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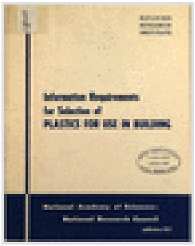

# Information Requirements for Selection of Plastics for Use in Building (1960)

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# Information Requirements for Selection of PLASTICS FOR USE IN BUILDING

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as part of the 1960 Spring Conferences
of the Building Research Institute
Division of Engineering and Industrial Research



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The Building Research Institute gratefully acknowledges the contributions to building science made by the speakers at this conference.

Milton C. Coon, Jr.
Executive Director

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# CONTENTS



The Attendance List for the 1960 Spring Conferences will be found in Publication 830, "Adhesives in Building."

# FOREWORD

By William F. Reardon, Real Estate and Construction Operation
General Electric Company
and Chairman, Information Task Group of the BRI Plastics Study Group

It was over two years ago that several architects and owners voiced their dissatisfaction with the lack of useful information available on plastics materials for use in building construction. This was the beginning of the Information Task Group of the BRI Plastics Study Group, the primary duty of which was to study and try to improve communication of plastics information. At that time we indicated specifically that the purpose was to determine the content and format of plastics information desired by the building industry as a means of assisting the plastics industry in preparing guides and data handbooks on plastics. The first part of this assignment culminated in this Workshop held at the 1960 Spring Conferences of the Building Research Institute.

It was only natural that the Task Group should be made up primarily of nonplastics people concerned with the needs of the architect and the user. It was our aim to promote the use of plastics based on accurate information on the products of one of the fastest growing industries, and to eliminate as quickly as possible misapplications. The Task Group devoted its efforts to developing, first of all, a general format for reporting information on plastics materials and then, as a follow-up, a series of specific formats covering a few principal parts of the building structure. All of these were reported in the Workshop to which experts in the field of plastics were invited to discuss the general and specific formats, and later the public meeting.

The members of the Plastics Study Group who have served with me on the Information Advisory Group are: Richard D. Clarke, George P. Dorrance, Anthony Ferrara, Walter E. Gloor and Henry A. Jandl.

## GENERAL INFORMATION FORMAT FOR PLASTICS USED IN BUILDING

1) Description of Product

   a) Trade Name and Manufacturer
   b) Type of Material
   c) Plastics Used
   d) Use of Product

2) Physical Properties

   a) Strength
   b) Dimensional Stability
   c) Fire Resistance
   d) Vapor Permeability
   e) Chemical Resistance
   f) Acoustical Properties
   g) Light Resistance
   h) Light Reflectivity and Transmission
   i) Thermal Transmission
   j) Electrical Characteristics
   k) Aging
   l) Toxicity
   m) Compatibility

3) Design Criteria

   a) Size, Thickness, Weight
   b) Finish, Color
   c) Workability
   d) Tolerances
   e) Limitations
   f) Adhesion and Cohesion
   g) Properties of the Complete Assembly

4) Installation

   a) Surface Preparation
   b) Description of Process
   c) Methods of Attachment
   d) Equipment Required
   e) Limitations

5) Maintenance

   a) Preventive Inspection
   b) Soiling and Cleaning
   c) Repairing and Replacement

6) Economics

   a) Material Cost
   b) Installation Cost
   c) Insurance Cost
   d) Maintenance Cost

7) Case Histories

   a) Installation and Check Dates
   b) Appearance
   c) Total Costs
   d) Other Properties

# ROOF MATERIALS AND ASSEMBLIES

By William F. Reardon,* Real Estate and Construction Operation
General Electric Company

It is indeed unfortunate that the people who develop new materials are rarely the ones who eventually specify or use them. Whenever a new field is opened up a new language appears, a vocabulary made up of terms that frighten and confuse the users. The field of plastics is no different, and fits only too well into this pattern of new materials. For a simple example, take the words "polymethyl methacrylate." Figure 1 is a schematic drawing of a polymer. This may be very clear and understandable to the chemist but to the architect or engineer it could just as well be a bunch of grapes or a baby's rattle. When this type of language is used continually, the designer tends to give up.

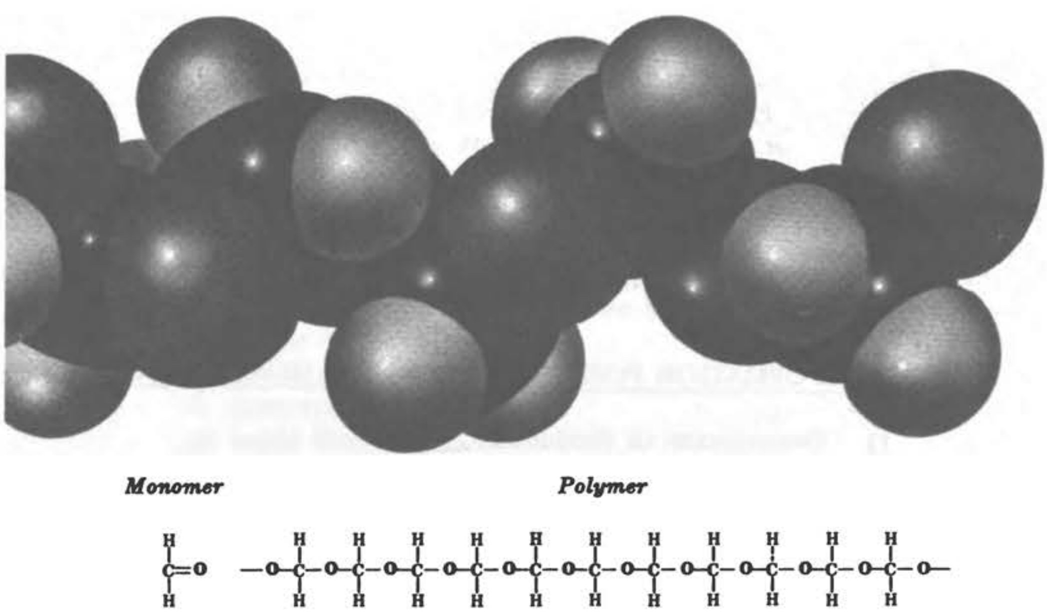


Figure 1

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*REARDON, WILLIAM F., Degree in civil engineering from Worcester Polytechnic Institute supplemented by post-graduate work in engineering and architecture at Worcester and at the University of Tennessee; Member of American Society of Civil Engineers and Building Research Institute; a registered Professional Engineer, associated with G. E. since leaving the U. S. Navy; Vice Chairman, BRI Plastics Study Group Planning Committee.

The confused reporting of information on plastics used in building was the reason for the formation of our Task Group within the Plastics Study Group of the Building Research Institute, which culminated in This Workshop. We in the Task Group are not made specialists in plastics, but people who wish to see plastics used; we are an architect, two research professors, two construction men, and a sales engineer, who incidentally works for a chemical company and has been able to keep us on the right track, plastically speaking.

About two years ago several of us became concerned by the fact that plastics were not being used to their fullest extent in building. Designers were steering clear of plastics, just as they tend to with any new material, but here the language was confusing them and they were being misled by advertising claims. We decided among ourselves that there could be a simplified standard method—a thumbnail sketch reporting of plastics information, and that we could develop a format which, if universally accepted, could go a long way in furthering the use of plastics. We felt that just as the Steel Handbook, the lumber data books, etc., have become acceptable standards for reporting information on these well-known materials, we could start on a similar project for plastics.

Our first step was to try and develop a general format which could be adapted for reporting information on just about any material in building. Once this was done, our next step was to develop several specific formats on the application of plastics. These include components for walls, pipe, interior partitions, wall and floor coverings, ceilings, roofing materials, etc. To the Workshop, we invited experts, manufacturers, fabricators, and architects, from the various fields of plastics—engineers and users—to review with us our general form of reporting. In addition, we asked a representative of a prominent manufacturer, and also an authority on data processing, to discuss the applications of these formats in building construction.

We have worked on and developed a form of reporting to aid everyone with the use of plastics and it is our hope that one or several of the national organizations will pick up this challenge, and that as soon as possible many manufacturers of plastic building materials will use this form or a similar form as a standard. We believe that much is to be gained by simple, accurate and factual reporting and that the uses of plastics will tend to increase at an even more rapid rate than in the past.

Below is the general format developed for reporting plastics information. The major breakdown of information falls into only seven principal classifications:

GENERAL INFORMATION FORMAT FOR PLASTICS USED IN BUILDINGS

1) Description of Product
2) Physical Properties
3) Design Criteria
4) Installation
5) Maintenance
6) Economics
7) Case Histories

At our workshop, it was felt that each format covering a specific material should have a descriptive title, an AIA file number, and a date of issue.

These categories are quite sufficient to cover adequately almost any building product and furnish sufficient information to the designer. I am certain that many will immediately say that this information is already available, and I am sure it is. The trouble is the form in which it is available, or how we can locate it. What we are seeking is a standardized method of reporting and a general simplification of the process. The information covered here could be a 500-page volume or just a few pages, and we believe the latter is what we want. Let us eliminate the unnecessary or unwanted information and always keep in mind the ultimate use of the data by the architect or engineer.

I will be using examples to illustrate this format directed at roof construction, which is the part of the building on which I have been developing formats as a member of this Task Group.

The first category is:

1) <u>Description of Product</u>

a) Trade Name & Manufacturer
b) Type of Material
c) Plastics Used
d) Use of Product

It is our intention to keep it simple and understandable. The trade name and manufacturer are self-explanatory. Under "type of material," we would like to know whether it is a liquid to be sprayed on, as in the case of an exterior roof coating, or a sheet used as a flashing or vapor barrier material, a board as insulation, etc. Under plastics used we are seeking the broad general designation and not the long name that confuses us all.

The "use of the product" is probably the most important and should state simply as in the case of a plastic sheet that this material finds its principal use as an incombustible vapor barrier in roof construction.

The second category refers to the physical properties:

2) <u>Physical Properties</u>

a) Strength
b) Dimensional Stability
c) Fire Resistance
d) Vapor Permeability
e) Chemical Resistance
f) Acoustical Properties
g) Light Resistance
h) Light Reflectivity & Transmission
i) Thermal Transmission
j) Electrical Characteristics
k) Aging
l) Toxicity
m) Compatibility

Under "Strength", we are interested in the flexural and compressive strength, the modulus of elasticity, impact, durability, abrasion. It was also brought out in the Workshop that temperature limitations, so important to plastics, should be included either as a part of Item a, or perhaps as a separate item. Under "Dimensional Stability," the most important things are the coefficient of expansion and the creep in the material. For example, it is of the greatest importance for the designer to know beforehand where to provide for expansion, rather than find to his dismay that the material has started to buckle or push. Under "Fire Resistance" all plastics have been looked on questionably in regard to their flammability and it is very important to cover this phase in order to eliminate distrust on the part of the designer. We want to know whether it has the approval of such agencies as Factory Mutual, F.I.A. and U.L. If sprinklers are required because of the material, let's say so.

The plastic vapor barrier with its special adhesive has made the difference in converting steel roof deck construction from its previous combustible rating to its new Class I construction not requiring sprinklers. Vapor permeability is important in any material used on the building exterior. In roof construction it is of paramount importance in the exterior coating and in the vapor barrier which protects the insulation from vapor migration and troubles due to blistering.

Under Item g, what happens to a roof when it is subjected to ultraviolet rays? Light reflectivity and transmission may not be necessary considerations for built-up roof construction, but they do have a place, for instance, in skylights.

For roof insulation we must know the conductance in order to design the heating or air conditioning system to reduce the heat flow through the roof to reasonable and economical limits.

Under Item k we want to know what happens in 5 or 10 years to the exterior roof coating. Will we be able to secure a bond or a suitable guarantee? We all know the troubles with our present built-up roofing materials—brittleness, alligatoring, blistering. Will the plastic materials eliminate these? And when all these materials are being installed, will the workman be exposed to danger from handling or fumes? Will the finished assembly be made up of a series of compatible units? This is how the physical properties of materials apply to roof construction and why the user must know the answers. Our Workshop felt that, wherever practical, the existing applicable standards or specifications should be included under these physical properties.

The designer will also be interested in:

3) Design Criteria

a) Size, Thickness, Weight
b) Finish, Color
c) Workability
d) Tolerances
e) Limitations
f) Adhesion & Cohesion
g) Properties of the Complete Assembly

Whether it is a roof deck, insulation, vapor barrier or flashing, the designer wants to know the answers to "Size, Thickness and Weight." For finished roofing its "Finish and Color;" its ability to adhere and make a complete homogeneous assembly capable of withstanding uplift forces of hurricane winds, and the destructive forces of heat, cold, sun and rain.

Of course, these criteria listed here apply in varying degrees of importance to just about all building materials—some points being stressed a little stronger, perhaps, for pipe or flooring than for others.

The next category concerns the installation:

4) Installation

a) Surface Preparation
b) Description of Process
c) Methods of Attachment
d) Equipment Required
e) Limitations

The best way I can cover the subject of installation is to describe how a vinyl vapor barrier is applied over a steel deck. The steel deck is clean and dry. A machine handles the sheet which it solid coats with .4 gallon of special adhesive on the bottom and places this same amount over the top, but in ribbons 6" on centers, while a brush smooths the sheet onto the deck, eliminating air pockets. The insulation is then pressed into the adhesive. In addition, there are certain temperature limitations below which the adhesive will not be effective. The foregoing illustrates most of the information required regarding installation.

The next category deals with:

5) Maintenance

a) Preventive Inspection
b) Soiling & Cleaning
c) Repairing & Replacement

Under "Maintenance" the manufacturer can do himself great harm if he does not honestly and factually report on the need for inspection, and establish periods between inspections. Preventive maintenance is now recognized by most large concerns as the best way of avoiding costly emergency type repairs. In the case of the finished roof surface, the questions that arise are: what precautions are required in walking across roofing, will it stand the service traffic to machine rooms, and how do you patch it? Is the patching a simple process of rolling on an additional layer with a standard paint roller, or does it involve cutting out and building up a new patch interlocked with the existing roofing?

Under the next category, Economics, are:

6) Economics

a) Material Cost
b) Installation Cost
c) Insurance Cost
d) Maintenance Cost

We are not asking anyone to quote the material or installation cost to the penny, because we know that installations vary with the size of the job, geographic location and many other factors. What we are after is an actual guide which includes comparative cost. Based on this information may be the decision to use or not to use the material. It is far better to know beforehand approximately how much it will cost, than to be rudely awakened and find at the last minute that the material has to be left out. If the use of the product increases the insurance rate, we should also know that beforehand.

In presenting case histories the following data should be included:

7) Case Histories

a) Installation & Check Dates
b) Appearance
c) Total Costs
d) Other Properties

It was with some misgiving that we decided to include this category but we honestly believe it would be well for the manufacturer to indicate some of the experience gained from actual installations. We realize he will always select successful jobs, and this is only natural, even though it would be far better to learn from him of any misapplications or limitations than to have these come from the rumor factory where real damage can result. Knowing the good and bad alike helps the designer and the product.

It was a constructive experience to hear two leading architectural firms publicize their poor experiences with curtain walls during the 1959 BRI Fall Conferences. We all gain from this honest reporting, and similar reporting by plastics manufacturers can help their products.

Some of the members of the Workshop felt that the last two categories, Economics and Case Histories, should not be included, but we decided to leave them in since others at the Workshop indicated a willingness to report this type of information. Now, where do we go from here? As a result of this Workshop, we are resolved to take this format to one of the national organizations working to foster greater use of plastics in building and see if it can gain general acceptance by manufacturers in reporting their materials. We feel it would be a boon to the designer to know where to find quickly the information on a particular plastic material, and to be assured that it was correct. As the Steel Handbook has become the bible of the steel industry, the use of a standard format could likewise become a permanent guide to the plastics industry.

# CEILING COMPONENTS AND ACOUSTICAL MATERIALS

By Richard G. Clarke, * Director
Division of Research, University of Hartford

The general reporting form presented earlier need not be departed from as far as ceiling materials and acoustical materials are concerned. However, there may be some important changes in emphasis. What seems most important are physical properties of a certain type. There are physical properties which the engineer describes as mechanics and, from the dynamic properties of these materials, evolve other properties with which the engineer does not bother. The true physical properties, the performance of a material in its treatment or mistreatment of the light and sound radiation, the manner of handling these materials and the interaction with radiation, are things that the engineering fraternity has not done as much with as it should have.

To illustrate this briefly, the human being relies principally upon the sense of hearing and the sense of vision to perceive information from the outside. It is the effect on these senses that is extremely important in determining material surfaces for our living spaces. There are some things about the sense organs that are not widely known. Usually we think that the eye, being the most useful and the most valuable of our sense organs, is the finest piece of design. Actually it's easily demonstrable that the ears are the most scientifically elegant of the sensory organs. Our eyes are only the competitors.

The eye contains a wonderfully fine-grained energy transducer that is capable of perceiving objects a hundredth of a millimeter in width, equal to the finest photographic plate. It has some sort of color analysis system that can determine hue and saturation of a color with considerable accuracy. If anyone has ever had occasion to attempt to duplicate the color sensitivity of the eye in a physical instrument, he realizes that the range of color vision is so excellent that it is a very difficult thing to duplicate. I doubt if more than a dozen investigators have succeeded in building an instrument which would duplicate the color vision performance of the eye at any range closer than 1%. It is incapable of any spectral resolution of a mixture of colors. This is also true of the three-color painting processes, color television, or color photography. You cannot adequately use these things for spectral resolution of colors, nor can the eye be used for that purpose. We have excellent instruments, however, easily obtained and relatively cheap, for doing this job thoroughly.

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*CLARKE, RICHARD G., Ph.D. in Organic Chemistry, Cornell University; Member of American Chemical Society, American Society of Mechanical Engineers, Building Research Institute, Optical Society of America; formerly associated with Wesleyan University in teaching and research capacities.

The optical system of the eye is about equal to what one might find in a 10¢ store magnifier for use by a person with good eyes. If the eyes are distorted, as is the case with 95% of us, then it's not that good. The beautiful transducer that we have in the retina of the eye is sloppily wired up with nerve endings, so that several units of the screen connect to a single nerve, and cannot separate bits of information to the brain. The eye cannot tolerate illumination much more than a million times the intensity of the faintest detectable signal. The eye is sensitive to one octave of electromagnetic energy, with one exception. The person who has had a cataract operation and has had this lens removed from the eye, has considerably increased color vision.

The ear surpasses the eye in many respects. It can detect sound at or near the theoretical minimum limit. If it were any more sensitive, it would hear a disturbing background noise of molecular collisions in air. The motion of the ear drum which is something on the order of a billionth of an inch, will produce a sound effect in the ear and in the brain. It can be exposed to sound energy a trillion times the threshold value—with damage, of course, but not with destruction. Exposure to the noise of the exhaust of a jet aircraft would be about a trillion times above the minimum level. If one should happen to be inside a tank that is being riveted in a boiler factory, he would receive somewhere in the neighborhood of a trillion times the threshold level. If he stayed close to this noise very long, his hearing would be damaged, but it would not be destroyed completely.

The hearing frequency range is about ten octaves, usually more in young persons and less in the aged. The ear possesses a decidedly unusual ability to analyze a musical sound into its predominant tones, such as obtained from a chord on the piano. Here, the ear has the capability of spectral resolution of sound, if it is not too complicated, into various frequency elements. Probably half a dozen different tones can be recognized by a person with a trained ear. A talented piano tuner can detect a deviation of one vibration per second from a standard interval, and occasionally a person possesses incredibly accurate absolute pitch. He can tell if he is one vibration off from the true pitch of the tone that he is trying to hit. The ear has the capability for this special analysis whereas the eye does not.

The trouble with analyzing sound is that the instrumentation we have available is not good for the particular purpose of spectral resolution of sounds, but the ear itself is quite good. Furthermore, the range over which the ear can tolerate sound is very large, but the accuracy of our instruments for sound detection is usually very bad. We consider that the usual limit of accuracy of measurement is something like the factor 2 in sound intensity, and good photometric practice with light is something in the order of 1 or 2. If a sound is too complex for the ear to resolve, or if it contains sharply defined wave fronts, it is interpreted as noise.

The usual task of the acoustical material is to diminish noise and an evaluation, to be adequate, must tell accurately what noise spectrum is being diminished. Is this diminution occurring in the soprano range, where it is perhaps not too important, or is it occurring in the bass? Most of the bothersome noises in buildings will occur in the bass range and that, of course, is where you might expect the acoustical properties of the materials to have the most difficulty in achieving proper silencing. If you are going to present acoustical data, and we're discussing a data presentation form which is going to be highly abbreviated, how can you do it?

A good many acoustical material manufacturers argue that there is a single rating you can apply. In this case, one can play safe and report sound diminution for the octave in which the material is least effective, but that isn't good for sales since you will usually find an octave in which the material will have no effect at all. The usual procedure is to report the performance for the best octave, but that is not particularly beneficial to building customer good will. The spectral analysis by octaves or fractional octaves is made ordinarily by instruments that have a tone resolving power of three or four octaves, and the manufacturer presents the results with a straight face. He's not being dishonest in this respect, because the acoustical expert has given these data to the manufacturer with a straight face.

The problem reverts to the fact that the best possible job is being done with the instrument at hand. If you have a silencing device, a resonator which will produce silence at the few wave lengths for which it is tuned and nothing else, and then you take one of these sloppy four-octave sound analyzers and measure the diminution of the sound in this resonator, you discover that it has a nice, broad diminution spectrum. This is put in the advertising literature and the instrument appears to be tuned, for example, to the frequency of 1,000 vibrations per second. Actually it is only 10% effective at 100 vibrations. It may not even work at all at 100. Thus we can realize what will happen if we measure with one of these instruments a single pure tone put out by an oscillator, for example, Standard A. We find that Standard A is read over several octaves and we see what the difficulty is.

Standards are continuously being established for acoustical testing and a great deal of work is being done on this problem. It is time consuming and expensive to duplicate use conditions, and the procedures usually represent short cuts. Occasionally, conditions of test and use differ so greatly that the test results don't apply to the installed material; likewise the test of the installed materials. A critical test may be so difficult to perform that the installer never has to worry because they can't prove it anyway. The least expensive and not always the least accurate means of evaluation is to guess the performance of the material. The problem of presenting acoustical performance data for a small space is to show results, character and validity of the test so that one versed in the art can make use of the information and select materials for construction with some measure of confidence. This is by no means a simple one.

We were asked to comment on the space allowed in this reporting form for esthetic considerations and I think these are esthetic considerations. Talking about the light and the sound treatment of the materials, there is no means known to man of putting this into an objective form. This is an interpretation the brain makes of the data that are received from the eye and the ear, and each person makes his own interpretation. You probably can't get any two architects to agree on what is esthetic and what is not esthetic, especially if they are talking about each other's work. The acoustical properties seem to be about the least understood and about the most difficult to handle. That is why I stressed them for this particular purpose, to point up one of the problems—the means of reporting. Getting the report would not be too difficult, but making it of real significance may be a very difficult matter. It is something that has to be looked at very carefully. The present reporting concerning problems that border on the esthetic use of materials in construction leaves a good deal to be desired.

# STRUCTURAL FLOORS AND FINISHED FLOORING

By George P. Dorrance,* Technical Advisor
Turner Construction Company

The subject of floors involves a host of products in the plastics field, including vapor barriers on the ground, both sprayed-on and the paper form of curing compounds for concrete floors, sealants and caulking compounds and a multitude of finished surface floorings.

While we can best present this format by applying it to specific products, the purpose of our study and development for the last two years has been the development of the format itself. We are most sincere in looking for a vehicle that will convey to us simply, understandably, and realistically, pertinent information on any given product. While we had to discuss many details about products in the Workshop, we still tried to stick to the format. It's not so important to decide just what the details are, but whether this form is an adequate means of expression. The criticism has been made that we oversimplified this format. I wish you could see some of the formats we started out with. We've rewritten them many times and we feel that we have made tremendous progress, but this is no indication that we have reached the ultimate. I feel that 10 years from now this format will be much different and much improved. However, we are firm in our conviction that today there is a place for it.

One point that has already been made bears repeating. We must know the bad as well as the good, and we must be told the facts as they are known. There often arises a conflict between the manufacturer and the user. What does an architect, designer or user want to know about floorings? We are all aware that this information is essentially available, but we have a particular need for a simplified, basic form for quick reference and analysis of it.

1) Description of Product

Quoting from an article in "Buildings" magazine for August, 1959: "The statistical importance of data on vinyl floor covering was weakened somewhat by the confusion which exists regarding terminology. Over half of the survey participants registered dissatisfaction with the descriptive labeling of the various vinyl types—indicating that the flooring industry would do well to clarify and classify information on vinyl floor surfacing materials."

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*DORRANCE, GEORGE P., Graduate mining engineer, Lafayette College; Member of American Concrete Institute, Building Research Institute.

This immediately raises a question. The very definition of what constitutes a plastic floor can present difficulties. Floor manufacturers may contend that all resilient floors are plastic. By their nature all resilient floors are plastic, but every resilient floor surface material is not a plastic material. For simplification here, we are going to settle on a vinyl plastic flooring. (In using the format, each type of flooring would, of course, be presented separately.)

2) Physical Properties

Under this heading the following points need to be clearly stated as regards use of vinyl flooring:

b) Dimensional Stability—This is the characteristic that enables the flooring to retain its original size without any appreciable expansion or shrinkage in use. This is a property which must be carefully checked in vinyl plastics and which may cause concern.

d) Vapor Permeability—This refers to water vapor transmission. In vinyl floors this is practically nil and therefore it can be a source of trouble. Vinyl tile just doesn't breathe.

e) Chemical Resistance—Perhaps the types of reagents, the specific materials and exposure time should be outlined for comparison with the conditions that will exist.

h) Light Reflectivity & Transmission—With modern lighting systems and the effect of lighter colors on the reflectance of light, this factor should be carefully explained. The floor that develops better light reflectance may be a harder floor to keep clean and maintain.

i) Thermal Transmission—Thermal conductivity of this particular floor might be 0.90. While normally not too important, in the case of radiant heating it could be very important.

k) Aging—The user is interested in whether his floor will stay resilient and whether the product itself is subject to deterioration as opposed to the wear which he places upon it.

At this point, a given format may be varied by adding properties which are peculiar to the particular product being considered. I would aid resiliency here, which is one of the more important properties of resilient floors. How does the material behave under impact, and how does it return to its original shape afterward? Other properties I would add to the format for flooring are residual indentation and stiffness.

3) Design Criteria

a) Size, Thickness, Weight—We are naturally interested in the various sizes in which vinyl flooring can be obtained, the various thicknesses or gages. Can it be produced economically in a size other than the specified size on special order, for example? I have known this to be done without increasing the cost.

b) Finish and Color—These are important in vinyl tiles. Here the format offers an opportunity to give a brief description of what is available. Once the material is chosen we can then resort to the more detailed catalogs and specifications for the particular product.

f) Adhesion and Cohesion—No single item in the use and application of resilient floors is any more important. I will discuss this item under a future heading.

I would also suggest here that Federal Specifications be referred to, as the manufacturer can cover appropriate characteristics of his product in this manner.

4) Installation

a) Surface Preparation—We need definite information on what surfaces are appropriate, what precautions should be taken, and whether underlayments can or should be applied. In the case of concrete floors, the manufacturer as well as the user or installer should insist on alkalinity tests, dusting tests, etc.

c) Methods of Attachment—As previously stated, the importance of this item cannot be minimized. Due to the fact that vinyl plastic tiles do not breathe, and that vapor pressure coming through the concrete slab may tend to lift the tile, very special adhesives may be required. These might be of a waterproof and alkaliproof nature. The manufacturer, under this heading, should endeavor to be most specific about the problem and the proper materials to be used.

e) Limitations—This item offers an opportunity to state briefly some known limitations in the laying of the tile, such as minimum temperatures, etc. Is the material suitable for on grade, below grade or above grade use? While the vinyl plastic is normally suitable for all three, we must know what limitations to place upon it.

5) Maintenance

Tile offers the advantage of unit repairs by replacing single pieces. Under this heading there could be added a fourth consideration, Matching Colors. Frequently tile of the same code number will have different shadings at a later date. Quite often tile from the original lot does not match the existing floor because of repeated polishing and treatment.

Another listing here might give details on Shelf Life. Only recently we learned that certain resilient tiles may have a limited shelf life and probably should not be used after a storage period of six months or a year. If the manufacturer knows this to be true, certainly he should so define it on the format.

6) Economics

I would suggest that the manufacturer state that any figures represent an estimate subject to variation in different locations and to periodic revision. The manufacturer should be contacted for the most up to date and accurate figures.

7) Case Histories

In this connection, I can only add that it is most desirable to show the prospective designer or user typical installations from which he can form an opinion as to just what materials suit his particular needs best.

# EXTERIOR WALL COMPONENTS

By Anthony Ferrara,* Partner
McLeod and Ferrara, Architects

It is natural for an architect, who wishes to specify window-wall panels, to consult all available data on window-wall panels. The selection of the proper panel depends on the ability of the architect to arrive at a reasonable and fair quality analysis of the panel. At the moment, architects operate somewhat blindly. We recall only the results of former calamities and as new products appear, new dangers come to the fore.

The format for this product, as amended from the basic format, is incomplete, and will remain incomplete because we are dealing with new materials and, until these materials have been tried through a reasonable length of time, we cannot know their performance abilities. Therefore, we are going to consider the items listed in our format that, to the best of our knowledge, we can foresee as considerations. In sandwich panels we must consider natural phenomena or relationships of one material to the other. When two, three or more products are laminated to each other, we must understand that each product has its own force and produces effects independently of the other. While one product may counteract the force of the other product to which it is laminated, to the benefit of the end product, it could also well be that the results of the action of one in concert with another may produce a very inadequate end product.

In applying the format to plastic window-wall panels, for instance, we find:

1) Description of Product

   b) Type of Material—Here we can state: A laminated sandwich with plastic foam core, between two asbestos cement sheets, with plastic outer skins—both sides.

   c) Plastics Used—Here, naturally, we should utilize the simple layman's language, not the laboratory names of the plastics nor the pet names of the individual producer, which often sound like the name of a fuel for interplanetary travel.

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2) Physical Properties

Here we have the meat of information that the architect is seeking.

a) Strength—It is evident that the knowledge of tensile strength is not necessary, but knowledge of compressive strength is a most important factor. The question which comes to the architect's mind is: Must each panel be supported or can one panel support two, three or more panels? Here I would depart from the basic format and place two other items under this item, impact resistance, and abrasion resistance.

Impact resistance is most vital in one- or two-story buildings of a nonbusiness nature, such as schools, churches and laboratories. In these areas vandalism has not lost its popularity, therefore this item is of the greatest importance to the designer.

Perhaps abrasion resistance may not seem important but architects do carry the same motif to about 6" above grade. Further, these panels could be used for interior partitioning, thereby becomine attractive areas for drawings of a child's version of his teacher or two hearts pierced by arrows, etc.

b) Dimensional Stability—Here, we come face to face with the age-old question of contraction and expansion, one of the most vital questions in building. An error in this calculation can cuase the greatest grief. Our basic villain is heat—the great amount of it or the lack of it. Heat also gangs up with its friends, air and water, and such friendship produces vapor which threatens the adequacy of materials. It may well be that the manufacturer can give temperature ranges as related to stiffness in flexure, coefficient of linear expansion, and/or state geographic areas where this product could safely be used.

c) Fire Resistance—When we speak of fire resistance, we use the terms flammable, nonflammable and self-extinguishing. However, when fire resistance is applied to window-wall panels, this is not enough. You must realize that an architect is designing in accordance with a building code. Codes specify fire ratings, and if the code calls for a two-hour fire rating, it will never do to specify a one-hour fire rated panel. Again, fire rating produced by the manufacturer's laboratory or an obscure agency will not be acceptable. It must be prepared by a recognized national agency.

d) Air Movement—I have substituted air movement in place of vapor permeability under this item, inasmuch as the subject of vapor is incorporated under other items. Air movement is very vital to a window-wall, because it acts in an unharnessed and violent manner. When our buildings are caught in tornadoes and hurricanes, our architectural details and materials are put to the test. As you will readily see, the architect must be well informed of the product's air movement resistance so that he can properly detail the structure against failure.

f) Acoustical Properties—This item has been included on the possibility that a plastic window-wall panel may be used for interior partitioning, but for exterior use, as we are discussing here, it is not applicable.

g) Light Resistance—This factor controls, in many respects, durability of materials exposed to the elements. The variety of rays often penetrates to the chemical formation of materials; and so potent are these rays, that they can destroy the very properties of the materials which are chosen to do the job. Ultraviolet rays, and all their cousins, have been known to destroy both natural and synthetic rubber, paints and even plastics.

j) Thermal Transmission—When we speak of thermal transmission, we must also consider water as still or driving rain, and in its frozen form of snow and ice. While water in its frozen state may be harmless, a slight thaw a few hours a day gives water its greatest opportunity for seepage. This seepage freezes again, causing great damage. Where seepage meets heat, vapors and condensation form and trouble begins. In window-wall sandwiches, the core is usually a porous material. When water, in any form, penetrates this porous material, a serious failure occurs. The very position of a window-wall panel makes it impossible to eliminate exposure to large thermal variation.

k) Aging. In this item we are concerned with the life of the panel—10, 20 or 30 years after installation. What fatigue will it show in the various stages of aging? It may be that plastic deformation will be apparent, or again, because of fatigue, modulus impairment may appear and disintegration be apparent. Will the adhesive endure the movements of the panel? We know that we are dealing with inorganic material, therefore, we can discount rot and mildew. Perhaps staining may need our attention, or clouding from contaminant of the elements.

3) Design Criteria

a) Size, Thickness, Weight—This is the principal information an architect desires. What is the size of the panel (length, width, thickness), and what are the size limitations, and finally, its weight? I need not tell you that weight of the window-wall panel will control the design of the frame of the building.

b) Finish and Color—While the architect may be intrigued by finish and its texture and color, he will want to know if the colors are permanent, and if not, how soon the panels will lose their color pigment. The architect will also question whether the finish and texture of the panel are so designed as to trap water and frost to the detriment of the panel.

c) Workability—This item is almost self-explanatory. Must a panel be completely machine fabricated in the factory and installed in the field as delivered, or can the panel be cut and trimmed in the field?

d) Tolerance—This tolerance, in window-wall panels, is troublesome because it depends on a thorough understanding of the panel's traveling habits. When too much unnecessary tolerance is allowed, it endangers the fastening of the material, while too little tolerance may bring failure of the panel. As an example, I was told of a building, where too little tolerance was allowed in its window-wall panels, and the crackling and snapping of the panels during expansion reminded one of the celebration of an old-fashioned 4th of July.

e) Limitations—Under this item we mean the several limitations that the manufacturer must impose to guarantee the performance of his product, and thus must inform the architect of their existence. For instance, size limitation as to width and height as related to thickness; over-all size limitation; exposure limitations, etc.

To the above I would add Properties of Complete Assembly. While I believe that most of the items preceding and those noted hereafter, probably answer this item, I have included it here in order that we may glean some new thoughts in this regard. Perhaps, under this item, we may consider the entire structural frame in which these panels fit—steel or aluminum—and the design of the sections.

4) Installation

a) Surface Preparation—Is there need of surface preparation beyond the cleaning of the frame? Does the frame have to be prepared by being treated with special paints to prevent bleeding and penetration into the panel?

b) Description of Process—Here we want to know the so-called "ground rules" for installation, what to do and what not to do. I would recommend that installation involve a minimum of handling and use of few tools.

c) Methods of Attachment—Is it a familiar method of attachment or is it an ingenious one? Perhaps it may be a method solely applicable to the particular manufacturer's product. However, it must be remembered that it is the attachment on which the whole installation depends.

d) Equipment Required—Does installation need handling that would require special scaffolding or crane?

5) Maintenance

I will dwell very lightly on this section, merely stating that manufacturers must recommend periods of preventive inspection and also the method of cleaning panels. The architect, armed with this information, can provide methods to facilitate the periodic inspection and cleaning. Will the panel assembly allow for the removal and replacement of any one panel, which may be damaged during construction, without disturbing the neighboring panels?

As far as the next two sections of the format are concerned, you may publish what you feel is necessary. However, be forewarned that before an architect specifies your product, he will want to know the cost of the material installed, and also the insurance and maintenance cost. He may ask you where the material has been installed previously, and the date of installation, what the total cost was and how it compares with his present project. Don't hesitate to invite the architect to visit personally the site of the installation to check on appearance.

# PIPE AND PIPE FITTINGS

By Walter E. Gloor,* Manager, New Product Development
Cellulose Products Dept., Hercules Powder Company

In discussing plastic pipe we have probably the greatest departure from the format in detail, although all the general subjects covered certainly are applicable to plastic pipe. There are a number of the different varieties of plastic pipe and fortunately for those of us writing formats, most of these types are either covered by existing national specifications of the Department of Commerce, Commercial Standards, etc., or standards are in committee and awaiting issue.

To use plastic pipe, one of the basic principles is that you must have an equally good system of pipe fittings, otherwise you don't have much of a system. We have tried to identify the types of fittings to be used with each grade of plastic pipe. Therefore, the first format section, "Description" will include not only the trade name, the type of plastic and the numbers of the applicable specifications, but also a reference to the type of fittings recommended for use for that particular type. Fortunately there is an ASA subcommittee that is about to issue specifications on three different types of fittings and there is also a joint SPI—ASTM committee working on fittings and specifications for fiber glass reinforced pipes.

Another variation that we would put in the description would be to break down the use of the products in terms of code acceptance. Certain codes permit the use of some of these pipes for certain kinds of water installations. The manufacturers can specify these, as well as the noncode uses for such things as farm water supply, wall drains and lawn sprinkling systems.

There are also provisions stated where the use of plastic pipe is not recommended. For instance, the SPI committee does not recommend the use of polyethylene pipe for hydrocarbon gases or natural gas. This type of information should also be stated at the beginning of the specification.

As to physical properties, we would omit much of the conventional and merely report the elastic modulus of the various materials at the standard test temperatures and, most importantly, the hoop stress for which the pipe is designed to take continuous pressure for a long time. Such items as fire resistance could be referred to by an ordinary burning-rate test indicating whether the material is flammable or self-extinguishing.

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As far as chemical resistance is concerned we are fortunate in that some of these specifications actually list chemical resistance of the pipe. Thermal properties are also a very important factor in many of these pipes. One would possibly report the modulus of elasticity at the upper limit of useful temperature as well as the linear coefficient of expansion and you would also give the hoop stress at the maximum useful temperature of the different pipes. From this the designer could easily tell whether he would recommend it for particular hot water use.

Electrical properties are hardly important. Most pipe people would say either that it was a good insulator or not. If it were a good insulator the manufacturer should make sure that his specification stated that one shouldn't use it for an electrical ground. Toxicity is an important factor in pipe because many of the pipe uses that I have named are in connection with the transport of potable water. The National Sanitation Foundation, working with the SPI committees, has set up standards and has a mechanism for approving pipe and issuing annually a list of approved pipe materials. Pipe and fitting manufacturers can then put the NSF label of approval on their products if accepted.

The strength data put out by many of the chemical companies for some of these plastic materials possibly apply to laboratory or shop moulded specimens and do not necessarily apply to the properties of pipe made under somewhat different conditions. It is also unfortunately true that different manufacturers can take the same material and produce pipes of quite different properties. That is the basic reason why the industry has issued this group of standards, to make sure that every product attains a minimum strength or quality.

Turning to Item 3, "Design," the formats, which will be abbreviated, would give only such things as the pressure rating of different sizes of pipe. They would not give dimensions, because reference to the specifications would give dimension tolerances, detailed sizes, etc. Each manufacturer, of course, would be responsible for denoting the colors available, would be responsible for detailing the workability of his material such as cold bending radii, how to cut it, how to join it, what type of insert fittings and clamps or fusion welds or solvent welding materials are required, etc.

From the data given in physical properties, it appears that the limitations of most pipes could be set forth without any extra information except possibly a note as to the behavior of the pipe when water is frozen in it.

As far as installation is concerned, we are very fortunate in that the Societies are planning to issue directions for the proper installation of pipe. There is one already issued on flexible polyethylene pipe. We also have on that type of pipe specifications for plastic insert fittings, and I believe that all the detail that would be necessary for accurate design with other types of pipe could be located. The format would act mostly as an aid in the selection of a pipe for a particular purpose on the part of the architect or designer.

On maintenance of pipe there isn't a great deal to say. One obvious caution that should be noted where applicable is that some of these pipes don't lend themselves to thawing out with a blowtorch.

When it comes to economics, it is very difficult to make any direct statements about the day-to-day and month-to-month cost of many of these materials. General comparisons of their cost with that of carbon steel pipe and of systems involving different fittings could be made, and the same is true of case histories. Each manufacturer has a file of various types of such information. This information could be put in the format, and also experience as to length of performance. Pipes which are covered by specifications have all been worked on very carefully and if the material is installed properly, according to the requirements set forth in these various specifications, there isn't any doubt that it will handle the pressures for which the pipe is rated, providing the conditions of temperature, etc., are maintained.

In general, this format could be applied easily to many of the grades of plastic pipes now on the market. I do know of one or two manufacturers who have already said that they are going to try to publish their information in this format, so you will be able to quickly determine such important things as physical properties and design criteria in this field.

## Format For Reporting Data To Architects, Designers and Builders on Plastic Pipe And Fittings

| 1) Description | | Example |
|---|---|---|
| a) | Trade name and manufacturer | |
| b) | Type of material | Flexible polyethylene pipe |
| c) | Plastic used | Polyethylene Types I-III |
| c-1) | Applicable specifications | CS 157-59 (-60 inpress) |
| d) | Uses of pipe: | |
| | (1) Code | Water main to house, Cleveland, Wisconsin State |
| | (2) Non-code | Jet wells, farm water supply, irrigation lawn sprinkling systems, mine water disposal, radiant heater slabs at 120°F. |
| | (3) Not recommended for: | Natural or city gas, hot water service (household) |
| e) | Fittings required for installation: | Insert fittings of impact styrene, nylon, polypropylene |
| f) | Applicable specifications on fittings: | Tentative ASA Committee B-16 "Plastic Insert Fittings for Flexible Polyethylene Pipe" |

| 2) Physical Properties | | Example |
|---|---|---|
| a) | Strength: | |
| | (1) Modulus of elasticity at 73°F. | Type I 20,000 psi min.<br>" II 35,000 psi "<br>" III 60,000 psi " |
| | (2) Maximum hoop stress in pipe at 73°F. for continuous use under pressure | Type I 385 psi<br>" II 510 psi<br>" III 600 psi |
| b) | Dimensional stability | Linear coefficient of thermal expansion: 6-14 X $10^{-5}$in/in/°F. |
| c) | Fire resistance | Burning rate $<1.2$ in/min. by ASTM D635 |
| d) | Vapor permeability | Nil to water |
| e) | Chemical resistance | Excellent for water, acids, bases, and soils: for detail see SPI bulletin "Proper Installation Procedures for Flexible Polyethylene Pipe" |
| f) | Acoustical properties | Damps out water hammer |
| g) | Light resistance | Black types may be used outdoors |
| h) | Light reflectivity and transmission | N.A. |
| i) | Thermal transmission | Type I: 1.8-2.3 BTU/$ft^2$/$hr^2$/$in^2$/°F.<br>Type III: 2.3-3.2 " " " " |
| j) | Electrical characteristics | Good insulators—cannot be used for electrical grounds |
| k) | Aging | Good for 15-50 years under hoop stress loadings shown |

2) Physical Properties (Cont'd) — Example

| | |
|---|---|
| l) Toxicity | Show NSF clearance if obtained |
| m) Compatibility | No plasticizer migration from pipe |

3) Design Characteristics

| | |
|---|---|
| a) Size, thickness, weight | See CS 197-59 (or -60) |
| b) Finish, color | Matt, glossy, black, copper, etc., as applicable |
| c) Workability: | |
| (1) Minimum cold bending radii | see table below |

| Pipe Diameter | Type I | Type II |
|---|---|---|
| 1/2" | 8" | 12" |
| 1" | 10" | 15" |
| 2" | 20" | 34" |

| | |
|---|---|
| (2) Cutting | Heavy knife or light saw |
| (3) Joints | Insert fittings and stainless steel band clamps (see spec.), fusion welds by proprietary methods. Mechanical joints |
| d) Tolerances | See CS 197-59 (or -60) |
| e) Limitations: | |
| (1) Pressure | Series 1 (Schedule 40 IPS) sizes: 1/2" 100 psi, 6" 30 psi; Series 2 sizes: 1/2" to 2", 75 psi; Series 3 sizes: 1/2" to 2", 100 psi |

(2) Thermal:

| | Type I | Type II | Type III |
|---|---|---|---|
| Upper temp. of use | 120°F. | 120°F. | 140°F. |
| Modulus of elasticity at this temperature | 8000 psi | 14000 psi | 24000 psi |
| Maximum hoop stress at this temp. | 152 psi | 203 psi | 240 psi |
| Maximum pressure at this temp. | 40% of those shown in e(1) | | |

| | |
|---|---|
| (3) Frictional loss in pipe | See SPI "Proper Installation Procedure" |
| f) Adhesion and Cohesion | N.A. |
| g) Properties of the complete assembly | Determined by the minimum of pipe and/or fittings used |

4) Installation

| | |
|---|---|
| a) Surface preparation ) <br> b) Description of Process ) <br> c) Methods of attachment ) <br> d) Equipment required ) | Refer to SPI Bulletin—"Proper Installation Procedures for Flexible Polyethylene Pipe Using Plastic Insert Fittings" |
| e) Limitations: | (1) Snake in trench 3"-1'/100' <br> (2) Burial depth: minimum - 6 to 8 inches. For occasional crossing by vehicles 12" to 18"; under roads - install loosely in street or concrete conduit |

| 4) Installation (Cont'd) | Example |
|---|---|
| | (2) Maximum depth: 7.7 feet for series 2, 12.2 feet for series 3 pipes |
| | (3) Distance between brackets on suspended installations of Type III<br>1" dia. or less 15 x O.D.<br>Larger than 1" 10 x O.D.<br>Vertically suspended 25 x O.D. |
| | (4) Back fill 6" over pipe with loose earth, no sharp rocks contacting pipe, before filling trench |
| | (5) Maximum setting depths in jet wells<br>Shutoff pressure 40 psi 50 psi 60 psi<br>75 lb. rated pipe 110 ft. 87 ft. 65 ft.<br>100" " " 180 ft. 156 ft. 133 ft. |
| **5) Maintenance** | |
| a) Preventive inspection | Hold water in pipe at twice rated pressure and inspect joints before filling |
| b) Soiling and cleaning | N.A. |
| c) Repairing and replacement | Will not burst if line freezes. Do not use torch to unfreeze—burns! use hot water or steam hose |
| **6) Economics** | |
| a) Material cost | Pipe cost about 0.8 linear cost of same size carbon steel pipe |
| b) Installation cost | Varies |
| c) Insurance cost | If available |
| d) Maintenance cost | If available |
| **7) Case Histories** | |
| a) Installation and check dates | |
| b) Appearance | N.A. |
| c) Total costs | Example—use of Type III with fusion joints on 4" line for industrial water supply at 60 psi cost \$4.00/ft; bell joint C.I. cost \$4.80/ft., in 1959 |
| d) Other properties | |

# INTERIOR PARTITIONS AND WALL COVERINGS

By Henry A. Jandl,* Professor of Architecture
Princeton University

One of the purposes of our proposed format is to try to provide enough preliminary information so that the architect, designer or user can make some preliminary decision as to the material that he will use. In this paper, I am considering partitions in terms of type of material in the complete panel, and possibly inserts of decorative plastics or translucent plastics used in wall covering. These may be in the form of tile, sheets, laminated films or even coated metal.

Under physical properties, and this is probably true of almost all of the plastics materials, there will be certain things that should be emphasized more than others. For instance, I emphasize flexural strength, impact strength and resistance to abrasion, characteristics that probably are not applicable to plastic pipe. Under wall coverings we are also interested in the tensile strength. Most of these properties will be based on standard tests. Certainly wall coverings also will be subject to abrasion.

In going through the literature, some of the more obvious physical properties are usually listed, and are usually given in a form that you can use, but there are many things that are not covered at all. In partitions, of course, such things as sound transmission and sound absorption are very important, as are the reaction to ultraviolet, the possible fading due to sunlight, aging characteristics, etc. I was particularly impressed on visiting a museum in Providence recently, by a relatively modern piece of sculpture built from sheets of plastic. You should have seen the condition of the sheets themselves, the color they turned, etc. It set me thinking about what may happen, in time, to some of our newer plastics. We really don't know. Some of the accelerated tests may point the way in proving that modern plastic will not react as some of the old ones did, but there is still doubt in the architect's mind as to what will happen 20 years hence.

In wall coverings, we're interested in reactions to various types of solvents, chemicals etc., that may affect the surface and, similarly, we have an interest in coverage of indentations, and the recovery from indentation. Many of the physical properties will vary depending on the temperature and the temperature range, and that fact will have to be stated under the various properties.

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*JANDL, HENRY A., Bachelor and Masters degrees in architecture, Carnegie Institute of Technology; Member of American Institute of Architects, Building Research Institute, National Council of Architectural Education; registered architect in New Jersey and New York State; affiliated with Princeton since 1940.

Under design criteria or design characteristics, knowledge of light reflectivity on the surface of the partition or the wall covering would be very important in designing artificial illumination. Concerning some of the plastics inserts used in partition work, we would be interested in the light transmission. Most cases that I have studied in that category follow the basic format closely. One of the very difficult things to know is exactly where to put it in the format. I have placed it under installation. For instance, the plastic panels in an assembly using either metal or some other material for framing, may introduce physical properties which are not the same as the basic panels. I am referring to the sound transmission or acoustical properties of the complete assembly which certainly will be different under impact noises or air-borne noises.

In partitions we are also very interested in the integration of the mechanical and electrical equipment. The requirements for wall coverings are very similar to the ones for plastic floors, such as backup requirements, type of adhesive and the problem of covering edges. We need to know what happens when you get to the edge of a sheet, or the difficulty in covering the edge or designing some detail that will take care of the door openings, windows, etc.

As far as categories 5, 6 and 7 are concerned, the general format covers wall materials very closely. Some of the men in the Workshop were concerned with trying to quote the exact cost in this format. That wasn't exactly what we were after. We realize that this can't be done since price would vary from area to area and from job to job. What we were mainly interested in was comparative or relative cost as compared to some well-known material or some alternate material that could be given in the form of a chart. You don't have to quote the exact dollars and cents. Comparative percentage of cost between various materials is just as valuable.

As for case histories, it will depend on the architect himself investigating actual installations. He will get the information from the format as to where some of the installations were made and he can investigate further their success or failure. We did some research on curtain walls and received much information from manufacturers on actual applications. We also visited the jobs and had an opportunity to discuss the actual installations with building managers, with the architects themselves and with the users. In some cases we got differing opinions, and certainly we learned many things that we would not have learned if we hadn't visited the jobs.

Our basic point in proposing this format for recording information on plastics materials for building construction is to get sufficient information so that the user can make a preliminary decision. This is not only needed in the plastics industry, but is also true, I think, of the building industry as a whole. Many other materials could lend themselves to the development of this type of information, to the profit of all concerned.

## Format for Reporting Data
## To Architects, Designers and Builders
## on
## Plastic Materials Used for Interior Partitions

I. Description of Product

1. Trade Name & Manufacturer
2. Type of Material
3. Plastics Used
4. Use of Product
   a. complete panel, translucent or opaque
   b. finish surface
   c. core material
   d. laminated inserts

II. Physical Properties

1. Strength
   a. flexural
   b. impact resistance
   c. abrasion resistance
   d. rigidity
   e. durability
2. Dimensional Stability
3. Fire Resistance and Flame Spread
4. Water Resistance
5. Chemical Resistance, Corrosion, etc.
6. Sound Transmission and Absorption
7. Reaction to Sunlight
8. Light Transmission
9. Thermal Properties
10. Electrical Characteristics
11. Aging
12. Toxicity
13. Compatibility

III. Design Criteria

1. Sizes, Thickness and Weight
2. Finish and Color
3. Workability
4. Tolerances
5. Light Reflectivity
6. Properties of the Complete Assembly

IV. Installation

1. Preparation of Surrounding Areas
2. Description of System
3. Methods of Attachment
4. Equipment Required
5. Sound Transmission (impact and air-borne) of Complete Assembly
6. Integration of Mechanical and Electrical Equipment
7. Demountability

V. Maintenance

1. Preventive Inspection
2. Soiling and Cleaning
3. Repairing and Replacement

VI. Economics

1. Material Cost
2. Installation Cost
3. Insurance Cost
4. Maintenance Cost

VII. Experience of Case Histories

1. Installation and Check Dates
2. Conditions of Material as Related to Properties Essential to Intended Use
3. Installed Costs

## Format for Reporting Data
## To Architects, Designers and Builders
## on
## Plastics Used for Wall Covering

I. Description of Product

1. Trade Name & Manufacturer
2. Type of Material
3. Plastics Used
4. Use of Product
   a. tile
   b. sheets
   c. laminates
   d. films
   e. coated metal
   f. etc.

II. Physical Properties

1. Strength
   a. tensile
   b. tearing
   c. impact
   d. abrasion
2. Dimensional Stability (range of temperatures)
3. Fire Resistance (flame spread)
4. Vapor Permeability
5. Chemical and Water Resistance
6. Light Resistance (ultra-violet)
7. Heat Resistance
8. Soiling and Staining Resistance
9. Indentation and Recovery
10. Aging

III. Design Criteria

1. Size, Thickness and Weight
2. Textures, Patterns and Color
3. Light Reflectivity
4. Backing Material
5. Radius of Curvature

IV. Installation

1. Back-up Requirements
2. Surface Preparation
3. Methods of Attachment, Type of Adhesive, etc.
4. Edge Covering
5. Equipment Required
6. Limitations

V. Maintenance

1. Cleaning Material
2. Repairing and Replacement

VI. Economics

1. Material Cost
2. Labor Cost
3. Maintenance Cost
4. Relation to Other Materials

VII. Experience of Case Histories

1. Installation and Check Dates
2. Conditions of Material as Related to Properties Essential to Intended Use
3. Installed Costs

## PANEL DISCUSSION

Moderator—William F. Reardon

Panel Members—Orville Pierson, Laboratory Head, Rohm & Haas Co.
Donald F. McAuliffe, Data Processing Section, Royal McBee Corp.

Mr. Reardon: We are fortunate in having with us Dr. Orville Pierson, Laboratory Head, Rohm & Haas, who will comment on how the manufacturer might feel about this format we have developed.

Mr. Pierson: My job is to summarize the discussions from the viewpoint of the raw material manufacturer. As most of you probably know, Rohm & Haas manufactures acrylic plastics and we are therefore somewhat in the same position as the grower of trees might be in the lumber industry. This is a parallel that might be carried a little further in trying to clarify what we are able to do, and to illustrate some of the problems with which we are confronted.

There certainly is a great wealth of information on plastics materials, as such. The great problem that seems to confront us, in entering the building industry, is how to convert this information to a form that is applicable to the plastics as it enters the building and to put it into language which is acceptable. Our situation might be very much the same as if the whole family of trees and timbers had been discovered within the past 20 years or so. Had this occurred, we might look with the same mystification on terms such as "Douglas fir" or "Philippine mahogany" as we now look at polystyrene or methyl methacrylate. The words are about the same length; it is only the long association which has made it possible for us to assimilate and understand the more familiar terms.

What this group is really trying to do here, is to find some way of compressing into a relatively few, short years, and presenting simply a great amount of information to people who wish to use these products properly. As suppliers of raw materials we can make our information available, of course, to anyone interested in using the product, as has been pointed out by members of this panel. However, many of the end uses are rather drastically affected by the processes through which the materials pass and the forms into which they are combined. It therefore seems generally desirable for us, as raw material suppliers, to work through the processors and to supply them with the information which may eventually find its place in the formats which we have been discussing here.

The situation is illustrated rather nicely by a simple case where acrylic sheet may be used for glazing. Even in such a simple application the performance of the product rests very heavily on the specification of sealing compounds and the competence with which these compounds are applied in the field. Thus, we have the usual chain of responsibility passing from the material maker to the processor, to the architect, to the contractor, and finally to the building owner. Certainly as we make progress in communicating information, the responsibility of each person in this chain is going to be more clearly fixed and it may also be possible for the several parties to cooperate much more effectively than they have.

On the question of economics and case histories, I feel that most of the raw material people would agree that it is essential to communicate as honestly and completely as we can on our experience with these materials, to give you a chance to evaluate their performance fairly. One of our problems, of course, is to get the feedback of this information. In so many cases we, as raw material makers, are very far removed from the actual field applications. One of the problems which has not been much discussed during the panels here, and well might be the next stage for the BRI Plastics Study Group to consider, is how to disseminate this information, assuming that we can get at least portions of it fitted into this format. Several channels are apparent. One of the interesting approaches is illustrated by the Armed Services' recently established clearing house for all information on plastics. Of course, it's going to take some time for this to become effective and it will be covering a great many uses other than building.

However, some central place in which such information might be made easily available is necessary, whether it be in the AIA Building Products Register, through the Manufacturing Chemists Association, Sweets Catalogue, or some other indexing systems. It certainly is becoming increasingly important as the body of information that we have to disseminate gets bigger, and the problems with which we are dealing become more complex. It also appears at this point that what has been done here is hardly a subject that should be restricted to the BRI Plastics Study Group. This type of approach to information dissemination, to be most effective, might well cover the bulk of all building products, even those that are apparently well established, to permit an easy comparison where a choice must be made between conventional and new materials.

Mr. Reardon: I would like now to ask Mr. McAuliffe to comment on the possibility of assembling the data requested, and the problems of organizing it in a uniform manner.

Mr. Donald McAuliffe: I am concerned with the paperwork mechanics that would be involved in the adoption of this type of format or uniform reporting. Basically there are three things that should be considered—where, how and the results obtained. Under "where" we have two possibilities. As I see it, we have a decentralized and a centralized location to which the information would be funneled. From the centralized location, the information would be passed out to the users, the architects and engineers. The other possibility is that of the processors, or the processor-manufacturer dealing directly with the architects and the engineers.

Now as to the "how." We have four possibilities that come quickly to mind. Number one, these sheets as they would come into the eventual users' hands, would be filed in a standard ring type binder, possibly by application, or, they could be put on a plain card which would be filed in some given sequence. The third possibility would be a card which is marginally punched and sortable; the fourth possibility would be, as Dr. Clarke said, a "million dollar Maniac" or computer.

Now let's look at the "results" as I see them from the "where" and the "how" that I have mentioned. The "where" on a centralized basis would have the information flowing into one place where one person would process it and put it into a format that would be acceptable to the user. On a decentralized basis, the information would be going into many places and the uniformity of reporting and usage would be lost. You would achieve a much better result if the data were processed in one spot, with the information all coming into one area and emanating from one location to the users.

As to the "how," the filing of this information in a standard ring type binder is all right except for two things: 1) When changes occur, the sheets have to be removed from the binders and updated constantly and 2) to find anything there has to be much thumbing through papers to extract the desired information. The second possibility is a plain 3" x 5" card filed in a given sequence where you have the flexibility of taking the card out and destroying it if it is obsolete or replacing it with a new data card. You would have a little bit more flexibility in searching this file for the required data or information that you were seeking. The third possibility is the edge punched card which I mentioned previously. This edge punched card is called a keysort, and it gives us the ability to select from a given file certain specifications or data without disturbing the file sequence. This method is in use in nearly all police departments.

Years ago I was instrumental in installing a "modus operandi" system for the Connecticut State Police. For instance, let's say the police are looking for a fellow who holds up liquor stores. He has a twitch in his left eye. He says, "Stick-em-up," and puts the money in a paper bag and limps on his way out and always smashes a window or something before he goes. This is his method of operation and these are the characteristics that the policemen are looking for. Basically, you've got the same thing here. This "modus operandi" application is used where you have many factors relating to one particular piece of data that you are looking for. Through this keysort card we would be able to locate it exactly.

The fourth possibility of processing or handling this type of format would be on a computer. The cheapest computer on the market that would handle this type of thing would cost about $1365 a month. I am certain that the average architectural firm is not going to install this machine to process this information alone, so therefore, if the computer is to be considered, it would have to be considered on a centralized basis where inquiries would be made to the centralized area for specific information. There are two drawbacks basically to this. First, a computer, a very expensive piece of hardware, is built to compute. The job we envision is not computing, but extracting information when we require it. You would be spending money for a computer and not utilizing it for its true purpose, if it were used this way. Second, in having a computer on a centralized basis there would be a time lag between the time the information was requested and the time it was actually sent back to the user. This time lag may or may not be important, but there would be a lag.

So, to summarize, if you were to file the data sheets in a binder, the data would be hard to find and would require much clerical time to keep up. In case number two, using plain cards, you have an advantage over the number one system, but you wouldn't have the flexibility of being able to get out multiple factors at one time. Number three, the marginally punched card, I believe would be the answer. We could file the data in random sequence and extract them readily from the file at the time the information was required. This is a very simple thing that any clerk can learn to utilize in a very short time. As to the computer, that is obviously expensive and would require specialized personnel and a centralized installation. I don't believe that such work is the true function of a computer.

Regardless of what system would be used this format, as your committee has presented it, appears to me to be very workable as far as the paperwork function is concerned. More and more people are getting into this uniform type of reporting. What comes to mind very rapidly are the hospitals throughout the country that are banding together into state associations and reporting on a uniform basis so that they can measure their operational results much better. But, regardless of what system is used, the results obtained from it would be no better than the data originally recorded and processed in the user's office.

Mr. Reardon: Here's a question I will read and try to answer: The citing of specific physical data is often meaningless and results in confusion unless very definite specifications of each installation are supplied. This tendency leads to descriptive literature which can easily be misleading. Is an effort being made to provide such specification? In reply, we do not intend to have this format supplant any brochures with detailed information which the supplier wishes to furnish. Basically, we are after thumbnail sketch data which the architect, engineer or user can use quickly and easily when he needs it.

Mr. Clarke: By using a system such as this, you might be able to single out from hundreds the five products you would like to investigate further. That would, of course, be simpler than getting out 100 brochures and thumbing through them.

Mr. Reardon: We intend to take this format to some national organization to see if they won't start it on its way. We don't want it to languish here.

Mr. Dorrance: In talking to manufacturers, particularly, we seem to create the feeling that we are trying to tell them what to do with their products. Maybe they received the impression that we were trying to standardize vinyl tile. They make the product and they know its characteristics, and if they make the best one, we are not trying to change it. We simply want information on what they actually know about their product in a form we can understand.

Mr. Ferrara: If we can frighten the manufacturers out of using big, long names it would be a great thing.

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Operating on the principle that the personal exchange of experience and ideas is the basis of the growth of a science, BRI conducts:

1) Research correlation conferences on specific design problems and the cross-industry application of building products (Open to the public)

2) Workshop, round-table and study groups on specific subjects (Open to BRI members with invited guests)

Research correlation conferences take the form of multi-subject meetings and are held twice a year, spring and fall. Programs on various subjects of interest to the building industry and its related professions of architecture and engineering are presented in half-day, full-day, two-day or three-day sessions, depending on the field to be covered and the amount of time necessary.

## PUBLICATIONS

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