The 'Society of Damping Technology' in Japan and Activities

with the trends of the damping materials & technology in Japan

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Abstract

The development activities of damping materials and their technologies in Japan have been given an active life speedily in the past several years. As the examples, the application of damping materials to the floor panel of motor vehicle body and the utilization of laminated damping steel sheets by various industries in Japan will be reviewed in this report.

Then, a report will be made on the activities of Society of Damping Technology in Japan, a society which was inaugurated with the background situation as indicated in the above. Among various activities performed by the society, a report will be made particularly on the outline of round robin test which was conducted by the society. The report will be concluded by a summary of the future trends to be realized in Japan and the role of the society to be played in the accomplishment of such targets.

1 Background

1.1. The Trends of Damping Materials in Japan

Stimulated by the enforcement of the regulations for the prevention of environmental pollution by the Japanese Government, particularly of the noise control regulations on motor vehicles, the application of damping materials has been rapidly and widely spread among various industries in Japan. This trend has been further enhanced by the fact that the industries become aware that the reduction of vibration and noise in products will heighten the value of their products in the market.

It has been realized that an appropriate damping effect can be achieved by an addition of damping material (such as free layer bonding type) or by replacement (such as laminated damping steel sheet) without altering a structure of product to a large extent.

Damping mechanism and material characteristics, however, are not known well by the people in Japan except for a certain number of technical experts and researchers. When an application of damping material is not made appropriately, the damping effect could be reduced drastically or sometimes may bring an

adverse effect and ends up with a wrong appraisal being cast upon it. Having such a situation in the background, interests in damping materials among the industries in Japan had been increased to an extent that Society of Damping Technology in Japan was inaugurated.

In the following, an application of damping material to the floor panel of motor vehicle body and a utilization of laminated damping steel sheet by various industries in Japan will be discussed.

1.2. Application of Damping Material to Floor Panel of Motor Vehicle Body

The historical trend of patent application in Japan for the damping materials for a use of damping floor panels of motor vehicle body is shown in Fig.1.[1] Applications for materials used for sound absorption, sound insulation and damping are included in this figure and the hatched portion in it corresponds to the number of patent application for the damping materials. It is obvious that the number of patent application increased quite remarkably with the advent of1980. As stated in the above, the trend clearly shows the heightening of technical interests in noise reduction obviously as the result of the stimulation given by the enforcement of noise control regulation.

Fig. 2 shows the historical trend of noise level prevailing in the interior of passenger cars produced and marketed in Japan.[1] The chart shows that noise reduction of some 8 dB(A) was realized in the past 10 years. This is obviously the result of the application of noise reduction methods stated in the above.

Fig. 3 shows the proportions by weight of noise control materials used in passenger cars.[2] Approximately half of the weight is taken by the damping materials. Majority of the damping materials indicated in this diagram are of asphalt materials and will be bonded as free layers type.

While damping materials are used widely as the principal means for noise control, materials having much better damping capabilities and lighter weight are being sought after earnestly with an aim of further reduction of noise level as well as vehicle weight. In order to achieve such purposes, adoption of composite materials and constrained layer damping system, foaming of damping layer, etc. have already been tried.

1.3. Laminated Damping Steel Sheet

Fig. 4 shows the transition of production volume of laminated damping sheet in Japan.[2] A sudden increase in production is seen in the latter half of 80s. After the enforcement of Phase II of the noise control regulation in '83, the

use of laminated damping steel sheet for the stamp formed engine oil pan was commenced. The consumption of the material by the electric home appliance industry was increased much after they adopted it for foaming the outer panel of home washing machine.

Fig. 5 shows the breakdown by weight of the application of this material for various industries in Japan. [3] The consumption by the motor and electric appliance industries are by far the largest, however, the applications for building materials and general machineries are being increase gradually. Table 1 shows examples of laminated damping steel sheet application by various industries. Obviously the materials are used for noise reduction of various products.

2 Society of Damping Technology in Japan

2.1. Inauguration of Society

As elaborated in the above, the application of damping materials for the purpose of vibration and noise reduction has become very popular in Japan and the market segments of products where the super great quality is given by damping materials have been expanded. But there are many subjects left unsolved in the technical aspects of damping materials. Mutual recognition of such problems, efforts in exploring their solutions and deepening people's understanding in damping materials are essential for their popularization and growth. Society of Damping Technology in Japan was inaugurated for the achievement of those objectives.

2.2. General Policies of Society's Activities

The general policies of this society's activities shall be;

- Activities will be centered in the industries, that is, the various seeds and needs for damping materials and technologies present in the industries would be picked up widely and discussed in various aspects.
- Public relations activities to be made by each member company in auxiliary to the above activities will be permitted.
- Exchange of informations and conversations between and among makers, users and neutral organizations (such as research institutions, universities, instrument manufacturers, etc.) on the subject of damping materials will be promoted.
- Research and study will be made jointly on the subjects relative to the damping. Those studies will be made principally by the study and technical committees and working groups subordinate to those committees.

- Publicity-activities on damping materials and technologies in such forms as lecture class, issuing manuals on measuring methods and utilization technologies.

2.3. Organization of Society

The society was inaugurated in July 1988 with the assistance of Tokyo Metropolitan Industrial Technology Center. The society's secretariat is located in that center. When the first general assembly of the society was held at the time of inauguration, there were 39 corporate members, 6 private members and 3 special members making the total of 48 members. The society now has the total of 145 members which consist of 120 corporate, 22 private and 3 special members. The number is still being increased by the enrollment of several new members in every month.

Fig. 6 shows the main business activities and involvement in damping materials by the society members.[4] About a half of the members are in nonmetallic industries (many are in polymer industries) and belong to the maker's side of damping materials. About 35 % are on the user's side coming from fairly wide range of industries. The rest are from the neutral institutions and industries. In an aspect of involvement in damping materials, it is recognized that members representing many sections are in a good harmonious balance.

Fig. 7 shows the organization structure and activities of the society. Under the executive committee formed by President, Vice President and chairman of each committee, there are a secretariat and 5 committees (2 in business handling and 3 in research and study). There are number of working group under the supervision of each research and study committee and the main activities of the society are pursued by those people.

2.4. Activities of Research and Study Committees

Researches and studies in various subjects related to the damping materials and technologies are actually carried out by 3 research and study committees together with working groups (W/G) placed under them as shown in Fig. 7.

Domestic and international literature study W/G collects the literatures and papers on the damping materials and technologies issued widely in Japan and overseas countries mostly supplied by the members and put them in a data base. Damping '89 W/G was formed for the study of technical reports in Proceedings of Damping '89 Conference.

Round robin test W/G performed in the last year a round robin test on a free layer damping material bonded to steel beam test piece . 25 members joined in this test. The details of the test result will be discussed later in this report. Similar test is being performed on laminated damping steel sheets, now.

Standard study W/G collects and studies the standards issued for the administration of damping characteristic measurement methods in many countries. It will also be issuing a measurement manual for the members by compiling the results of their study, the results of round robin tests performed in supplement. Those results will also be studies for reflecting them into the official standardization of damping characteristic measurements in Japan.

Examples of damping material application have been announced to and discussed by the members. Problems in the utilization technology unique to each individual section will be studied and solved by such method as organizing new W/Gs for motor vehicles and building materials.

3 Round Robin Test [5], [6]

3.1. Objective and Principal Test Conditions

The objective of this test is to have each member get mutually acquainted with other member's technical levels in the measurement method and to make clear the subjects and problems on the measurement which have been carried by each individual member. The test results will be further utilized in the compilation of manual on the measurement guideline to be issued for the distribution to all members. They will also be used in the society's cooperation to the official standardization of damping characteristic measurements.

The principal test conditions are;

- 3 type of steel beam test pieces bonded with free layer damping materials.
  { damping layer : 2 types of PVC plastic
  and a type of SBR(styrene-butadiene rubber) }
- Testing temperature : 25 ℃ (constant)
- Measurement method and data process method can be determined at an option of each member. Table 2 shall be referred to the details.

The test results of cantilever method and both end free with center excitation method, the methods which attracted many participants, will be discussed in the following.

3.2. Cantilever Method

Fig. 8 shows all measurement data obtained by the cantilever method. As the end clamping was not rigid enough, dispersal of damping characteristic in bending mode of first order, where the influence of boundary condition is largest, is noted. It was also revealed that several test data contained problems due to data analysis by FFT (Fast Fourier Transform).

Fig. 9 shows a graph in which data with the above problems are all omitted. The dispersal of damping characteristic measurement data is also made smaller. The results of measurement by the members, except for data B of an original steel beam having a small loss factor η-value, are fundamentally consistent even though somewhat smaller data dispersal is still evident. Further study to explore the cause of such dispersal is required.

3.3. Both End Free with Center Excitation Method

All measurement data obtained by both end free with center excitation method are shown in Fig.10. An impedance head is installed in this method on the center portion where an excitation is applied. The exciting input and the vibration response are measured by it. Data with fairly large dispersal are included in this case, too.

Fig. 11 shows the excitation structure applied in the test. The method in which a nut is used for clamping as shown in the figure will present a problem in processing the damping layer at the portion where it is tightened by the nut, for example, damping layer is cut or tightened together with steel sheet. In a method where an extension rod is used, it is noted that the bending mode of steel beam, the main target of measurement, tends to be mixed with unnecessary mode because the excitation structure is not installed accurately on the center of a test piece.

Fig.12 shows the graph where the data containing problems are all omitted. As in the cantilever method, all the measurements are consistent except for data B. Further exploration is also necessary to the cause of data dispersal still left on this graph.

3.4. Summary

All the results obtained from the round robin test performed by the society this time, except for the data of steel beam having smaller η-value (smaller than 0.01) and for the measurement data in which the cause of large dispersal is clarified, are found to be fundamentally consistent with each other. It means that as long as the basic rules for the measurement are carefully

observed, a dispersal of measurement can be minimized.

The values shown in Fig. 9 to 12 are consistent with each other and the fact suggests that the variation due to different methods of measurement can also be minimized.

However, some significant dispersal of data is still present even after those data are screened and, therefore, further exploration is still required. It is intended that supplementary tests on the dispersal of data on steel beam bonded with free layer damping material and round robin on laminated damping steel sheet will be carried out in this year for the clarification of the subjects and problems associated with the measurement methods.

4 Conclusion

4.1. Damping Materials and Technologies in Japan

(1) The product value of damping material has been recognized by the people quite recently.

①They are very effective means for the reduction of noise and vibration.
②The spreading of use has been expedited by turning them into massproduction.

(2) New problems have appeared, on the contrary.

①The damping method alone can not, in many cases, insure a satisfactory results.
②Improvements in the ratio of cost and weight vs η-value and in the total performance of the materials are required.

(3) Under the circumstances, the future course shall be;

①High performance

- High η-value (loss factor)
  Free layer damping type → Constrained layer damping type,
  Material improvements, etc.
- Multiple functions (multilayers, composition)

②Heightened level of employment technology

- Establishment of predicting technique
- Optimum design (ratio of cost and weight vs η-value)
- Build up of data base

4.2. Society's Future Role

(1) Contribution to new developments in the damping by the study and research works to be made on this subject.

(2) Engaging in the publicity activities of the damping materials and technologies to expand the bottom layer of the needs.

(3) Grasping the needs and seeds through the exchanges of information and conversations among and between the makers and users of damping materials and neutral institutions and industries, and feeding them back to all members.

4.3. Final Conclusion

It is my great honor and pleasure to have been given an opportunity of making a presentation on the trend of the study in damping and the activities of Society of Damping Technology in Japan to this conference in the presence of the most prominent people of the damping technologies in the world.

It is my strong personal belief that the society in Japan should also try to enhance their international activities from now on. I believe the cooperation of all the members present here will be honored and appreciated by all the members of the society in Japan. Thank you very much.

Reference

(1) J.Satoh;Technical trends of damping, sound absorption and sound insulation materials used in passenger car, Toyoda Gosei Technical Review, Vol.28 No.3, (1986), p121-127.(in Japanese)
(2) T.Nitta,M.Momozawa;On vibration damping by mean of visco-elastic materials, The Journal of INCE of Japan, Vol.15 No.1 (1991) (in Japanese)
(3) Based on the investigation of statistics reported in newspapers,journals,etc.
(4) According to the questionnaire for the members of SDT in Japan.
(5) S.Takada,K.Okada,S.Daimon and M.Yamaguchi; Results of the round robin tests on 2-layer type damping beam",Proceedings of the 1990 Meeting, Acoustics Society Japan (1990),p579-580.(in Japanese)
(6) M. Yamaguchi,S. Takada,T. Aoki,K. Okada and S. Daimon; Results of the round robin tests on 2-layer type damping beams, proceedings of the 1990 Meeting, INCE / Japan (1990),p309-312 (in Japanese) □

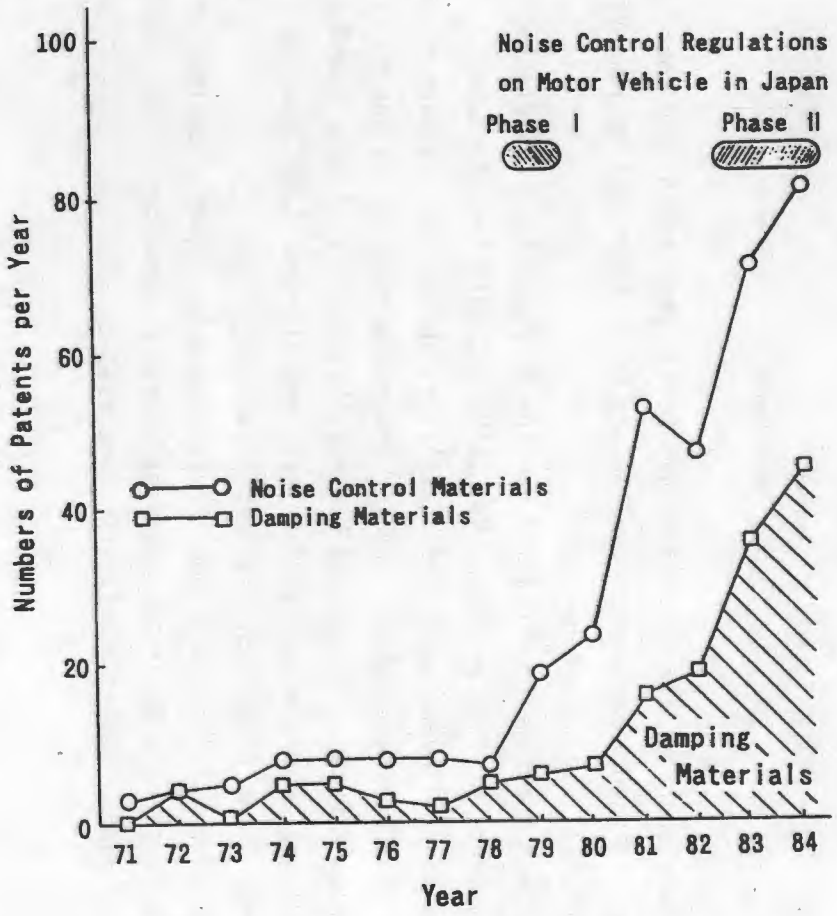


Fig. 1 Trends in Patents about Noise Control Materials for the Floor Panels of Vehicle Body

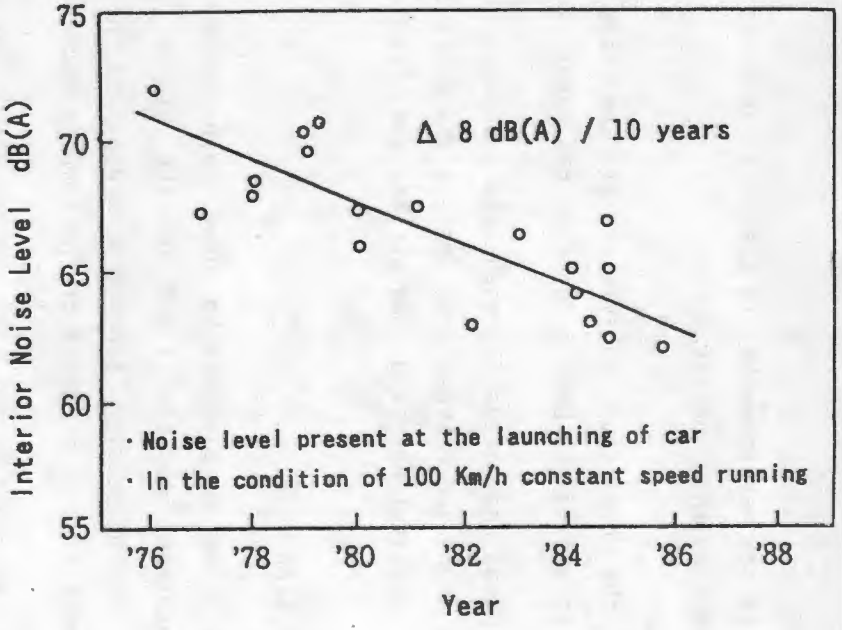


Fig. 2 The Historical Trend of Noise Level in Interior of Passenger Cars with 2000 cc Class Engine

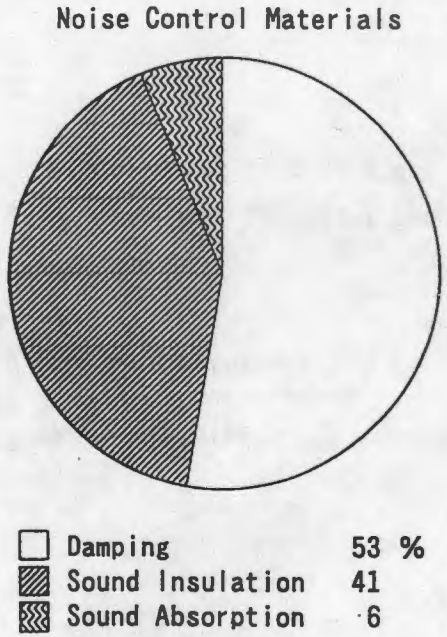


Fig. 3 Breakdown by Weight for the Purposes of Noise Control Materials used in Passenger Car (with 0.65～4.0 liter class engine)

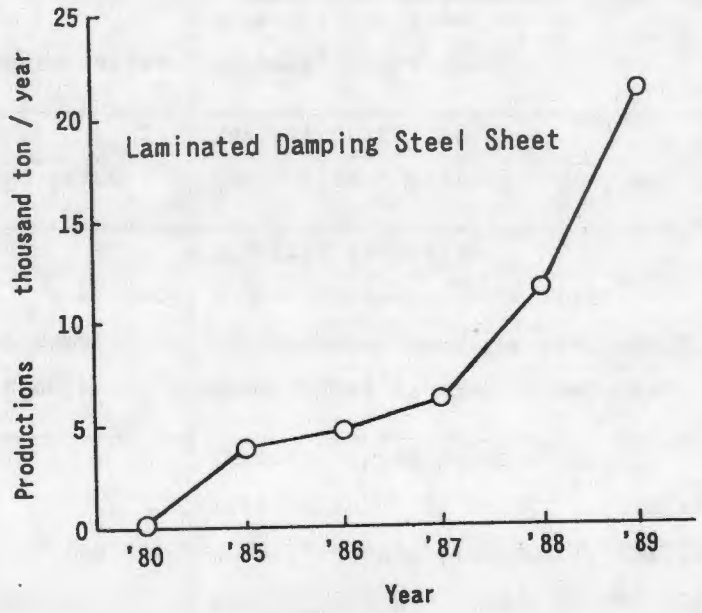


Fig. 4 The Productions of Laminated Damping Steel Sheet in Japan

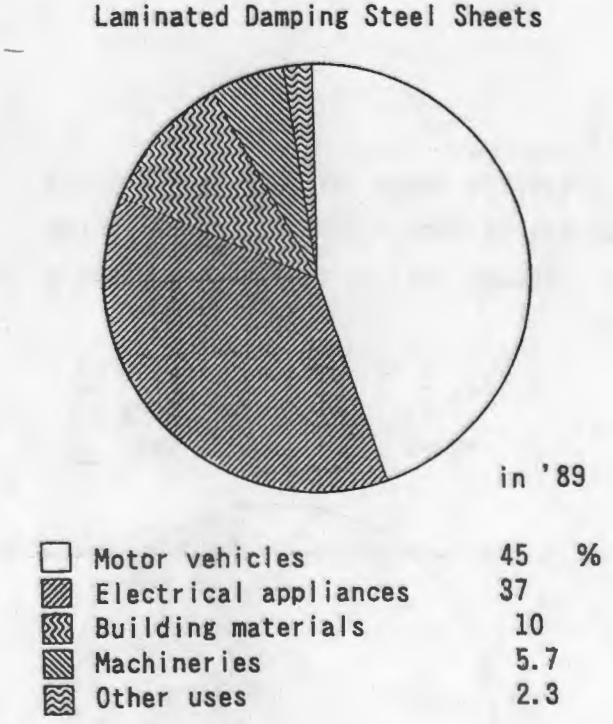
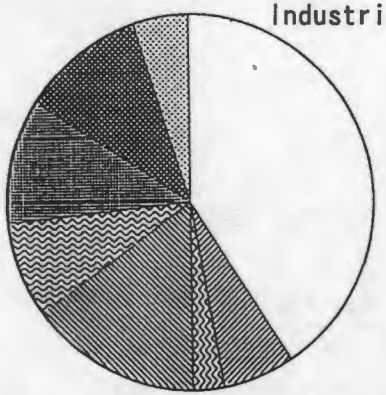


Fig. 5 Breakdown by Weight for the Use of Laminated Damping Steel Sheets

Table 1 Application Example of Laminated Damping Steel Sheet

Industry	Application Example
Motor Vehicle	Engine (oil Pan, front cover, rocker cover), Vehicle Body (floor, door, tire house, dash panel) Transmission cover, Parking brake cover
Electrical Home Appliance	Outer panel of washing machine, OA equipment cover(printer,etc.), Audio Equipment Components, Electric Generator
Building	Roof, Floor, Stairway, Shutter, Railway bridge (steel)
Machineries	Hoppers, Ducts, Partially enclosed cover

(A) Type of Member's Industries

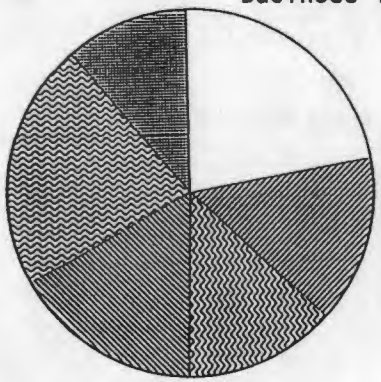


Industries

Nonmetallic Industries	41 %
Metallic Industries	6
Machinery Industries	3
Transport Industries	15
Electrical Industries (*1)	8
Architecture Industries	11
Univ. & Institutions	11
Others	5

(*1) to contain Measuring Instrument

(B) Member's Business Relations with Damping Materials



Business Types

Material Production	22 %
Product Production	15
Marketing and Sales	14
Purchasing for application	16
Research	22
Others	11

Corporate members: 120
Private members : 22
Special members : 3
Total members : 145

Fig. 6 Membership Structure

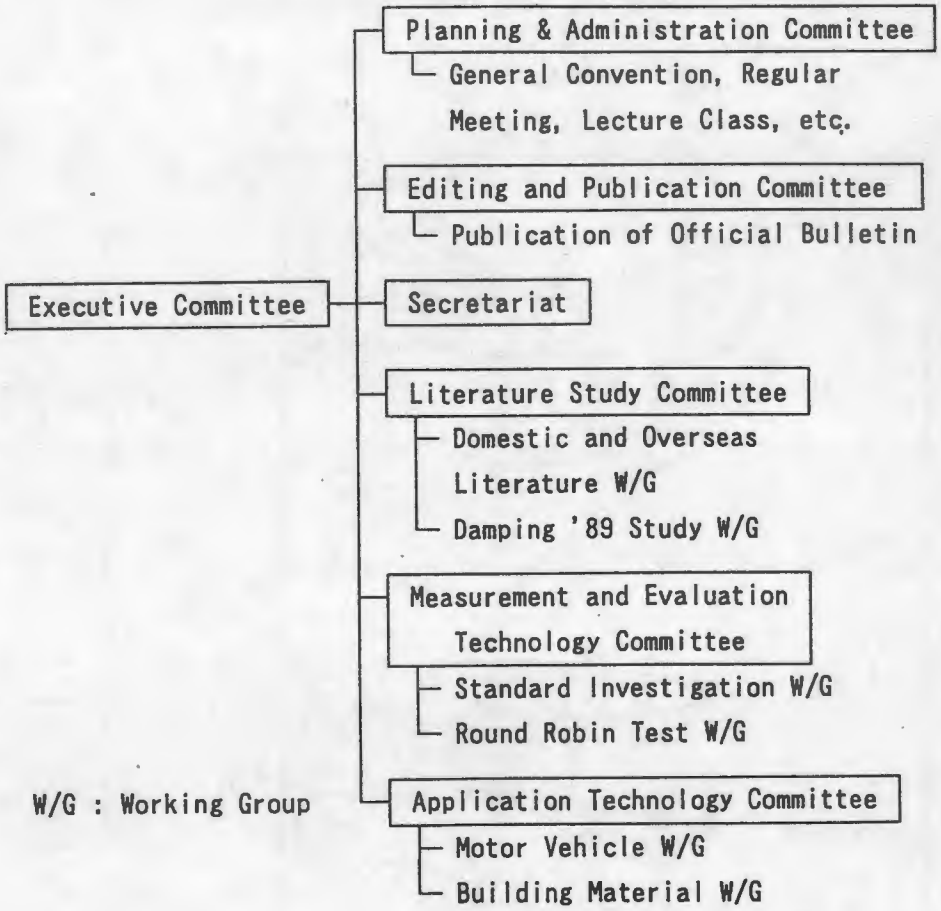


Fig. 7 Society's Organization and Activities

Table 2 Condition for Round Robin Test

Measurement Method	Strain & Stress Method	Cantilever Beam	Both Ends Clamping Beam	Both Ends Free Beam (1)	Both Ends Free Beam (2)
Damping Base (H+B)	0.5～2.5	2.5/ 1.0	2.5/ 1.0	2.5/ 1.0	15 / 9
Layer Plate (M+B)	〃	1.5/ 1.0	1.5/ 1.0	1.5/ 1.0	〃
t_D mm / t_P mm (L+B)	〃	〃	〃	〃	〃
Effective Length mm	20 ～ 50	220	300	280	500
Width mm	2.4～ 5	10	10	25	50
No. of Participants	3	13	2	9	3
Measurement Order	parallel	round robin test			

(Note) ① H,M :PVC damping materials, L :SBR rubber,
B :Base Plate of Steel Sheet
② Temperature for measurement··· 25 ° C

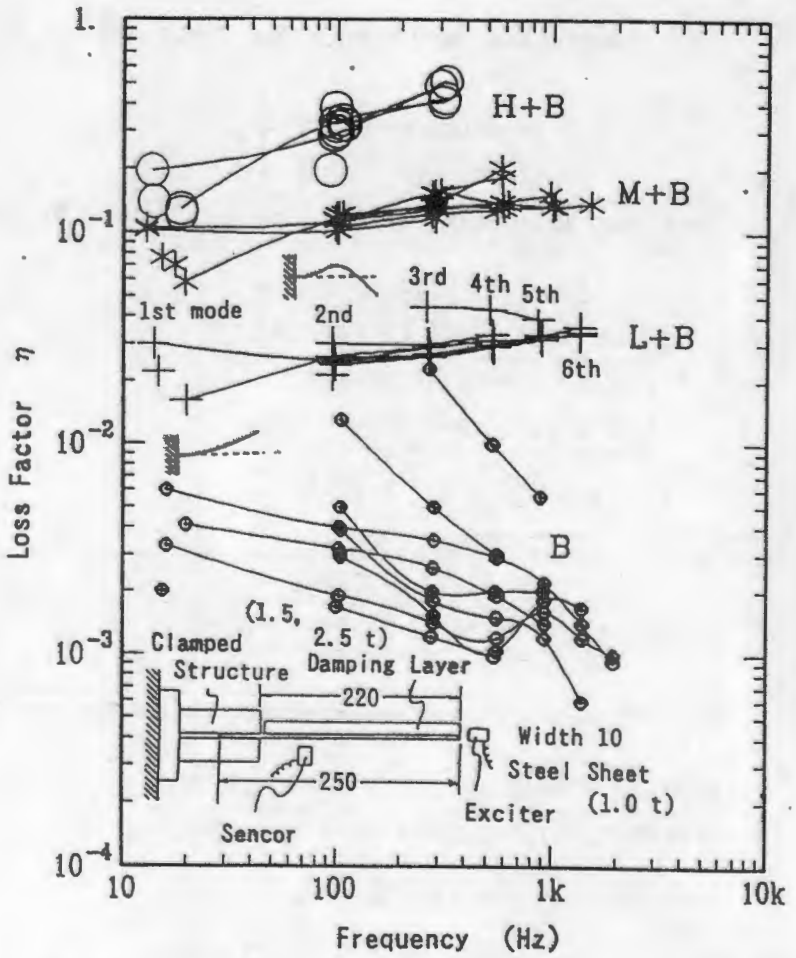


Fig. 8 Round Robin Test Measurements (all data) by Cantilever Beam Method

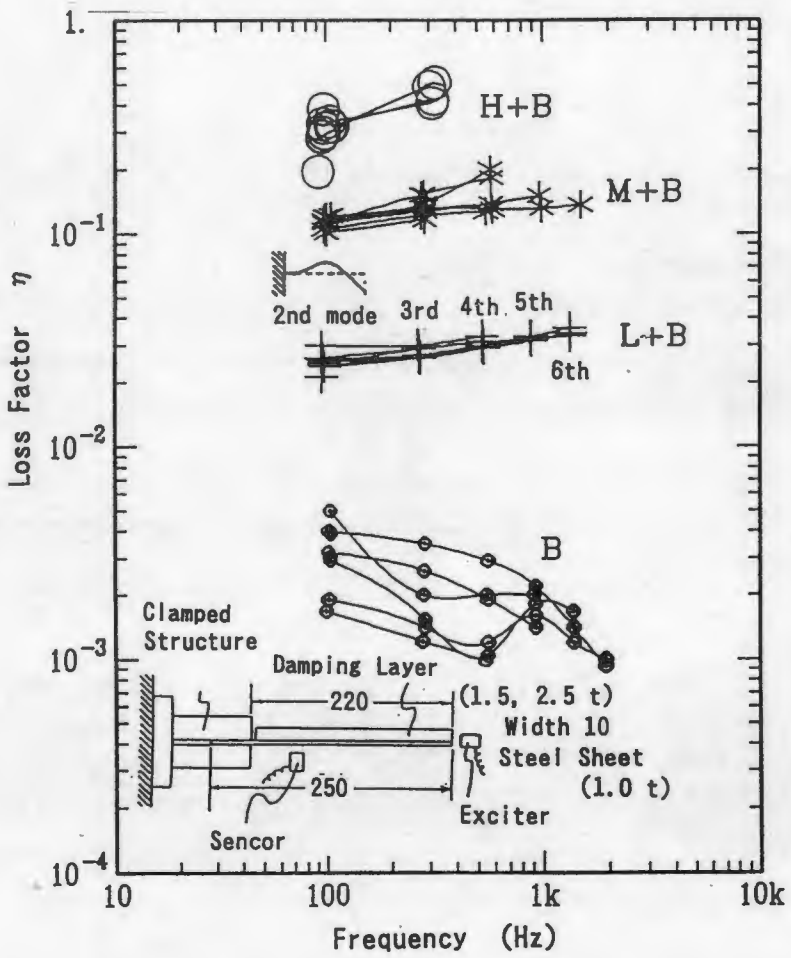


Fig. 9 Round Robin Test Measurements by Cantilever Beam Method (Data partially omitted)

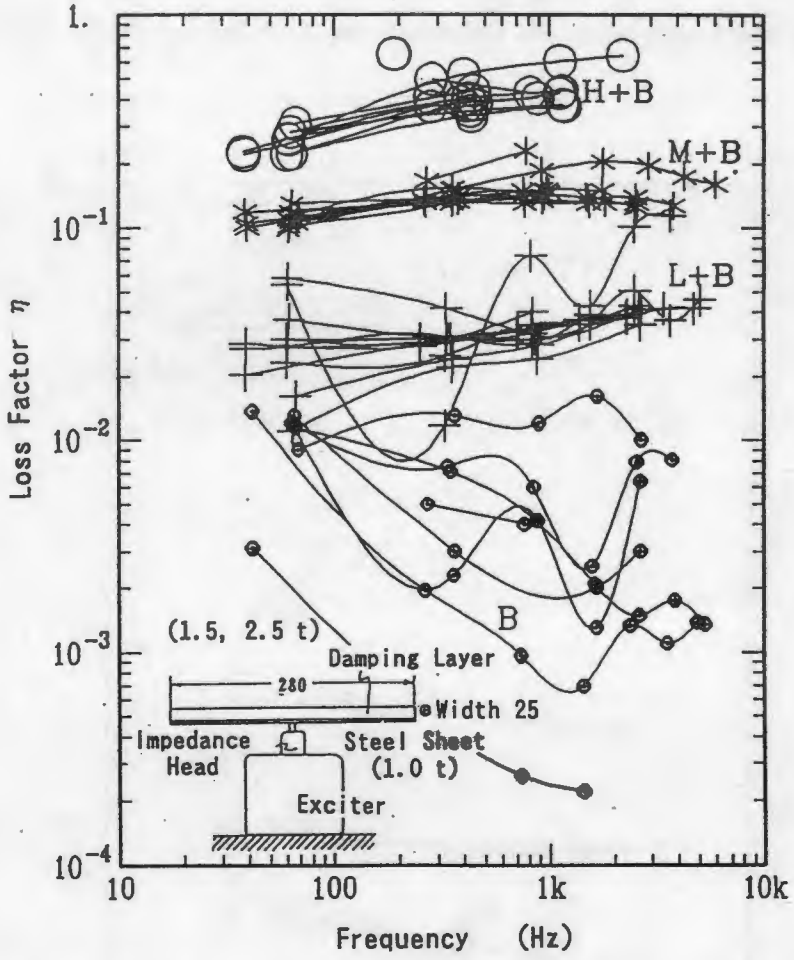


Fig. 10 Round Robin Test Measurements by Both Ends Free Beam with Center Excitation Method (all data)

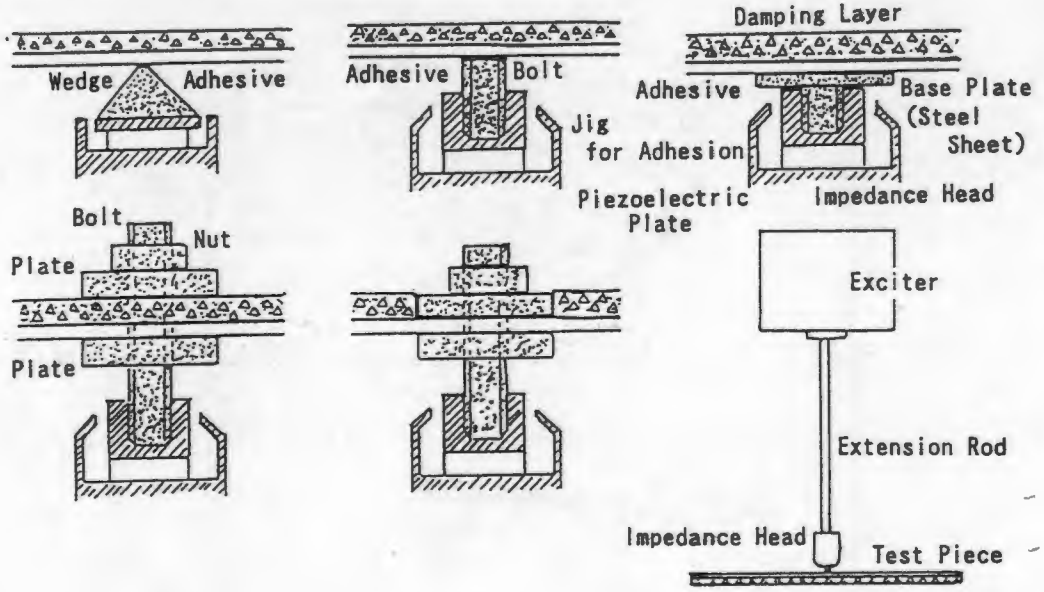


Fig. 11 Installation of Test Piece in Both Ends Free Beam with Center Excitation Method

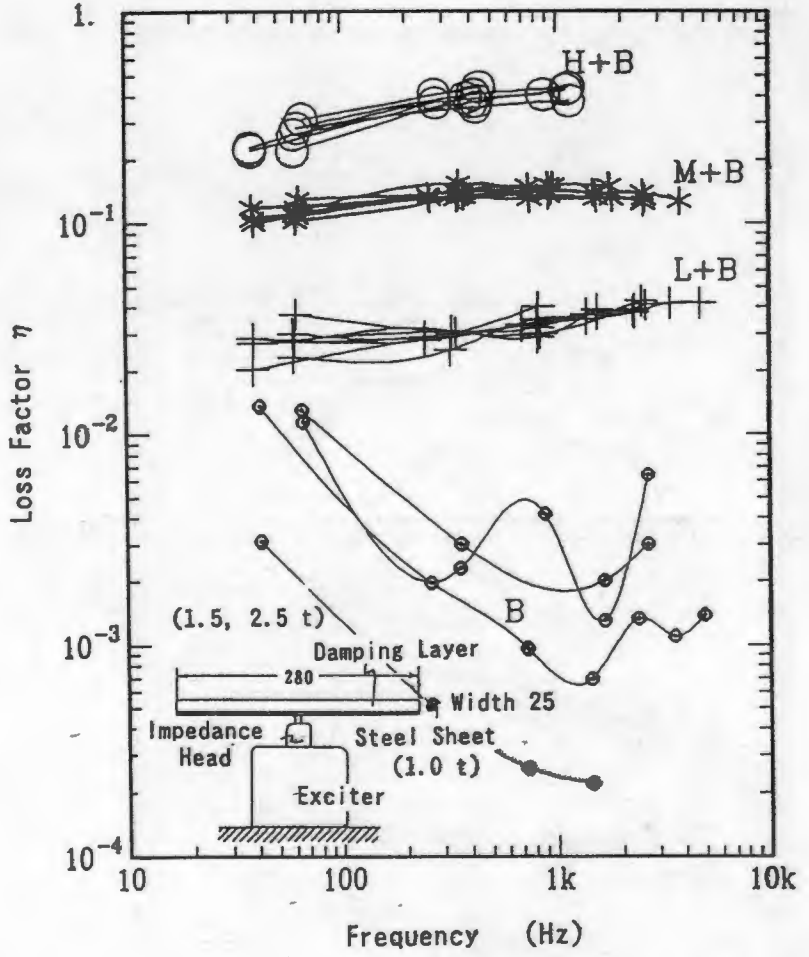


Fig. 12 Round Robin Test Measurements by Both Ends Free Beam with Center Excitation Method (Data partially omitted