additional and un-necessary costs. The owner may be called in to serve as a mediator between the various hired parties; they should prioritize this activity when it is needed. The owner community has made a minimal contribution to recent problems. There are some cases where owners have selected “low-bid” engineering firms to the detriment of themselves and the project, or not required certain items from the engineer which they should have; however, overall, the owners are not the root cause of geosynthetic project failures.

The design engineer is where the project really begins. A competent design engineer/firm is experienced in their field and uses a current standard of practice. They design with current technology/methodologies and use materials that exist and have established performance specifications and product history (2). I believe, the design engineer should validate the design at the end of the process with peer review by a competent engineer (3) as well as conduct testing to validate design assumptions and prove critical performance requirements (4) such as direct shear. The designer should create a clearly written specification which emphasizes critical issues (5) and eliminates or dramatically reduces trivial “non-value added” testing (6). The design engineer must consider the time component of their testing requirements and where testing time is of a long duration, they should advise the appropriate parties of these requirements and make certain that the overall project is scheduled accordingly. There is currently no certification or licensing program established or under development for “geosynthetic engineers”; this means that the experience of the engineer should be carefully considered as it is likely the best criteria for making a good selection. In my opinion, the design engineering community (specifically the worst performing firms) is where some recent problems have begun. A design engineer/firm should use materials that exist: they should not design with some imaginary product and then send bidders and general contractors out to try and find some materials which will work in the design; this is a formula for trouble. A design engineer/firm should validate their designs at the end of the process with peer review and should always conduct a direct shear test to prove critical interface friction performance requirements. A design engineer/firm should create a clearly written specification which uses current testing standards and frequencies.

The purchasing authority is usually the owner as well, or the owners representative. The purchasing agent must buy wisely (the lowest priced product or service is not always the least expensive). Scheduling of deliveries and task completions dates should be done in a logical and organized fashion. It is the purchasing agents’ responsibility to make certain that the final purchase agreements contain all critical specifications and issues. It is common practice for all parties to minimize exceptions, both in number and scope during the bid process. Post award, it is the purchasing agents’ responsibility to assure that all deviations from the specification are addressed and agreed to by the engineer as well as final requirements supplied to the parties required to complete the tasks.

Several recent problems have occurred because the general contractor agreed to accept responsibility for complex and critical engineering considerations without having sufficient skills and experience to make the proper and correct decisions. Also, purchasing authorities have occasionally demurred from the responsibility to fully address schedule changes which affect a projects progress. Only deciding who to blame / back charge for a schedule change does not contribute to mitigating the effects of the delay.

The general contractor must also buy wisely. The general contractor should only accept bids and consider prices from firms capable of doing the work as specified. This is a dangerous area as some general contractors have limited skill at recognizing an unqualified geosynthetic subcontractor. The general contractor is responsible for scheduling deliveries and completion dates in a logical, organized fashion. There are two critical issues for the general contractor to understand and to convey to the earth worker (if a sub-contractor exists). The earth worker should understand the quality requirements of the subgrade preparations (7). It is also important to communicate that the covering of the geosynthetics is at least as critical as installing them and should involve written equipment load and placement plans and calculations (8) as well as an attending third party inspector to assure that this critical step in the projects progress occurs properly and any mistakes are identified and corrected, not "buried". During the step of the covering of the geosynthetics, both equipment choices and methodology have caused multiple slides. It is well known and published information that the placement of soils over geosynthetics is the most critical period for slope stability (9), yet we continue to see down slope placement of soils, improper equipment being used, no written loading / soil placement plans or calculations and occasionally, an absence of attending third party inspectors. We know this is the project step when the damage and failures occur yet a collective amnesia occasionally occurs about what to do during this critical time period.

The materials supplier must deliver a consistent quality product (10) which meets the agreed specifications; that delivery should occur where and when it is scheduled. The materials supplier must coordinate production schedules with the project requirements and notify the appropriate third parties for timely and efficient sampling, if required. The materials supplier must supply manufacturing quality control information and documents either with or in advance of shipment. GSE is currently supplying our quality information digitally via an internet site to allow easy inspection and organization by the reviewers of our quality data. The materials supplier must coordinate properly with the appropriate third parties; the review and material approvals should be completed by the time the materials arrive on site.

The geosynthetic installer must complete a quality installation (11) in a timely fashion. The installer must make their subgrade requirements known and understood well in advance and complete a subgrade acceptance review which is documented by all involved. The installer must have sufficient resources, both qualified and experienced people and sufficient, well maintained equipment to meet the schedule which has been agreed to. The sampling program, both nondestructive and destructive testing must be properly coordinated (12) and executed with construction quality control parties. The installer must have qualified and experienced people who know and live all of the details of good installation quality control every day. Welding equipment should be of recent vintage and more importantly, properly maintained; this means a preventative maintenance schedule to tune the machines at intervals and replace wear items, not run the welder until a failing weld is reported and then figure out what to do. IAGI (the International Association of Geosynthetic Installers) currently offers a qualification program for installers; while this program as it currently exists is certainly not optimal; we endorse the "pre-qualification" and certification of installers.

The third party auditors and laboratories as well as construction and installation quality assurance firms should complete their sampling and testing in a timely fashion. They should work cooperatively with the manufacturer and on-site personnel to minimize any disruption and impact of their presence. They should use qualified experienced staff that is knowledgeable in what they are auditing and testing. It is important that the auditors and laboratories try to mitigate any problems or disputes. Where they have available knowledge or information on solutions to problems, it should be supplied promptly, not after the generation of retesting fees. Ideally, the quality assurance staffs should work in the background and not get in the way of the people actually doing the work unless it is absolutely necessary. The Geosynthetic Accreditation Institute is currently developing a program for the "pre-qualification" and certification of CQA personnel. GSE is working to support this development and we believe this concept will be very helpful in improving overall project quality.

FOOTNOTES AND REFERENCES

(1.) Lundell, C.M. and Rohr, J.J. (1991), "Interface friction: An owner's perspective,"Geotextiles and Geomembranes, Volume 10, Issues 5-6, Pages 499-505

(2.) Koerner, G.K. and Narejo, D. (2005), "Direct Shear Database of Geosynthetic to Geosynthetic and Geosynthetic to Soil Interfaces," Geosynthetic Research Institute, Report No.30.

(3.) Opfer, N.D. (Fall 1997), "Construction Peer Review: A Technique for Improving Construction Practice", Journal of Construction Education, Vol. 2, No. 3, pp. 211- 233.

(4.) Richardson, G.N., (March 1997), "Fundamental Mistakes in Slope Design," GFR, Vo. 15, No. 2, IFAI. [www.gnra.com]

(5.) Richardson, G.N. and Thiel R. (August 2001), "Interface shear strength part 2: Design considerations," GFR, Vo. 18, No. 3.,IFAI. [www.rthiel.com]

(6.) Giroud, J.P., Zhao, A., and Richardson, G.N., (2000), "Effect of Thickness Reduction on Geosynthetic Hydraulic Transmissivity", Special Issue on Liquid Collection Systems, Geosynthetics International, Vol. 7, Nos. 4-6, pp. 433-452.

(7.) Thiel, R.S. and Stewart, M.G. (1993), "Geosynthetic landfill cover design methodology and construction experience in the Pacific Northwest." Proceedings of the Geosynthetics 1993 Conference, IFAI, pp. 1131–1144.

(8.) Kerkes, D. J.,(April 1999) "Analysis of Equipment Loads on Geocomposite Liner Systems," Proceedings of the Geosynthetics '99 Conference, IFAI, pp. 1043-1054. [www.geotechconsultant.com]

(9.) Paruvakat, Nandakumaran and Richardson, G.N. (Sept. 1999), "Landfill cover failure prompts standards upgrade," GFR, Vo.17, No. 7, IFAI.

(10.) Ramsey, B.J. et.al., (2005) “Manufacturing Quality Assurance Manual”, private publication of GSE Lining Technology Inc. << www.gseworld.com >>

(11.) Ramsey, B.J. et.al., (2005) “Installation Quality Assurance Manual”, private publication of GSE Lining Technology Inc. << www.gseworld.com >>

(12.) Thiel R., et.al. (June / July 2003), “Cutting holes for testing vs. testing for holes,” GFR Vol. 21 No. 5, IFAI.