Minutes of the Technical Advisory Board for Mechanical Environments of the Confederation for European Environmental Engineering Societies

Held on 24th October 2005, Paris, France

Present at the Meeting of the Technical Advisory Board for Mechanical Environments (TABME) were;

- Dr Ulrich Braunmiller  GUS
- Mr Dave Corben      PLOT
- Mr Ton Geise        PLOT
- Mr Markku Juntunen  KOTEL
- Mr. David Richards  SEE (Chairman)
- Mr Thomas Trost     SEES
- Dr Karl Zieghan     GUS

Matters Arising

Apologies were received from Mr M. Dumelin (SSEE). A list of TABME members, including corresponding members, was circulated. As usual this list is attached to the minutes as Attachment No 1.

CEEES Website – TABME Content

The chairman reminded the group that discussions had occurred at the last meeting on the content of the website. Currently the website does not include any real information on the individual TAB’s. Proposed headings for the TABME content were listed in the minutes of the last meeting these were used as the starting point for more detailed discussion. The discussion identified a number of reports / documents that could be included these are listed below along with a few subsequent thoughts.

- TABME Home Page. A home page setting out the aims and short history of the TABME, but mostly a link to further pages.
- Members – Existing membership list. A brief description of each of the TABME members had been circulated previously with the intended that this should go on the CEEES website. This had been passed to the CEEES secretariat for inclusion.
- Meetings – last and historic meeting minutes. It had been agreed at the last meeting that it would be appropriate for the minutes of the TABME to be included. The chairman indicated that he had assembled, on a CD, the previous minutes (all since 1995 plus one from 1993) as PDF files for inclusion on the website. It was stated that the minutes of the earlier meetings did not include all the attachments (which had been circulated in hard copy form only).
- TABME Studies – Reports on the two round robins are available and had been put to a CD in PDF format. The chairman stated that he still had the full data for the second round robin but only about 40% of the full data record of the first (which had been supplied in analogue form). The group felt that the inclusion of the round robin data was not necessary.
- TABME Reports & Studies supported by TABME – A number of papers had bee identified by the chairman and put to CD. These included the C17 data discussed at the last meeting, the SRETS final report (since supplied by Ulrich to webmaster). The inclusion of additional papers was discussed in particular one from Markku.
- Methodologies Championed –In particular some of the work on FDS & MRS such as earlier workshop note.

As a general point the group discussed the possibility of including on the CEEES website information from previous workshops. The chairman indicated that the London workshop was available and suggested that the possibility of including others should be investigated. It was agreed this point should be raised at the main CEEES meeting.
Systematisation of Measurement Methodologies

STANAG 4370. The chairman reported that he had attended a NATO Stanag 4370 meeting held the previous month at Glasgow. The aim of the meeting was to undertake a final review of version 3 prior final version being prepared for submission for circulation. The meeting also addressed comments made in the CEN Workshop 10 Expert Group 8 as well as results of a (US) comparison exercise with Mil Std 810. The group were reminded that the NATO ratification process can take around 2 years. It was mentioned that the group responsible had recommended the Stanag be designated as releasable on the internet. The

Mil Std 810G. The minutes of the last TABME included a presentation on Mil Std 810G supplied by Karl. The meeting was told that the US had widely circulated a request for comments and proposals for Mil Std 810G. It was understood that the various working groups that will generate the new version were currently being formed. The

Def Stan 00-35. The chairman reported that work on Def Stan 00-35 version 4 was essentially complete. It was reported that the vibration and shock test severities were being revised and that new chapters had been included on test rigs as well as control strategy. Version 4 would also include a new guidance section on the generation of test programmes and a number of operational usage profiles specifically applicable to environmental life assessment. Def Stan 00-35 along with many other UK defence standards can be downloaded from www.dstan.mod.uk

IEC TC104. It was stated that the last maintenance team meetings had been cancelled. It also seemed unlikely that the TC104 meeting, originally scheduled for December, would take place. It was reported that the chairman of TC104 had resigned.

DIN 30786/7. Karl reported that a meeting on the climatic aspects of this group of DIN standards was scheduled for the next month. He reported the measurements identified for this standard and progress on these.

CEN TC 261 SC5 WG14 – Test Methods & Test Schedules. The next meeting of this group was scheduled for the day after the CEEES meeting and also in Paris. Ulrich and Thomas reported they would be attending. At the last TABME it was reported that the DIN Std had been offered to this group but not sufficient countries had voted YES with a technical expert. Because of the lack of experts acceptance of the DIN as a PAS had been on hold. It was reported that the PAS was not an agreed work item. The group was told that the test schedules discussed at the last TABME had been submitted both to CEN to ISO.

UN Orange Book. At previous meeting it was observed that once again it is rumoured that the US / Spanish proposal for the inclusion of a vibration test had been accepted by the responsible technical group. No information was available at this meeting.

CEN WS 10 EG 8 (Workshop on Defence Procurement). It was reported that the work of this expert group was complete.

Overview. At a previous meeting the group had generated an overview of European and International work currently underway relating to transportation stresses. That overview was included as an attachment in the minutes of the last meeting. This meeting reviewed and updated the chart. The updated version is include here as attachment No 2. [Chairman’s note: It is intended to review this chart on a regular basis.]

Technical Papers - Working Practices

At the previous meeting the Chairman had proposed the possibility of using the C17 data in the methodologies paper. He had undertaken to prepare a modified version of the existing paper and circulate for additional input. The modified paper was presented and discussed. Some additional work was still needed.

Discussion of Comments to IEC 60068.

The Chairman reiterated to the meeting that Dave Corben had written a paper which was referenced in comments on the recently updated test & fixtures chapter of IEC 60068. The comments related to an annex on computing shock responses across AV mounts. The chairman said he had produced the approach for the
authors of the chapter, however, the only portion of the method actually used only adopted assumed transmissabilities. The comment / paper questioned one of to the assumptions in the method. The Chairman had invited Dave Corben to discuss this at the TABME. Dave made a presentation (included as attachment 3) to the group and it was agreed that the TABME should prepare a proposal to update the annex to IEC document.

**Topics for Future Consideration**

The members of the TABME had previously identified a number of potential future topics for future consideration;

- Basic techniques for data collection / analysis.
- FDS / MRS - Potential variations between different methods.
- Test tailoring – “How do other people do it?”
- Lean testing and / or virtual testing
- Life estimation and Extension

**Any Other Business**

Thomas highlighted the organisation call ECTRI. Information can be found at ww.ectri.org

Markku discussed need for a virtual group on virtual testing.

**Next Meeting**

The date of the next meeting of the TABME is planned for Thursday 16\(^{th}\) February 2005 in Brussels.

**Attachments**

1. Names and Addresses of TAMBE Members
2. An Overview of European and International work
3. Dave Corbens presentation.
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## An Overview of European and International work

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Using transmissibility curves to account for packaging or isolation in vibration testing

Dave Corben
CEEES TAB ME meeting
Paris, 24-Oct-2005
Revised 30-Oct-2005
Approach if packaging (or isolator) not available

- Fix sample (without packaging) directly to shaker
- Filter input signal with the appropriate transmissibility curve

For light CE internal dynamics is the same in both cases
But what if CE heavy?

- Eg CRT TV, washing machine

Packaging changes internal mode!
Comparing (undamped) transfer function for both cases

\[
\begin{align*}
\frac{x_2}{x_0} &= \frac{a_2}{a_0} = \frac{\alpha_1^2 \omega_2^2}{s^4 + (\alpha_1^2 + \alpha_2^2 + \alpha_i^2) \cdot s^2 + \alpha_1^2 \cdot \alpha_2^2} \\
\frac{x_2}{x_0} &= \frac{a_2}{a_0} = \frac{\alpha_1^2 \omega_2^2}{s^4 + (\alpha_1^2 + \alpha_2^2) \cdot s^2 + \alpha_1^2 \cdot \alpha_2^2}
\end{align*}
\]

\[
\alpha_1 = \sqrt{\frac{k_1}{m_1}} \quad \alpha_2 = \sqrt{\frac{k_2}{m_2}}
\]

\[
\alpha_i = \sqrt{\frac{k_2}{m_1}} 
\]

Note: this is the frequency of the product if fixed at \( M_2 \)
Condition for use of transmissibility curves

Use of transmissibility curves is valid if:

\[ \alpha_1^2 \ll \alpha_1^2 + \alpha_2^2 \]

This is quantified in the next section.

Alternatively

\[ M_R K_R \ll M_R + K_R \]

where:

\[ M_R = \frac{M_2}{M_1}; \quad K_R = \frac{K_2}{K_1} \]

*A refinement of the condition \( M_2 \ll M_1 \) given by Robert Newton in his paper on the Damage Boundary Curve. See example 2*
Quantifying this condition

The transfer function for the 2 mass spring system can be rewritten as:

\[
\frac{x_2}{x_0} = \frac{\alpha_p^2}{\left(\frac{1}{\alpha_1^2 + \alpha_2^2}\right) \cdot s^4 + \left(1 + \alpha_i^2\right) \cdot \frac{1}{\alpha_1^2 + \alpha_2^2} \cdot s^2 + \alpha_p^2}
\]

where:

\[
\alpha_i' = \frac{\alpha_i}{\sqrt{\alpha_1^2 + \alpha_2^2}} \quad ; \quad \alpha_p' = \frac{\alpha_1 \alpha_2}{\alpha_1^2 + \alpha_2^2}
\]

Note: for positive real values of \( \alpha_1 \) & \( \alpha_2 \): \( 0.0 \leq \alpha_p' \leq 0.5 \)

The dimensionless natural frequencies can be found by substituting \( s = j \omega \) and equating the denominator to 0 giving:

\[
\alpha_i^4 - \left(1 - \alpha_i^2\right) \cdot \alpha_i^2 + \alpha_p^2 = 0
\]

where:

\[
\alpha_i = \frac{\omega}{\sqrt{\left(\alpha_1^2 + \alpha_2^2\right)}}
\]
Dimensionless curves

- The graphs show the 2 dimensionless natural frequencies as functions of $\omega_i'$ and $\omega_p'$.

Note: $\omega_i' = 0$ corresponds to infinitely light internal dynamics and/or measurement with transmissibility curves.
Relative dimensionless natural frequencies

- By dividing each curves by the value at $\omega_i' = 0$ the change in natural frequency due to internal dynamics can be plotted.

Suggestion: Transmissibility curves valid if $\omega_i' < 0.5$
For $\omega_i' = 0.5$ the natural frequencies change at least 10%
And at most 40% due to internal dynamics.
Verification with 20-sim

Complete dynamics

Dynamics with transmissibility curve
Example 1

- Total product mass 25 kg
  - Case 1: housing 24 kg, internal 1kg
  - Case 2: housing 20 kg, internal 5kg
  - Case 3: housing 5 kg, internal 20kg
- Internal dynamics at 100 Hz (when product fixed)
- Packaging/isolation frequency set to 10 Hz (based on total mass)
Case 1: $\omega_i' = 0.2$

- $M1 = 24, M2 = 1$
- $\omega_i' = 0.2, \omega_p' = 0.2$

With transmissibility curves

With packaging
- Little difference
Case 2: $\omega'_1 = 0.5$
- $M_1 = 20$, $M_2 = 5$
- $\omega'_1 = 0.49$, $\omega'_p = 0.21$

With transmissibility curves
- Frequency 10% higher

With packaging
Case 3: $\omega_i' = 1.8$

- $M1=5$, $M2=20$
- $\omega_i' = 1.8$, $\omega_p' = 0.37$

With transmissibility curves

With packaging
- Frequency > 2X higher
- 10 Hz much less damped (lower contribution of product damping?)
Example 2: high mass ratio but transmissibility curves valid (theoretically possible but unlikely)

- This is possible if the Stiffness ratio is small.
- $M_r = 10; K_r = 0.1$
- Note: Packaging is now the higher frequency

With transmissibility curves

With packaging
  • Little difference
Criterion if internal dynamics not known

- Often the criterion derived here can not be used in practice as the internal dynamics of the product are not fully known.
- The term missing in the differential equation in the case of transmissibility curve is that of the force from internal dynamics onto the housing.
- Possible criteria:
  - The effect of internal dynamics on the housing accelerations in the final situation (with packaging/isolators) should be negligible.
See also...

“The use of Fragility test results in cushion design for products containing heavy critical components”

Dave Corben & Gary Burgess

CEEES Nurnberg conference, May 2003