Quality Control and Quality Assurance Procedure for Geosynthetics

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ABSTRACT: The control of quality in the production of geosynthetic products is of critical importance to their reliability of performance in the field. Furthermore, the supply of statistical analysis information to the design engineer should be both meaningful in its statistical sense and understandable by the engineer. If the engineer does not comprehend the meaning of the supplied production quality statistics, then he will not be able to specify appropriate synthetic products properly. This paper describes the quality procedures which must be followed by manufacturers and their necessity in complying with the demands of a high-technology engineering science. The paper points out the additional but vitally important quality roles of both the design engineer and the contractor placing the textile. The Author emphasises that overall quality of product and performance is a joint product of design engineer, manufacturer and placement contractor.

1 INTRODUCTION

Geotextiles can no longer be considered as developmental materials in a newly-forming science. They are being increasingly used in large scale, high risk applications and consequently, they must be treated with the same rigor as any other fully fledged building material.

The design engineer's expectation of a building material is that it will provide forecastable performance behaviour within mathematically defined ranges, thus permitting the accurate calculation of proposed engineering functions.

It can be understood that the control of performance limits on, for example, a natural material is not capable of precise execution. All behaviour parameters are subject to natural variations and generally highly susceptible to post-manufacturing storage time and conditions. Therefore, these products fall outside the scope of this paper, since they will have additional quality parameters in growing, harvesting, treatment, transport and storage, that are not covered here.

Today, the long term reliability of polymer manufacturing processes by a limited number of major polymer manufacturers assures that the concept of controlling the product is globally realistic. After all, what point would there be in careful control of textile manufacture if raw product was not itself controlled to the same level. This would revert the industry to the 'natural materials' scenario of potential high level variability.

Complete Quality Assurance (Q.A.), from design of the specified geotextile, through manufacturing, the storage at the yard to the final installation, is absolutely essential for the successful completion of a project. It must also be preceded by equally stringent control of raw product processing.

It may be taken for granted at this time that the production of textile polymers, which has been taking place for considerably longer than that of geotextiles, is subject to high levels of Quality Control (Q.C.) and Assurance. However, this does not preclude the geotextile manufacturer from undertaking his own index testing of input raw material, as part of the first steps of a manufacturing Quality Control procedure.

2 DEFINITION OF QUALITY

What is the 'Quality' of the geotextile? 'Quality' is the confidence that can be placed in the product consistently meeting the numerically claimed variation limits in properties taken into account by the design engineer and extrapolated into the in-situ installation and functioning of the product.

The above definition automatically specifies Quality as being

a phenomenon judged by the engineer in site performance. Quality is aimed at the client and the success of his paid-for structure.

3 THE INTERACTIVE RELATIONSHIP BETWEEN DESIGN ENGINEER AND MANUFACTURER.

a. The design engineer calculates the requirements that the geotextile must fulfil in terms of:-
b. The main purpose of the geotextile (reinforcement, filtration, drainage, protection, separation, etc. ...).
c. The ancillary purposes of the geotextile.
d. The specific end use of the geotextile (road and railroad construction, harbour construction, dike construction, waste management, reflective cracking, etc. ...)
e. The local environment -

Soil features (bearing capacity, density, stability, composition, permeability, chemical composition, etc.).

Climatic conditions (temperature, sun radiation, precipitation, etc.).

f. The anticipated construction period.
g. The construction method (e.g. to be covered with large rocks, asphalt, etc.)
h. The anticipated life span of the structure.

The design engineer then specifies, on the basis of the above, the requirements for the geotextile:- Tensile strength @ x% elongation, perforation resistance, thickness, porometry, permeability perpendicular to and within the plane, chemical durability, light resistance, creep, etc. Eventually, these specifications result in the engineer having to chose or approve a particular geotextile for the works. To do this, the engineer or contractor must rely upon the published information from the manufacturer. The important questions arise then, as to how much information is available from the manufacturer; how reliable is it, and is it statistically understandable and relevant? Unfortunately, all three of these prerequisites may not be present.

If they are to be met, then the geotextile manufacturer must work according to a QUALITY CONTROL SYSTEM. This is a system of fixed company rules and procedures used by the manufacturer, to control the processes of design, manufacture and supply, in order to ensure the requirements of the supplied products are fulfilled. Beyond this, the distributors and stockists must participate in controlled procedures for transporting and supplying these technically controlled products to site without adverse conditions occurring. In such cases, long storage, inappropriate storage conditions (high temperature, excessively low temperature, ultra-violet exposure, etc.) and inappropriate transport conditions are examples of adverse conditions. It is the manufacturer's responsibility to ensure that his stocking and distributor networks and agents are fully informed of the necessity for continued product control and to ensure that such control is executed through to on-site delivery. Purchase of product through 'grey' channels, must be recognised as containing a potential break in a controlled Quality Assured service and product supply.

4 CONFORMING PROCEDURES FOLLOWED BY THE MANUFACTURER.

Quality Control is strictly the statistical control of the product in the machine system during manufacture. However, this is not sufficient to conform to the above stated requirements. To achieve this, the manufacturer needs a QUALITY ASSURANCE SYSTEM, OF WHICH Quality Control IS ONLY A PART. Indeed, the manufacturer's Quality Assurance system is only part of a larger group of working Quality Assurances exercised by parties before and after the textile manufacturing operation. Fig.1 shows the general

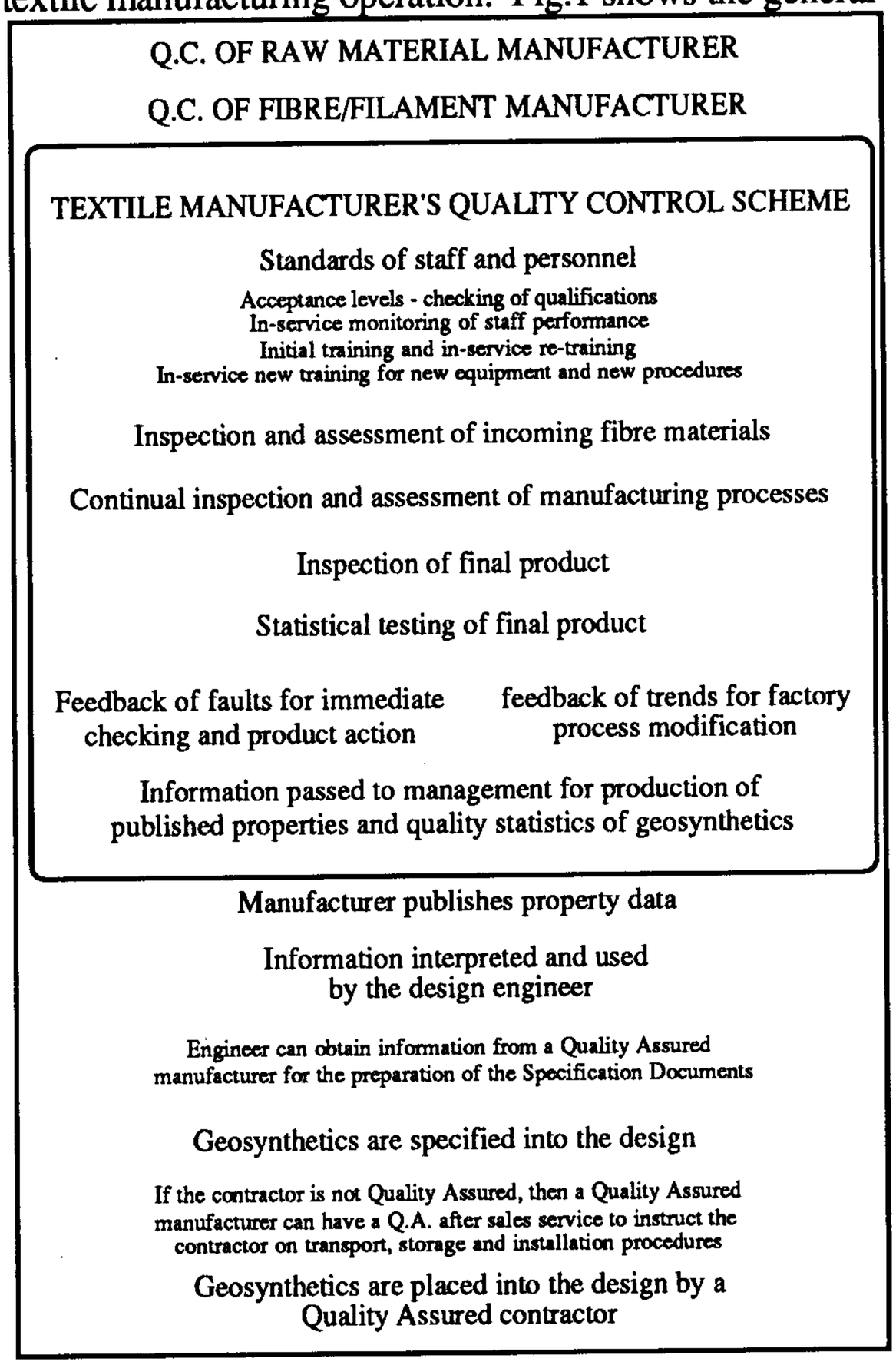

Fig.1. Overall context of Quality Assurance systems affecting the manufacture and placement of geosynthetics.

position of the textile manufacturer's Quality Assurance scheme within the wider Quality Control context.

Quality Control is a documented system which, from a higher level, ensures the standard of the Quality Control System, and proves that the Quality Control System fulfils

its specified requirements. Quality Assurance, as implemented at present is not the same as Total Quality Management. In the latter, all aspects of a business are documented under a controlling system, of which Quality Assurance is a part. Quality Assurance, as discussed in this paper, documents and controls all aspects of a company's activities which impinge on and affect the quality of the product only.

Quality Assurance only exists if the Quality Control System is being constantly monitored, performance documented and analysed and if inadequacies are being remedied appropriately. Appropriate actions vary from immediate rectification of machine errors to long term adjustments of product as statistical tests are repetitively analysed over months and years. The Quality Assurance documentation also sets many other parameters affecting direct product quality, such as the qualification and training level of operatives and management.

The Quality Assurance scheme must be capable of demonstration to clients, contractors and design engineers. To this effect, a Quality Statement document is prepared which is available for inspection and which sets out the policy of the manufacturer with respect to all aspects of Quality Assurance and Quality Control.

Verification, screening and assessment of the Quality Control systems are therefore essential components of Quality Assurance. These documented systems serve to inspire confidence in contractors, designers and end users, both in the quantitative and qualitative sense, that the product is being supplied to agreed specifications and standards.

The manufacturer's desire to implement a Quality Assurance system is not only motivated by wanting to inspire confidence, but also to a great degree by wishing to obtain the benefits of decreased costs due to reducing operating inefficiencies, machine down-time, improved motivation of the work force through better working conditions, and substantially decreased risk of structure failure as a result of product inadequacies, with concomitant decrease in the possibility of engendering consequential losses.

The introduction of Quality Assurance helps the manufacturer to meet the strong pressure from the open European market (and indeed, from substantial competition in the World Market) to supply high quality products for the lowest possible prices. It assists the manufacturer to achieve the so-called "fit for purpose" principle, which is to supply as many products as possible at the relevant quality per Ecu (p + q)/Ecu (p = product, q = quality).

There is, today, a noticeable increase in litigation due to the development of a formal system in the field of product liability. The adoption of Quality Assurance makes the manufacturer more capable of both avoiding litigation and of responding to it should it arise.

There are important incentives exerted to increase quality, by various authorities who wish to improve the image of their products and increase exports. For example, "This is Belgian" in Belgium, "het Stappenplan" by "Nederland B.V." in Holland, and in the U.K., the slogan "Buy British".

Geotextile manufacturers have their Quality Assurance system certified by an internationally recognized and independent evaluator, in compliance with internationally recognized standards.

The client and/or end user is assured of the relevant "quality competence" of the manufacturer by means of the quality certificate which is issued to him. ISO-9001, ISO-9002 and ISO-9003 are the best known certification systems of the ISO-9000 series standards.

Manufacturers who are awarded one of these certificates are able to prove that:-

ISO-9001:They have a Quality Assurance system in place which guarantees the quality of the end product, from its design, through incoming base material assessment and in process assessment during manufacture, to final assessment, including delivery and after sales service.

ISO-9002:They have a Quality Assurance system in place which ensures the correct execution of the incoming raw/ base materials assessment, the "in process assessment" during manufacture, and also the final assessment of the products produced by them.

ISO-9003:They have a Quality Assurance system in place which ensures the correct execution of the quality assessmént procedures relating to the final inspection of the products manufactured by them.

When it comes to Complete Quality Control in the use of geotextiles, ISO-9001 certified suppliers clearly demonstrate the best Quality Assurance system offering products with the greatest reliability and consistency.

The assessment and certification of Quality Assurance Systems to ISO-9000 is done by nationally, and preferably internationally recognized and certified independent bodies, such as Lloyds Register Assurance Ltd. and others. In compliance with ISO standards, they assess manufacturers on the following criteria:-

1. Description of the Quality Control system
2. The quality related arrangements/responsibilities
3. Assessment of the Quality Control system
4. Design control
5. Quality planning
6. Document control
7. Work instructions/procedures
8. Incoming goods control
9. Manufacture control
10. Inspection
11. Skill criterion/production management
12. Final inspection/test procedures
13. Sampling procedures
14. Reject material control
15. Inspection level/status indication
16. Protection/preservation procedures
17. Training/qualifications
18. Internal/external assessments (audits)
19. Storage and Delivery
20. After sales service

ISO-9001 certified manufacturers also have their products certified. In doing this, they can demonstrate publicly that the quality of the products supplied by them fulfil the agreed criteria. Again, this requires the intervention of an impartial national or an international evaluator, by whom the certification is awarded on the basis of national or international standards.

To this effect the following minimum requirements must be fulfilled:

The manufacturers are ISO-9000 certified.
The test procedures at the manufacturers facilities are executed according to the accepted standards, by means of periodically calibrated equipment, and by qualified staff.
The test frequency is statistically adequately efficient.
The identification of the products is according to specifications.
At regular intervals, comparative tests are done by independent inspection organisations.

5 ACCEPTABLE ALTERNATIVE PROCEDURES.

There are possible alternatives to product certification:-
a. Quality control tests are undertaken at the laboratory of the manufacturer in the presence of the client or a representative appointed by him (e.g. an independent evaluator).
b. At an independent laboratory, which is ISO-9000 certified, the supplied products are subjected to Quality Control procedures on the basis of index tests. This method is usually expensive, time consuming and less efficient than the above. Adequate assurance can only be achieved if 100 % of the product is inspected - especially if the manufacturer is not ISO-9000 certified.

6 THE PLACEMENT CONTRACTOR - THE FINAL LINK IN QUALITY.

Storing the geotextiles at the yard, and the placing of the geotextiles, requires that the contractor should have proper Quality knowledge, skill and know-how, to ensure that the quality-giving process continues through this stage also.

The contractor might be assisted by the design engineer, and or the geotextile manufacturer, who may offer such after-sales service within the ISO-9001 certification framework. Contractors who are also ISO-9000 certified for geotextile placing will prove to be an important advantage within the Total and Complete Quality framework.

7 SUMMARY

Complete Quality Geosynthetics are provided into a Civil Engineering Structure by:-
a. The quality requirements of the geotextile being calculated by the Engineer/Developer in function of the application.
b. The Engineer/Developer accurately specifying the requirements the geotextile must fulfil, how it should be stored and placed.
c. The manufacturers having a Quality Control system and a Quality Assurance system.
d. The manufacturers being ISO-9001 certified for geotextile design, manufacture, Quality Control and after sales service.
e. The manufacturers possessing either product certification or a test report.
f. The contractors having a Quality Control system and a Quality Assurance system.
g. The contractors being ISO-9000 certified for storing and placing geotextiles.
h. The Engineer/Developer, the geotextile manufacturers and the contractors working together towards a Complete Quality situation.

8 CONCLUSIONS.

Quality Assurance means many parties working conscientiously and achieving standards to ensure that product going into any civil engineering structure will have, in the structure, those properties published by the manufacturer and factored by the design engineer for the purposes of the particular design.

For the Client, a Quality Assured team means the greatest peace of mind and an assurance that his investment is made under the best possible techno-commercial conditions, derived from documented technical cooperation and understanding between engineer, manufacturer and contractor.