Minutes of the Transport Stresses Working Group of the Committee for European Environmental Engineering Societies Held on 3rd March 2000 at Paris France

Present at the Meeting of the Transportation Stresses Working Group (TSWG) were;

Mr M. Dumelin	SSEE
Mr H. Jansen	PLOT
Mr M. Juntunen	SEEF
Mr. D. Richards	SEE (Chairman)
Mr T. Trost	SEES
Mr H. Torstensson	SEES
Dr K. Zieghan	GUS

Matters Arising

The group welcomed Haken Torstensson who was already known to many of the group. Apologies were received from Dr Braunmiller, J. Moriceau and Dr P. Dehombreux.

A list of TSWG members, including corresponding members, was circulated. This list is attached to the minutes as Attachment No 1.

As the meeting was only scheduled for a period of 2 hours, a number of items on the agenda were either deferred or taken out of order. However, for convenience the following notes are in the same order as usual.

Systematisation of Measurement Methodologies

CEN TC 261 Thomas Trost reported that no meetings had occurred, the next meeting was scheduled for April.

CEN TC 320 (Transport Quality). Karl Ziegahn reported no news from this group.

DIN 30787. Karl reported that parts 1 to 6 were now available.

IEC TC104 WG 15. David Richards reported on the recent TC 104 Working Group 15 meeting. This working groups was created to establish databases on dynamic environments for inclusion in IEC 680721. The databases that need to be identified include transportation (by road, rail, sea and air) as well as deployment in such vehicles. The chairman asked to be informed if that anybody who knew of such databases (they only need to be identified at this time).

IEC TC104 Testing of Soft Packages. The chairman reported that that the preliminary report of this Swedish led work was circulated to national committees late last year. The second report was in its final stages of compilation.

ISO TC 108. The chairman reported (at the last meeting) that two new working groups had been proposed to set out methods of vibration and shock analysis. Although the work proposal had yet to be submitted for national approval, the TC had provisionally agreed to go ahead. It is likely that the vibration and shock groups will be run "back to back" at the same meeting locations thus permitting the same people to attend both.

SRETS. Thomas Trost said he had colour copies of the final report. Black and white copies are now available from the EU.

Standards Report. At the last meeting it was suggested that the TSWG attempt to produce an overview of European and international work currently underway relating to transportation stresses. Mainly due to lack of time this item was not progressed at the meeting.

Plot Measurement Programme. Harro Jansen updated the group on the work programme proposed by PLOT to acquire transportation data. He stated that they were having problems "signing up" the various companies who had previously expressed an interest. He indicated that they intended to continue pursuing the project till May.

Monograph on Round Robin Methodologies. The chairman apologised that this was not yet complete. A copy of the draft had been circulated before the previous meeting for discussion. However, time did not permit this. Work continues on this topic. The chairman agreed to get a final version out for the next meeting.

Miscellaneous. The next meeting of IEC TC104 (responsible for IEC 60068 & 60721) was scheduled for September in Stockholm. The next meeting of ISO TC108 was scheduled for March in London. Karl reported that he had heard the "committee of experts" of the UN Dangerous Goods Organisation were proposing an additional vibration test. The proposal seemed to be the same as that made some time ago by the US and was essentially a crude bounce test.

Round Robin Exercise

No time was available to discuss the Round Robin exercise. In consequence the discussion was deferred till the next meeting.

Future Work

A discussion paper was tabled by the chairman on future testing methods (attachment 2), however, time limitations prevented discussion on this. A discussion occurred on future work of the TSWG. Thomas used two vu-foils to focus the discussion. Karl demonstrated a link between CEEES with SRETS, the work of some national and standards organisations. Karl suggested that CEEES could make contributions from the view point of end users, as a networking platform and possible as a means of promoting technical advances. The vu-foils and summary of the flipchart from this discussion are included as attachment 3

Any Other Business

Thomas Trost made a brief presentation on an optical measurement system that Packforsk were about to purchase (attachment 4).

Next Meeting

The date of the next meeting of the TSWG is planned for 21st September in Karlsrue.

Attachments

1 Names and Addresses of TSWG Members
2 Paper on Future Methods of Testing for Transportation Stresses
3 Discussion on Future Work
4 Presentation by Thomas Trost

Distribution
As attachment 1
plus CEEES President and Secretariat

Attachment 1
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Attachment 2
Paper on Future Methods of Testing for Transportation Stresses

Future Methods of Testing for Transportation Stresses

Background

1. As part of the SRETS project the participants had to decide on the testing methodology for which the test schedule were to be developed. This involved considerable discussions on whether to adopt existing or likely future methodologies. However, the SRETS group was not the most appropriate forum to identify future methodologies which may have advantage to simulating transportation stresses. It was suggested at the last CEEES meeting of 1999 that the TSWG may be a more appropriate forum. This draft note is intended as the basis for discussions.

Summary of Existing capabilities

2. Many existing shock and vibration test procedures originate from a time when few other options existed. Unfortunately, (or fortunately depending upon your point of view) most of these are still in common use. Somewhat of a catch 22 situation seems to exist, national / international standards do not include new procedures because insufficient people require them, however, uses do not call for them because there are no standards which require them.

a. **Shock**. Many shock test procedures used today are fundamentally the same as those used 50 years ago. The basic design of the shock test facilities these procedures relate to also remains largely unchanged. However, in recent years advances in computing power has allowed the ability to control shock tests on electro-dynamic or hydraulic vibrators. The ability to control shock testing has been accompanied by the wider availability of long stroke electro-dynamic vibrators as well as the increased frequency bandwidth of hydraulic systems. Although test procedures exist which allow use these new facilities, a common theme of these is that they attempt to replicate the older tests. Unfortunately these older tests are not ideally suited to application on electro-dynamic or hydraulic vibrators. Nor are they necessarily representative of actual conditions.

b. **Vibration**. The introduction of digital vibration control systems in the mid 1970's swept away most of the older analogue systems. In the early days of digital vibration control systems available computer power limited loop cycle time and the complexity of the control process. Since then computing power has risen by several orders of magnitude, yet for most applications we are mostly still undertaking the same type of broad band random vibration test.

c. **Loose Cargo (or bounce)**. Although not always undertaken today, the test machines mainly used for this test are mechanical vibration generators based upon motor driven cams. A few hydraulic systems exist, but again they are expected to replicate the older test rather than one more suited to their capability or actual conditions.

d. **Bump**. Although this test still exists in several national / International standards, it is rarely now considred as an environmental simulation test. Essentially the bump test induces repeated half sine pulses on an equipment. The bump test machine is usually able to undertake a programme of such shocks frequently involving many hundred. Originally the intent of the bump test appears to have been to reproduce the effects of bounce on equipment when the package was not available.

3. Two generic reasons exist for wanting to adopt improved testing methodologies for testing packages and equipment against transportation stresses. One of these is to reduce costs the other is to allow the test to more accurately replicate actual conditions. Reducing test costs may be achieved by minimising the duration of testing, reducing the number of times an equipment has to rigged on the test facilities and/or reducing capital equipment costs.

Improvements Identified by SRETS

4. The Part EU funded project known as SRETS identified a number of ways by which current simulations of Transportation Stresses could be improved. SRETS identified several different testing methodologies, all of which were restricted by current facilities.

5. **Increased Crest Factor**. The "real world" vibration transportation data identified by SRETS indicated that the vibration crest factor of 3 used in testing, was exceeded. Attempting to envelope peak accelerations whilst adopting a limited crest factor had the potential to result in overtesting. In theory increasing test factor is possible with existing control equipment. However, crest factor is rarely increased above the value of 3, indeed, there is some evidence it is reduced to permit some tests, such as that in Mil Std 810E, to be achieved. In support of the SRETS work it was shown that within the current control methodology a crest factor of 8 to 10 could be achieved and still maintain a credible gaussian distribution. An argument for not increasing crest factor is that larger vibrators and associated amplifiers would be required. However, this is not entirely the case, for example an increase in crest factor to 6 would not require twice the vibrator/ amplifier capacity.

6. **Varying rms Profile**. In reality amplitudes are related to vehicle speeds. A testing strategy particularly suitable for reliability of fatigue type simulations would be to undertake the vibration test at several different levels. On most test equipment this can only be practically achieved currently by undertaking several discrete tests. SRETS proposed several ways by which a variable amplitude test could be achieved. These were mostly intended to match a particular Amplitude Probability Density profile. Realistically current vibration controllers increase test amplitude in discrete steps. Allowing the user to programme an amplitude / time should be a relatively simple change to the software.

7. **Loose Cargo Testing on Vibrators.** The SRETS work indicated that a significant number of agencies were simulating transportation tests on equipment by replicating actual restraint conditions. In many cases this resulted in the equipment "bouncing" on the vibration table when test excitations were applied. Currently such restraint methods are not permitted in IEC 60068, mainly because test reproducibility cannot be ensured. Some debate occurred as part of the SRETS work as to whether current vibration test control methods are able to cope with the impacts that occur when the equipment is "bouncing" on the vibration table. Practical experience indicates that some bouncing can be tolerated without upsetting the control loop. However, the extent to which this is possible and the likely consequences seem to be unknown.

Improved Methods Available but Not Widely Used

8. A few procedures exist today which would permit both cost reduction and/or improve the simulation of road transportation stresses. However, some of these are either little used or not used in a manner allows their full potential to be achieved.

1. **Shock Response Spectra.** Although some procedures for testing against Shock Response Spectra exist they are not often used for simulating the shocks that arise from transportation. This seems to be the case even though the available SRS test procedures offer some advantages. Using an SRS description an oscillatory waveform can be adopted, which is closer the type of transient waveform experienced during transportation. An oscillatory waveform can be undertaken on a vibrator provided a compensation pulse is included. This can save setting up time on a separate shock facility. The oscillatory waveform is also applied in two senses, saving test time. Additionally, the current SRS test procedures adopt tolerances of around double those specified for basic pulse tests. Few SRS test software allows a programme of shock severities and durations to be easy applied.

2. **Large Displacement Excitations.** Not really an improved method but rather improved facilities. The transportation vibration environment can contain significant low frequency contributions, particularly from poor road surfaces. These result in significant displacements which can easily go beyond the capability of electro-dynamic vibrators. Two inch stroke vibrators are now becoming common place, however, some test specifications (notably Mil Std 810E) still requires displacements even beyond this capability. The ability to control hydraulic shakes over the required frequency range is starting to emerge as a potential solution.

Emerging Tests Methods

3. A number of tests methods particularly applicable to transportation stresses have been postulated in recent years. However, few of these have been taken up by either National / International specification or suppliers of test control software.

4. **Control of Skewness and Kurtosis**. Current vibration control systems create random time histories which match a specified PSD. Steinwolf has proposed a procedure to extent this to generate a time history which also matches specified skewness and kurtosis properties. A time history with a kurtosis greater than 3 would constitute a better simulation of actual conditions than the existing process. Whilst, the Steinwolf process would currently significantly increase the loop time of the vibration controller, improvements in computer speed will soon mitigate this limitation.

5. **Embedded Shocks**. Embedding shocks within a vibration test has been undertaken by several agencies in the past. However, this was mostly achieved by replaying a recorded time history into a vibrator. This tends to be a difficult process and does not lend itself to wide spread use. Several workers have suggested approaches by which the existing random generation process is modified (usually by adjusting phase values) to create a shock embedded with the vibrations. A programme of shocks within otherwise random vibration, especially if the crest factor is increased, is more representative of the real world transportation environment, than applying vibration and shocks separately.

6. **Multi-axis Control**. The ability to undertake tests in multi-axes has been proposed for some years. It is already available for low frequency conditions mainly using hydraulic excitations methods. Some facilities already adopt multi-axis control for testing packages, particularly on hydraulic vibrators. However, the general purpose multi-axis system is still not available.

D.P. Richards
28 February, 2000

Attachment 3
1995 Overview Of European And International Work

SRETS : Spin - offs

- Technical exchange within measurement, analysis and testing
- Increased competence for participants, means increased competitiveness
- International network
- Harmonised laboratory work
  - more cost effective for customers
- New EU projects; a ”positive spiral”

New EU projects

1. Shocks, follow up of Round-Robin 2
2. Handling studies
3. Handbook in Data Aquisition and Analysis, DIN 30787

SRETS
CEN TC 261

IEC TC 104
Dynamic Data Analysis

DIN 30787
Methodology for data acquisition for transportation loads

ISO TC 108

DIN 30386
Compilation of Data

+ Users Point of view

= CEEES

a. Networking Platform

b. Promote technical advancement

Attachment 4
Presentation by Thomas Trost

Modern Measuring Techniques :
General Shape Measurement with Moiré Techniques

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2000-02-29 / Thomas Trost
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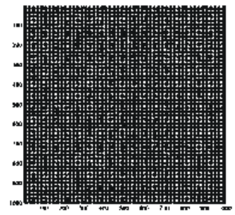
/ Anders Greppe 1999 / Moiré with projected fringes /

Modern Measuring Techniques :
General Shape Measurement with Moiré Techniques



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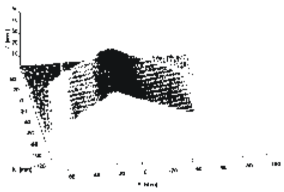
/ Anders Greppe 1999 / calibration

Modern Measuring Techniques :
General Shape Measurement with Moiré Techniques



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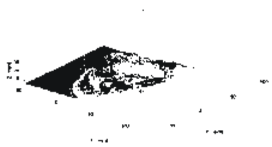
/ Anders Greppe 1999 / ... measurement

Modern Measuring Techniques :
General Shape Measurement with Moiré Techniques



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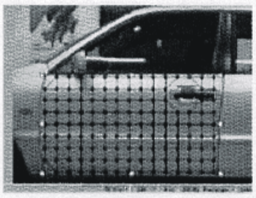
Modern Measuring Techniques :
Shape Measurement with Laser Doppler



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Exempel på fullfältsmätning av bildor: [polytec1.doc]

Modern Measuring Techniques :
Shape Measurement with TV Holography(Shearografi)

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Deformationsmönster hos en propeller
(från Steinbichler Corp., USA)