SCAN-TENS - The study of load-induced deformations through tensile testing combined with 3D laser scanning

We have developed a fast and accurate method for measuring deformations even on components with complex geometries. The process, referred to as SCAN-TENS, consists of loading the specimen using mono or multi-axial testing machines, with applied forces ranging from a few newtons up to 250 kN, followed by high-resolution 3D scanning using a laser scanner. This workflow enables detailed spatial mapping of deformations at different load levels. The results can be directly compared with FEM simulations and serve as a robust preliminary support for more in-depth analyses, such as those performed with strain gauges or other experimental techniques.

"Deformation analysis through 3D scanning: a fast and effective approach"

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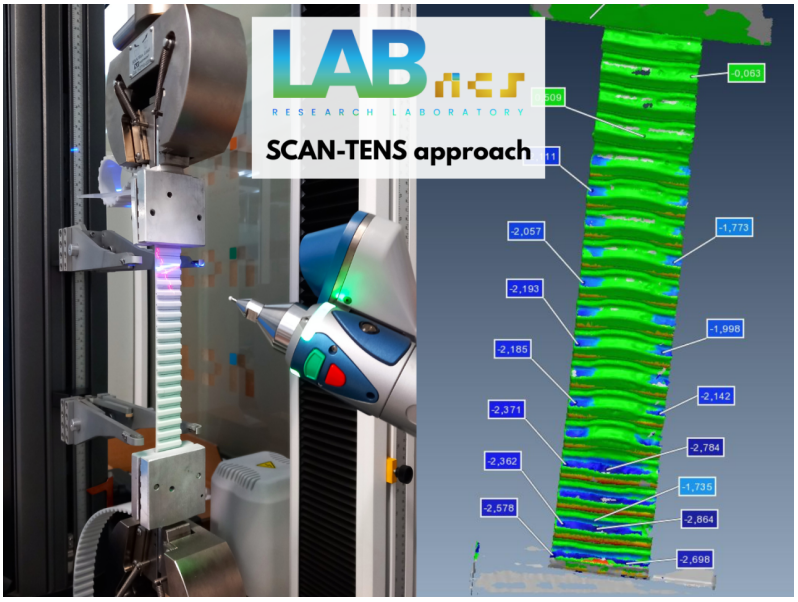


Fig. 1: SCAN-TENS method applied to the analysis of a toothed belt



Fig. 2: 3D scanning during the application of static load on a toothed belt

Description

The SCAN-TENS method combines controlled mechanical testing, typically by applying incrementally stepped loads, with high-resolution 3D geometric acquisition, providing a fast and accurate approach for measuring deformations on components with complex geometries. The procedure begins by loading the specimen using mono or multi-axial testing machines capable of applying forces from a few newtons up to 250 kN. At each load level, the component's geometry is captured through 3D laser scanning, generating a high-density point cloud that accurately represents the deformed surface.
By comparing the geometries acquired at different load steps, a complete deformation map can be obtained, even in the presence of complex shapes or non-homogeneous materials. The method is particularly suitable for components that are difficult to instrument with traditional sensors, such as thin structures, composite parts, curved surfaces, or elements subjected to combined loading conditions.
The acquired data can be directly compared with FEM simulations, enabling effective experimental validation of numerical models. In addition, the spatial mapping can guide the placement of strain gauges or other experimental measurement techniques by identifying the most critical regions. The method is non-invasive and allows detailed deformation analysis without any physical contact with the specimen.

Innovative aspects

The technique stands out for its direct approach to deformation measurement, based on the real geometric observation of the component under load. The use of 3D scanning makes it possible to detect even very small dimensional variations across the entire surface, without requiring the application of sensors or markers. This enables fast analysis of complex or hard-to-instrument components, while achieving high accuracy and complete spatial representation.
The innovation lies in the integration of mechanical testing with three-dimensional acquisition, which provides results that are immediately interpretable and directly comparable across different load conditions. In addition to simplifying the testing phase, the method reduces the risk of localized errors and highlights unexpected behaviors, which are valuable for guiding more in-depth investigations.
It is particularly suitable for prototyping, reverse engineering, or quality control, when a global and reliable assessment of mechanical behavior is required within short time frames.

Potential applications

This methodology is applicable across multiple sectors: in the automotive and aerospace industries for the analysis of complex structural components; in mechanical engineering for monitoring deformation in highly stressed parts; and in construction for non-conventional structural elements. It is also particularly valuable in the medical field, for studying prostheses and implantable devices, where a non-invasive and highly accurate assessment of mechanical response is essential. Ideal for R&D and prototyping, it enables fast and reliable analyses even on complex geometries.

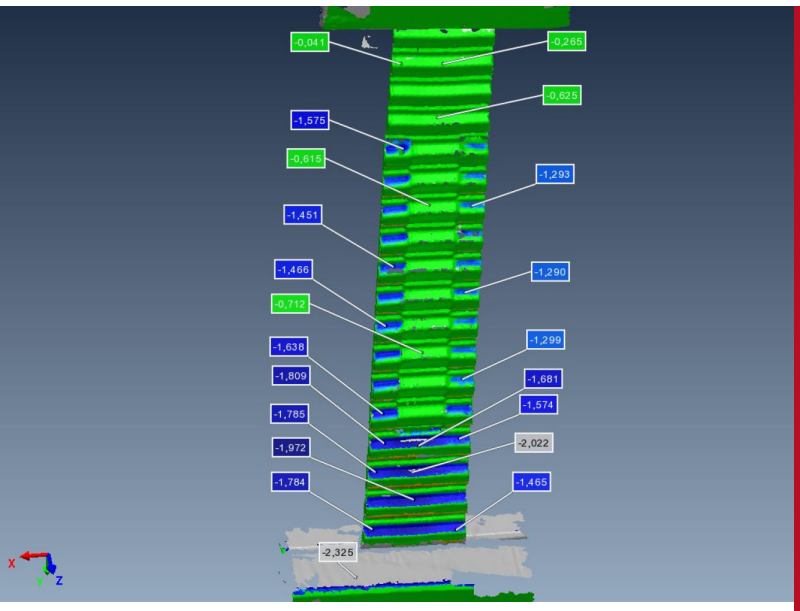


Fig. 3: Deformation mapping of a toothed belt with a joint under static tensile loading.

Involved partners

- Industrial companies specialized in the design and manufacturing of machinery and mechanical components
- Commercial companies performing product benchmarking activities
- Producers of prototypes and components via additive manufacturing
- Engineering design firms

Implementation Time

6–8 days or fewer

Technology Readiness Level

TRL9 - Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

Exploitation

The SCAN-TENS methodology has been validated and is frequently employed by our Laboratory across various application fields, with force ranges from a few newtons up to 250 kN.
It is therefore a service that provides crucial information for R&D activities and product benchmarking.

Application example

Investigation of load-induced deformations in toothed belts with different internal structures.

A specimen of this type exhibits complex, heterogeneous deformation distributions under load, which are difficult to predict. The use of conventional techniques, particularly in the early stages of study, rarely allows an accurate assessment of deformation magnitude and distribution, and typically involves significant setup time and costs.
By employing the SCAN-TENS method, multiple scans at incrementally applied static loads can be performed within minutes, in successive load steps, while simultaneously monitoring the stress–strain curve. Each scan captures the deformations of all specimen surfaces at the applied load, relative to an initial preloaded condition or a different load state, with sub-millimeter accuracy.
This study enabled a rapid and cost-effective evaluation of the performance of toothed belts with different internal structures. It also allowed determination of the maximum allowable operational load, establishing the product's technical specifications through a robust experimental approach.

NCS Lab



NCS è un centro multi-tecnologico votato all'innovazione di prodotto, in grado di gestire un processo integrato dalla generazione di nuove idee, fino alle omologhe/approvazioni necessarie per la commercializzazione.
L'attività di NCS si compone di varie competenze, impiegate singolarmente o integrate per la realizzazione di progetti, nelle varie fasi:
• creazione di nuove idee o soluzioni da failure analysis,
• progettazione meccanica ed integrazione di controlli/sensoristica necessaria,
• selezione di materiali e processi in funzione dei requisiti di progetto,
• stesura dei requisiti/capitolati per la realizzazione o controllo di un processo,
• simulazione numerica e caratterizzazione sperimentale (prove normate o set up customizzati) e realizzazione di prototipi e produzioni (con tecnologie additive, CNC, per fusione e sinterizzazione).
A questo si accompagna la competenza regolatoria e le certificazioni del sistema qualità aziendale, oltre alla definizione in ottica strategica del portfolio brevettuale.
NCS opera principalmente nei settori automotive e medicale ma ha un track record di successo anche in ambito aerospace e macchine automatiche.
L'attitudine all'innovazione in NCS è trasversale agli ambiti industriali e si concretizza con una gestione efficace della complessità in un ambiente flessibile, competente, esperto. Nel corso della propria attività NCS ha contributo alla generazione di più di 20 brevetti riconosciuti a livello internazionale.

Website https://ncs-company.com/

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