CASE STUDY: TRIAXIAL SYSTEM UPGRADE WITH ELTAS SOLUTION

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The "Special Testing Division" of **LEMO Corporation** is one of the leading providers of commercial static triaxial tests on soils, for both the private and public sectors of the Portuguese construction industry. This division has also been LEMO's laboratory marketing and investment centerpiece since 2003.

The capability to carry out simultaneously tests on multiple samples while maintaining the highest quality standards to specific customer needs. Complying with either standardised practices or procedures tailored by LEMO's soil mechanics experts, has led LEMO to establish business relations with the major Portuguese contractors and engineering consultancy corporations.

Useful Link:
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THE PROBLEM

Since its launch in 2002, LEMO's "Special Testing Division" has gradually established itself as one of the leading providers of high quality static triaxial tests on soil, for the Portuguese civil engineering industry. As their market position became stronger, LEMO faced an increasing demand for triaxial tests. This resulted in the need of a laboratory expansion which, took place between 2002 to 2009 and led to an increase in the number of available triaxial cells from 3 to 9. This allowed CU-CDUU triaxial tests to be carried out simultaneously on three samples by means of three independent non-automated triaxial systems, relying on a common pneumatic pressure source.

In 2009, consecutive peaks of demand led to a back-log of work, which caused delays and jeopardised the fulfilment of their clients deadlines. Although this would not directly reduce overall yearly productivity, client satisfaction is of high priority for LEMO, so failure to meet deadlines could lead to the eventual reduction of tests required. It was at this point that LEMO's administration decided to increase capacity by purchasing a new triaxial test system with three cells, allowing standardised testing of four different samples and saturation or consolidation on twelve specimens simultaneously. There were however, limitations that had to be overcome without putting at risk the accuracy of test results:-

- Funds available for the acquisition of a new triaxial system were very limited and only accounted for a non-automated system, which would rely on the pressure source already in use by the other three working systems.
- The physical space available for new equipment was very limited, the equipment would have to fit in a 1.3m^2 area. In addition, there was just one load frame available, this meant that shear stages had to be carefully planned, as only one specimen could be subject to shear at any time.
- The setup of the new triaxial system also had to allow triaxial cell mobility, so each cell could be transported individually to the load frame for shear stage, and pressure lines reconnected without interfering with the remaining ongoing tests.
- The strain of adding a new triaxial system had to have a minimal impact on human resources. LEMO, at that time, had just one operator allocated to the "Special Testing Division" and it was already challenging to coordinate legal leave time with workflow.

THE SOLUTION

It was agreed during procurement that GDS' Triaxial Automated System (GDSTAS) was the best solution to increase LEMO's "Special Testing Division's" triaxial capacity and at the same time overcome their existing limitations.

It soon became clear during the decision process that the most restrictive limitation was the fact that any further increment in manual equipment would also require an investment in human resources. Especially, in periods of high demand when all the triaxial systems would be working simultaneously.

This limitation could be solved by choosing an automated triaxial system instead of a common/manual system. The initial funding available however, was insufficient for the acquisition of the automated triaxial system.

A production capacity study in which, a solution based on the GDS Triaxial Automated System (GDSTAS) was compared against a common/manual triaxial system and presented to LEMO's administration. The study showed that GDS' solution would

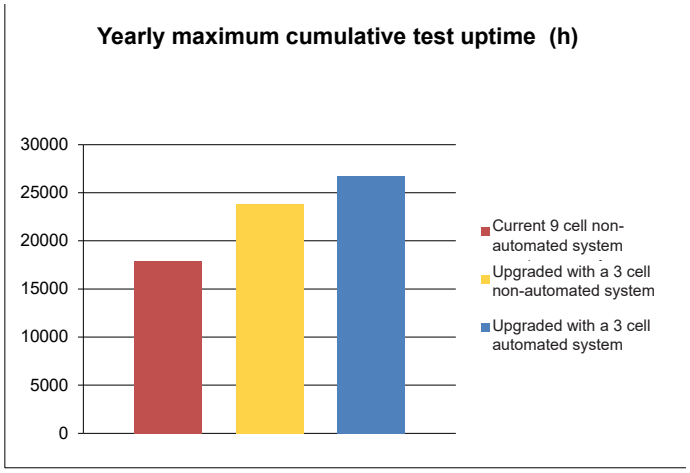

Fig 1. Comparison between yearly effective working hours for the original triaxial setup and both upgrade solutions.

provide a greater increase in the maximum effective working hours within a year, compared with a non-automated solution (see Fig. 1 for the results).

The difference was mainly due to the fact that, when using a non-automatic system, presence of an operator is necessary to manually change the pressure on valves, register values at every pressure increment at triaxial saturation stage and to manually start the consolidation stage. This meant that a test would only progress effectively on business days, therefore, making a big difference in the productivity between a non-automatic system and GDS' Triaxial Automated System.

The capacity to create fully automated test plans using GDS' software, GDSLAB (which are implemented by GDS' pressure/volume controllers connected to triaxial cells) would effectively withdraw the need for routine user intervention during saturation/consolidation stages, disregarding distinction between calendar days and business days for triaxial test purposes. It would not be possible to fully automate transition from consolidation to shear phases, given the fact that before this phase, triaxial cells had to be physically moved to the available load frame.

Overall, it was estimated that the implementation of GDS' Triaxial Automated System would allow LEMO' "Special Testing Division" to increase static triaxial production by 49% (see Fig. 2).

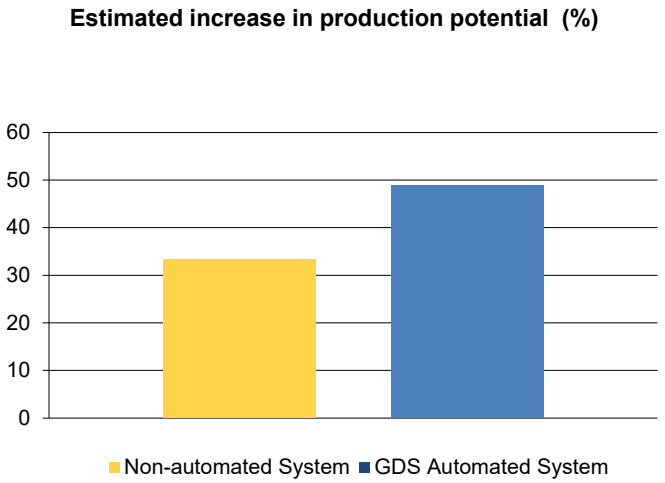

Fig 2. Comparative estimated production increase between a non-automated solution and GDSTAS.

To minimize the additional funding needed to acquire an automated system, a compromise between cost and system flexibility was reached. This was accomplished by designing a system to include a GDS enterprise level pressure/volume controllers (ELDPC, with a capacity of 1MPa/200cc) in which, a back pressure line was shared between the three triaxial cells. Therefore, reducing the number of controllers needed from six to four and still assuring the systems automation.

Based on this setup, using the average equipment occupancy rate calculated for the time period between 2003 to 2009, and the predicted increase in potential production, LEMO's "Special Testing Division" estimated that the payback period of a non-automated triaxial system would be of 4.2 years, whereas the proposed solution, using GDS Enterprise Level Triaxial Automated System (ELTAS), would have a payback period of 3.7 years therefore, offering the most viable investment.

The implemented solution (see Fig. 3) was an automated GDS system (ELTAS), including three traditional passive triaxial cells for specimens up to 76mm, four 1MPa/200cc capacity Enterprise Level Pressure/Volume Controllers (ELDPC) and three GDS pore pressure transducers connected to a standard GDS 8 channel data acquisition device, known as "serial pad". Test control and data acquisition was assured by GDSLAB software. Using a hydraulic pressure circuit which included control valves for complete segmented control of pressure lines, the implemented system maintains full functionality even with a shared back pressure line.

THE RESULTS

GDS' Triaxial Automated System (ELTAS) is fully integrated with existing equipment from LEMO's laboratory. Hydraulic hoses and data cables supplied by GDS ensured full mobility of each triaxial cell and allowed use of existing load frames, load cells and transducers from other brands.

Specimen saturation became fully automated. GDSLAB software allowed the user to set a specific saturation ramp for a gradual increase in cell pressure and back pressure, otherwise impossible to achieve in non-automated triaxial systems, which can be intercalated with Skempton's pore pressure coefficient B checks. Alternatively, an automatic saturation mode can be selected to reach a desired B value, through consecutive automatic pressure increments defined by the operator. Transition between every test stage can be done automatically according to the users criteria.

A data connection between load frame and a PC, running GDSLAB software (see Fig. 4), allows a user to set custom failure criteria, control axial displacement, strain rates and monitor all test parameters in real-time.

The additional demand on human resources was minimal, as active intervention of the operator during test execution was only needed for sample mounting, software test plan selection/creation and to move the triaxial cell to load frame. The gain in response capacity initially estimated was later confirmed, with the average completion time for a full CU triaxial test performed with the ELTAS calculated at 11 calendar days, according to data from tests performed between 2010 and 2012. With earlier non-automated solutions, it was averaged 15 calendar days per test.

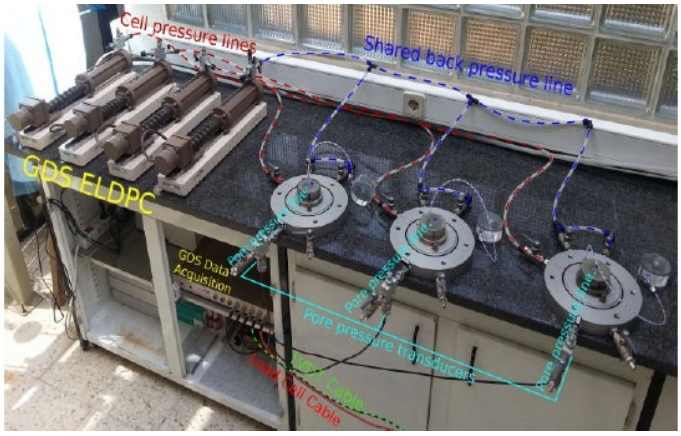

Fig 3. GDS Enterprise Level Triaxial Automated System (ELTAS) at LEMO Soils Laboratory.

Fig 4. Load Frame connectivity.

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..."The performance and adaptability provided by GDSLAB software working together with GDS pressure/volume controllers is remarkable. During our procurement preparation, we didn't find this extent of test control and automation on any other potential supplier. With fully computer controlled testing, we are able to check on test progress and alter test plans in a few seconds, even when working abroad or on the field, through remote desktop connection using any PC or smartphone with internet access. The high quality of the materials and fittings on triaxial cells, guarantees a completely watertight cell with a ram casing that permits a very smooth low friction movement of the loading ram" says Diogo.