The 2023 Koerner Lecture Q&A session

J.P. Giroud replies to George Koerner, Barry Christopher and Jie Han

George Koerner: Geomembranes used as landfill liners may experience differential settlement or local strain due to protrusions or anomalies in the subgrade. Therefore, it is important to define a maximum allowable strain that any given geomembrane can tolerate without compromising its integrity. Do you have an opinion on what this strain limit should be for high-density polyethylene [HDPE] geomembranes in such an application?

J.P. Giroud: This is an important question. As you rightfully said, George, there are two aspects: protrusions and anomalies in the subgrade.

For the protrusions, I do not think we can design or specify in terms of allowable strain. There is a German recommendation for a maximum geomembrane strain of 0.25% at protrusions. I must confess that I never understood the way it was established. And I note that, except in research projects, we do not measure the geomembrane strain on protrusions. Therefore, as I said in the lecture, we should not specify things that we don't measure. The practical approach in my opinion is to conduct puncture tests. This is a rare opportunity in geosynthetics engineering when we can make a full-scale test very easily. Therefore, we should do it. This is my answer on the protrusions.

Concerning the anomalies in the subgrade, we can define an allowable strain. For HDPE geomembranes, the allowable strain should be the yield strain divided by a factor of safety. Considering the parabolic stress-strain curve of HDPE geomembranes, a factor of safety of 4 on strain corresponds to a factor of safety of 1.5 on stress. This leads to an allowable strain of 3% if the yield strain is 12%, or an allowable strain of 4% if the yield strain is 16%. Sorry for the long answer, but it was really a very good question.

Barry Christopher: Bearing in mind the topic of your lecture, should the Europeans reduce the obligatory protection levels, which are significantly greater than puncture approach protection requirements used in the Americas, or should we consider the more aggressive approach required in Europe?

J.P. Giroud: Thank you for this question, which complements the preceding question. It is true that the geotextiles used for geomembrane protection are heavier in Europe than in North America. This does not mean that one practice is better than the other. As I said a minute ago, I do believe that we should rely on puncture tests, which I consider more appropriate than following local practice. But the tests must be representative of the field situation, with actual soil, actual geotextile, and actual geomembrane, tested together under representative loads. This reminds me of a project where we performed tests for the bottom and the side slopes of a mining facility. A geomembrane that passed the bottom test did not pass the side slope test: it resisted normal loads but did not resist inclined loads. This was a good lesson: not only should the test be conducted on the exact liner system configuration, but also the test load must be representative of the field load.

Barry Christopher: Some engineers and even a major U.S. public agency are still skeptical of using geotextiles in filtration applications. Considering your extensive experience with the performance of geotextile filters versus graded granular filters, could you please comment on this issue to help dispel these misconceptions?

J.P. Giroud: Barry, you have more experience than me on the performance of filters! All I can say is that, in many cases, the problems are caused by misuses of geotextile filters due to

incorrect design details or incorrect decisions inspired by common sense. This is similar to situations I have described with geomembranes in my lecture. I think that, with geotextile filters, the problems are not with the filter criteria, but with misuses.

Let me tell you an anecdote that illustrates the importance of design details. In the 1980s, I was presenting a lecture on geotextile filters in South Africa. At the end of the lecture, Bill Legge, the civil engineering director of the Department of Water Affairs, told me he was going to immediately change their specifications for stones used to fill the toe drain with geotextile filter in a dam that was being designed. They had specified large stones for maximum drainage capacity, but he understood from my lecture that, with large stones, there would be no intimate contact between the geotextile filter and the soil on the other side of the filter. Indeed, Barry, you and I have repeated that intimate contact is essential for the proper functioning of geotextile filters. This is a design detail, but it is essential, and Bill Legge was remarkably quick to react. (Incidentally, Bill Legge was the father of our distinguished colleague Kelvin Legge.)

Let me tell you a story about my old enemy, common sense. I was visiting a site with a representative of the United States Environmental Protection Agency [U.S. EPA]. I saw a drainage trench being backfilled with dirty gravel. At the bottom of the trench, there was a perforated pipe wrapped in a geotextile. Of course, clogging was going to be automatic. The site superintendent explained to us that he had improved the design by using a perforated pipe with a filter rather than the specified perforated pipe with no filter. This big mistake by the superintendent was the result of common sense.

These examples show that misuse of geotextile filters may be the main cause of many of the failures of geotextile filters and may explain why some potential users are skeptical. The solution is education, education and education!

Jie Han: The practice of geomembrane installation may be site specific and installer dependent, which often leads to variable conditions of installed geomembranes (e.g., possible damages). Can you please provide simple guidance on how design engineers should consider such variabilities in the design stage?

J.P. Giroud: Thank you, Jie, for this question, which is well related to my presentation. Design engineers should learn from the field and should learn from installers. Also, guidance is available from organizations such as the International Association of Geosynthetics Installers [IAGI] and the Fabricated Geomembrane Institute [FGI], and from geomembrane manufacturers. Even though guidance documents are intended primarily for geomembrane installers, they are very useful for design engineers. In addition, personal experience is indispensable. Engineers who do not spend time in the field interacting with geomembrane installers cannot be good design engineers for liner systems. I hope they will be motivated by this lecture, which will be made widely available.

Jie Han: In recent years, the materials engineering field has developed smart materials (including smart polymers and textiles) responsive to environmental conditions or stimuli (e.g., mechanical, chemical, electrical, temperature and water). How can our geosynthetics industry take advantage of these advancements to better address challenging problems in our field?

J.P. Giroud: Smart question on smart materials! Jie, I think you are right. Geosynthetics will probably benefit from the innovations you have mentioned. We can imagine self-monitoring geosynthetics, which would be a major progress because, today, only a few structures incorporating geosynthetics are monitored. We can imagine self-healing geosynthetics, which would be a major progress because repairing a geosynthetic under meters of soil or water is very difficult. We can imagine smart geosynthetics that would adapt their behavior to changing applied loads. And the smartest geosynthetics are those we do not imagine at this point in time.

Your question is specifically how the geosynthetics industry can take advantage of these innovations. I think that a strength of our industry is the cooperation between a wide variety of professionals. When I was president of the International Geosynthetics Society [IGS], the president of the International Society for Soil Mechanics and Geotechnical Engineering [ISSMGE] told me that he was impressed by the way the IGS had closely associated the corporate members to its activities. This was a recognition of the spirit of cooperation that exists in our industry. As a result of this cooperation, the manufacturers of geosynthetics are well aware of the needs of the users, on one hand, and well aware of ongoing research, on the other hand. This is why I believe that our industry is well prepared for adapting and adopting smart materials.

George Koerner: Which has been more valuable in your career, your education or your experience?

J.P. Giroud: This looks like a question from the son of a professor! I will say: education at the beginning of my career, then both education and experience during most of my career, and now, in the last part of my career, education of others based on my experience. This was a quick answer, but I add a comment: experience without education can lead to relying on common sense, which often leads to incorrect conclusions.

George Koerner: What is your greatest achievement and what do you consider your legacy?

J.P. Giroud: George, this is a personal question about my career and after my career! I will try to answer.

What I consider achievements is subjective. Maybe, achievements, from my viewpoint, are professional actions that are consistent with my personal philosophy, which is that theories should provide a quantitative support for practice; for example, the filter criteria, the theory of wrinkle development, or the demonstration of the key role of yield strain in the tensile behavior of HDPE geomembranes. In all three cases, the analysis was done with only pencil and paper, but the quantification provided by theory turned out to be a useful guide for practice. Rather than a personal viewpoint, an external viewpoint is that achievements are applications that are now considered part of everyday practice, such as the double liner or the use of geotextiles to protect geomembranes. But, you know, sometimes the state of practice is more influenced by a quick decision than by a complex theory or a significant innovation: a typical example is the frequency of one destructive seam test every 500 feet [150 m], which I decided because it was necessary to put something in the first CQA plan! But this practice is still in use today. There are also nontechnical achievements, such as initiating the IGS and starting a consulting company. But, here again, there are great differences. For the IGS, I had a clear vision, but for the consulting company I envisioned only a 10-employee company, certainly not a 1,000-employee company.

Well, it seems that, in fact, I just replied to the second part of your question, the legacy. However, it is not up to me to decide what will constitute a legacy, if any. In fact, the real legacy is what remains in the state of practice for such a long time that the origin is forgotten. This is fine with me: I am a geotechnical engineer, and my task is to create sound foundations on which others will build. Observers who admire a building take it for granted that it rests on good foundations, and they do not need to know who designed the foundations.

George Koerner: Recognizing that your body of work is extensive, what are your thoughts on the future of geosynthetics and the biggest changes coming to our industry?

J.P. Giroud: I do not have a crystal ball, but I do have a polymeric ball. However, there is so much carbon black in it that I cannot see what is inside! Therefore, I have to guess. The use of smart geosynthetics has been mentioned earlier in this discussion. We should also think of smart construction, such as

remotely controlled underwater repair and installation of geosynthetics. Also, we should consider the use of biological materials and techniques in soil structures. As a result, our discipline should not be limited to the use of synthetic products. In fact, we have already adopted in our discipline some non-synthetic products, such as steel reinforcement and erosion control systems made of natural fibers. But, while the term "geoproducts" may be used to encompass geosynthetics per se, natural fibers and metallic reinforcement, it doesn't apply to biological matter. Could we perhaps consider that "geoadditives" might encompass all we add to soils to enhance the performance of soil structures? Regardless of terminology, I think we should be prepared to expand the scope of our discipline. We should not be shy. We expanded the scope of our discipline twice already, first from geotextiles to geomembranes, then to all geosynthetics; and we changed the name of the IGS accordingly, while keeping the acronym.

After these tentative thoughts about a possible future for our discipline, I would like to point out that there are more immediate challenges. One of them is water conservation. Geosynthetics have been, and still are, the main contributors to the protection of the environment from contamination by leakage from waste disposal landfills and mining facilities. We can be proud of this accomplishment. As shown in my lecture, we can use our expertise on leakage control to minimize water waste. Today, a significant fraction of the water that is collected and transported for agriculture and domestic uses is wasted, often because of leakage. As a result, the wasted water (which has returned to groundwater or rivers) must be collected again and transported again to be finally used or wasted again, etc. We know how to control leakage and we must use this expertise for the great challenge of the 21st century, water conservation. And, as we continue to be at the forefront of the efforts for the protection of the environment, we should also make sure that the progressive degradation of some geosynthetics is not detrimental to the environment. Many geosynthetics are more durable than concrete and we should make sure that this fact is widely known, but, at the same time, we know that the general public is concerned by what people call "the plastics." We should take measures to control the use of a few geosynthetics that may cause a problem to the environment. Thus, our discipline will continue to be at the forefront of efforts for the protection of the environment and water conservation.

In conclusion, I see a bright future for our discipline provided we are open to broadening its scope, and I am confident that the challenges will be met.

George Koerner: How do we motivate the next generation of young professionals to join our industry?

J.P. Giroud: When I was young, we wanted to do more; now young people want to do better. Therefore, I would tell young professionals that they will like geosynthetics because geosynthetics make it possible to do things better. This is particularly true regarding the environment and climate, subjects dear to young generations: I believe that young professionals will appreciate the beneficial effects of geosynthetics on the sustainability of construction projects. Another aspect of the geosynthetics industry which should attract young professionals is that creativity and original solutions are appreciated because the geosynthetics industry is less codified than many other industries. Also, I would tell young professionals that they are most welcome in the geosynthetics industry because, as I said in my lecture, this industry is characterized by cooperation between professionals with different backgrounds, as well as between generations. Young professionals will like to work in such a stimulating professional environment, which provides opportunities to interact with a variety of experienced people and provides opportunities to work on challenging projects. Clearly, our industry will grow with young professionals and will help young professionals to grow. This may be the best conclusion for this discussion.