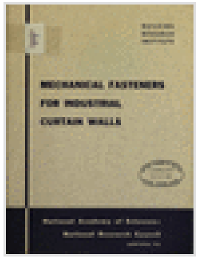

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MECHANICAL FASTENERS FOR INDUSTRIAL CURTAIN WALLS

Report of a workshop-conference held as
part of the 1960 Fall Conferences of the
N.R.C. Building Research Institute
Division of Engineering and Industrial Research

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Milton C. Coon, Jr.
Executive Director

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Inquiries concerning this publication, the Workshop-Conference on Mechanical Fasteners for Industrial Curtain Walls, or other publications from the BRI 1960 Fall Conferences, including:

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Introduction

Presented by William R. Wyckoff, Marketing Manager,
Fabricated Products Div., The Townsend Company
Chairman, 1960-61 BRI Planning Committee on Mechanical Fasteners in Building

The deliberations of this workshop were undertaken by a group of fastener manufacturers, architects, building component producers, engineers and erectors. The areas for exploration were established on the basis of a give-and-take type of discussion, and the conclusions are presented here.

Although the general subject of curtain wall construction has received considerable exploration, the area involving fastening and anchoring methods for industrial walls has been given relatively little attention.

Since a wall also depends on the integrity of the fasteners holding it together, or to the framework, it is a subject worthy of study. Also, it is the intention of those in the fastener industry specializing in fasteners for building construction to meet the present needs, as well as to continue research for fastening methods that will progress with and assist the growing use of curtain walls for industrial buildings.

To best be of service to the industrial curtain wall industry, the fastener industry must be continually aware of design needs, installed costs, and future needs in this field. Therefore, the purpose of this workshop-conference on industrial curtain walls was to explore the subject of fastening and anchoring devices, and to reach conclusions as to action needed to classify, improve, or recommend use of classes of fasteners with specific designs. The scope of the conference was restricted to fastening systems or anchoring devices used with nonload-bearing, insulated walls used to cover industrial buildings.

Definitions, Nomenclature and Classification

Presented by William R. Wyckoff

Definitions

The workshop's first topic concerned establishment of definitions for various categories of fasteners, and their nomenclature.

A. Components of wall and supporting structure:

1) Girt—a horizontal beam that is fastened to columns to support the side walls.
2) Purlin—a beam that rests on the top chord of a roof truss and supports the roof-covering sheets.
3) Inner skin—a flat or corrugated metal or nonmetallic sheet placed against the girts for protection of insulation.
4) Outer skin—sheet of material used on the exterior to protect the insulation and complete the wall.
5) Insulation—a blanket or rigid type material having a relatively high resistance to heat flow.
6) Sandwich panel—two sheets or pieces of material with an insulation between them.
7) Bay—the distance between two trusses or columns.
8) Flashing—a material compatible with or similar to that used for wall or roof covering, used to provide weathertightness at the joints of the wall and roof in such areas as the ridge, cave, corners, gable, etc.
9) Side lap—an expression used in conjunction with formed metal, plastic and asbestos materials denoting overlap of the sides of the material.
10) End lap—same as above, except ends of material overlap.
11) Sub-girt—horizontal stiffening and spacing member used between the inner skin and outer skin, typically a 1" or 2" flat bar or 2 bars.
12) Sandwich—more than one thickness of material (or different materials) fastened or anchored together.

B. Fastener Nomenclature

1) Point—the end of the fastener which penetrates the material first.
2) Shank—the portion of the fastener from the pointed end to the head; the shank may be plain, knurled, or threaded.
3) Head—portion of fastener preformed on one end, usually larger than shank and providing a bearing area.

4) Side lap fastener—the fastener normally used for fastening the overlapping edges of two sheets of metal siding or roofing.
5) Panel fastener—the fastening device used to anchor or attach the curtain wall or sandwich to the structural framework.

C. Classification of Fasteners as to Types

1) Powder-driven fasteners—fasteners with armor-piercing point opposite internal threads, external threads, or rivet heads, used in powder-actuated tools or impact devices.
2) End-welded studs—fasteners used to fasten wall and roof material to structural members by means of welding with an electric power tool or apparatus.
3) Self-tapping curtain wall studs—screw type studs by which curtain wall components are assembled and fastened to the building framework, having threads which form mating threads in the structural member.
4) Bolts and clips—bolts threaded through clips which fit over the girt or purlin and lock in position in relation to such clips.
5) Self-tapping screws—threaded screws which form their own mating threads in the material into which they are driven, typically designated as Type A (thin materials) or Type B (thicker materials). Such fasteners may or may not include material or washer designed to seal the joint.
6) Blind fasteners—any fasteners which are installed from one side of the work.

Recommendations

It was concluded by the workshop-conference group that the following actions should be instituted by the BRI Planning Committee on Mechanical Fasteners in Building:

1) A glossary of common curtain wall terms and their definitions should be developed and published.
2) A glossary of common curtain wall fastener nomenclature should be developed.
3) A library or bibliography of current curtain wall manufacturers' literature should be developed and maintained.

Design Criteria for Field Assembled Curtain Walls

Presented by Paul V. Mara, Chief Product Engineer, Technical Services,
Kaiser Aluminum & Chemical Sales, Inc.

This category of curtain walls was considered to include those walls which are field assembled using large, longitudinally formed sheets, lapped at the joints and requiring exposed fasteners for the exterior sheet. In addition, it includes the narrower, longitudinally formed panels which usually have interlocking joints and nonexposed fasteners.

The following design requirements for industrial curtain walls were considered and discussed in relation to the mechanical fasteners used to assemble them:

A. Structural Requirements.

1) Inward loading—The wall should resist and transmit to the building frame the inward wind forces prescribed for the locality of the building. In regard to this requirement, it was felt that where subgirts are used, the fasteners are not stressed significantly unless the wall deflects excessively since the loads are transmitted through the subgirts. Where shoulderless fasteners are used without subgirts, the compressive strength of the insulation should be considered with respect to the design loading, since the inward loading will be transmitted through the insulation. Where shoulder-type studs are used, the compressive strength of the insulation should also be considered, since part of the inside loading may be transferred through the insulation.

2) Outward loading—The fasteners should resist and transmit to the building frame the outward wind forces on the wall as prescribed for the locality of the building. These forces may be composed of a negative component on the exterior sheet and a positive pressure component on the interior sheet. Hence, the fastener must be designed to eliminate the possibility of pull-out or tensile failure, and must provide sufficient head-bearing area to preclude sheet failure at the fastener.

3) Downward loading—The fastening system should retain the curtain wall components in their intended positions and transmit the dead load of these components to the building frame. In general, it was felt that, since the components are relatively light in weight, the fasteners are not critically stressed by this loading for the commonly used curtain walls. However, if long shank fasteners are required, or if heavy exterior skins are used, bending of the fastener should be considered.

4) Vibration—The fasteners should resist the effects of vibrations caused by wind loads or other dynamic forces on the building structure, such as those resulting from traveling cranes, without loosening or fatigue failure of the fastener, fatigue failure of the sheets, sheet rattle, or water leakage. There was a consensus that the sidelap fasteners are most susceptible to loosening. The ASA Type A coarse-thread, sheet metal screw provides greater resistance to loosening than do fine threads, when securing two thin sheets of metal. The addition of a sealing gasket also reduces the tendency of this fastener to loosen. It was also pointed out that there is increasing evidence, where considerable structural vibration is encountered, the 400 series stainless panel fasteners are more likely to fail than carbon or 300 series stainless fasteners.

5) Seismic loading—Where earthquake loading is a consideration, the fasteners should retain the curtail wall without failure under the displacement expected for the wall structure. It was not considered that the curtain wall should or would resist the seismic loading, but rather, the anticipated displacement of the structure should be determined and the fastening system designed so as to permit this movement to take place.

6) Expansion and contraction—Wall component temperatures will vary above and below the temperature at erection, and also above and below the temperature of the structure to which they are attached. Hence, differential expansion and contraction of the components must be provided for by the fastening system. It was the consensus that, as a result of field observations, expansion and contraction of metal skins have not caused serious field problems with the fastening systems used at present. However, it was concluded that studies of wall panels with varying fastening methods should be conducted to establish additional information on this matter. It is hoped that anyone who has any available test data on this subject will make it available to the Committee.

B. Watertightness.

While retaining the wall components under load, and permitting them to expand and contract, the fasteners should not contribute to water leakage which will cause the wall to become ineffective in its function as defined for specific job conditions.

C. Thermal Insulation.

Fasteners should have a minimum tendency to reduce the over-all thermal resistance of the wall construction by means of through-wall conduction. It was recognized that through-wall fasteners have some effect on the over-all thermal resistance of the wall. The published U values generally take this into consideration. Under certain conditions, frosting occurs on protruding fastener points. This frosting has been noted where fasteners penetrated the interior skin, but not the structural girts, from the cold side. Where thermal conductivity is a problem, thermal breaks can be built into the fastening system at some increase in cost.

D. Demountability.

In some instances it is required that the wall be removable for plant expansion or other purposes, with maximum salvagability of the wall components. It was felt that all of the fastening systems presently used permit demountability. Those walls which are erected with exposed, through-wall fasteners can best be replaced with self-tapping screws, although stud-type fasteners have been successfully used.

E. Pressure Release.

In some instances it would be desirable to have pressure release fasteners for curtain walls to permit the pressures induced by interior explosions to be relieved through blow-off of the wall, without causing extensive damage to the building structure. On this point, it was noted that fasteners are presently available which can be modified to permit release of the wall panels, provided the release load for the fasteners is specified.

Goals for Fastener Specifications and Standards

Presented by Jack Godley, Marketing Manager
Gregory Industries, Inc.

It was determined by the workshop that manufacturing standards for the several classes of fasteners are quite well defined by the manufacturers; i. e. , dimensional tolerances, chemical analysis, quality control, etc. , are well spelled out to protect the buyer. Hence it was determined that the major need was a set of performance standards for each class of fasteners that would aid the architect and the erector, and also protect the building owner.

With this objective established, each class of fasteners was examined individually and the workshop unanimously agreed that the following goals should be established as starting points for the development of performance standards for industrial curtain wall fastening devices:

A. Self-tapping Studs and Screws.

1) The screws should meet ASA Standard B18.6.4-1958. This standard is explicit in detailing dimensional tolerances and performance. Since the reliability of the device depends greatly upon its ability to form its own thread in the structural member, it was felt important that the conditions of this standard be met.

2) Screws must withstand a 15^{o} minimum bend without fracture. Because of the stresses imposed on the fastener by racking, expansion and contraction, this is a desirable requirement.

3) Minimum and maximum torque requirements should be established, since either underdriving or overdriving of the screw could materially influence its effectiveness.

4) Minimum allowable thread engagement should be defined, since the long-term dependability of the fastener depends upon achievement of maximum thread engagement. These data are necessary for adequate inspection.

5) The fastener should not contribute to water leakage. The manufacturer should assure the owner or designer that, when properly applied, the fastener will be weathertight. A performance standard should be established on this point.

6) A minimum specification for the life of the sealant washer (when required) should be established, since there is little value in a sealant washer that will not last as long as either the fastener or the wall.

7) The recommended drill size for the thickness of the building girt should be published to facilitate job-site inspection. Drill diameter is much easier to check than hole diameter.

8) Minimum head-bearing area of the fastener should develop the required outward design load of the panel. This point has reference to the head diameter.

9) A minimum standard for finish should be established, since it is necessary to have a finish on the fastener that is compatible with that of the wall material and will last at least as long as the finish of the wall material.

10) The fastener material should be compatible with the wall and structural material to prevent the adverse reaction common to the use of dissimilar materials.

B. End-welded Studs.

1) A minimum bend requirement of 15° should be established. The fastener should be capable of a 15° bend in both directions to satisfy the demands put upon it by expansion and contraction, and possible building racking.

2) A minimum standard for shoulder-bearing area to support the outside skin should be established. This area should be defined in terms of inward loading.

3) The fastener material should be compatible with the wall material in order to prevent the adverse reaction common to the use of dissimilar materials.

4) The erector should be required to clean the stud at the point of weld, either by center punch mark, powered end mill, or some other readily accessible means. As in any welding process, this fastener needs bright steel from which to draw its arc, if adequate and consistent welds are to be assured. The workshop felt it wise to spell this out for the protection of the owner and the designer.

5) The weld should develop the full strength of the stud, both in tensile and in shear, to accommodate outward loading and dead load requirements.

6) The fastener cap and joint should not contribute to water leakage. In those cases where water leakage could be a problem, an adequate sealant washer should be used in conjunction with the aluminum sealing cap.

7) The minimum life of the sealing washer should be defined. Some assurance that the life of the neoprene washer will equal the life of the fastener and the wall material should be given the architect and the building owner.

8) Minimum standards for finish should be established. The new color finishes that are common to many of the wall materials should be matched in longevity and durability on the fastener cap, in those instances where this is not impractical.

9) Dimensional standards should be established. The dimensional tolerances of the extension over which the aluminum cap must fit are critical, and hence should be subject to definitive requirements.

10) The minimum cap-bearing area of the fastener should develop the required outward design load of the panel. The flange diameter should be controlled by the type and gauge of the wall material. The objective here is to prevent untimely sheet pull-over, as in the case of a light gauge sheet and extraordinarily small flange diameter.

In addition to the two fasteners which the workshop had time to study here, there are, of course, a wealth of other fastening devices. The workshop group regrets that it was not able to discuss them and draw up standards for each classification or type. The group does, however, wish to go on record as feeling that it is imperative that this study be continued to include all classes of fastening devices, and that the data should ultimately be made available to architects and contractors.

Appearance and Durability Requirements

Presented by William R. Wyckoff

Workshop conclusions in this area were:

1) Fasteners should be selected with appearance as an important consideration.

2) The fastener should not detract from the architectural effect desired of the wall.

3) Exposed fasteners should maintain their finish, weathering at the same rate as the curtain wall, outer skin or panel.

4) In designing and specifying fasteners, it should be remembered that panels or fasteners can fail from an appearance standpoint, as well as structurally, if adequate precautions are not taken.

5) Since the durability of a fastening system is critical for any installation, the fastener should be selected to develop or transmit the design load from the panels to the structural frame without failure.

6) To be adequately durable, the fastener should have the same life as the other components of the system.

7) The fastener chosen should not be subject to stress, corrosion or fatigue stresses which could lead to failure, even though panels are designed for demountability and relocation. In other words, the quality of the fastening, in terms of its design requirements, should not be sacrificed in favor of demountability.

Installation Practices and Fastening Techniques

Presented by William R. Wyckoff

Once we had considered the design requirements, we discussed how fastening techniques might affect the function of the fastener or its design. The consensus was that the fastening system manufacturer's recommendations for correct installation should be followed. To assure the quality of structure desired by owner and architect, the group urged that specification writers and designers describe proper installation procedures in greater detail than is currently the practice. Also, the designers should use extreme care to describe properly the exact fastening system or alternate system desired. It is hoped that the proposed performance standards discussed in this report will eventually be of assistance to the specification writer in describing performance desired.

Requirements for fastening of preassembled panels are much the same as those for field assembled panels. The major exception to this is the anchoring of preassembled panels to the structure by welding. This method of fastening can only be used when interior skins of steel are joined to steel framing members. For preassembled panels, it is essential that all shop-applied fasteners be designed for the most rapid assembly techniques practical. As previously stated, the structural requirements, watertightness, thermal insulation, demountability, etc., are basically the same for preassembled panels as they are for panels assembled in the field.

Open Forum Discussion

Workshop Reporters - Messrs. Godley, Mara and Wyckoff

E. George Stern, Virginia Polytechnic Institute: What suggested the 15° minimum bend resistance of the fastener? This bending angle appears to be small in light of field conditions commonly encountered.

Mr. Godley: The 15° bend, insofar as welded studs are concerned, has been a test applied against welded studs by the Navy for as long as I can remember. If you recall, the standard would be 15° in both directions, or in either direction, or a total 30° bend. For all practical purposes, this should be adequate for a welded fastener. In the case of the self-tapping stud and self-tapping screw, we also feel that this is adequate, particularly in light of the stresses and forces that are applied against the fastener in the case of either a curtain wall, a field assembled insulated wall, a panel wall, or a single skin. Our experience would indicate that forces exerted in the wall section would not require anywhere near this kind of bending. I might add that experienced people in the workshop—technicians from the fastener industry, contractors, designers, and architects—were all in accord on this point.

Mr. Wyckoff: The way this became a standard practice, which it has been for several years, is that the load requirements had to be considered in conjunction with the ability of the manufacturers of fasteners to provide this much bend. Certain materials will take a much greater bend than others, and we need a minimum that will meet the requirements of the average load conditions.

Henry J. Stetina, American Institute of Steel Construction, Inc.: Why was this study of fasteners for curtain walls restricted to industrial buildings?

Mr. Mara: When our BRI Committee first discussed the possibility of holding workshop-conferences on fastenings and anchors for curtain walls, we thought we might hold two simultaneous workshops, one on the architectural type of curtain wall and one on industrial walls. However, we eventually concluded that there wasn't sufficient interest in architectural curtain wall anchors at this time. As a result, we decided to concentrate on industrial walls alone.

Mr. Stetina: A large part of your conclusions would apply equally well, would they not, to curtain walls used on commercial buildings? Isn't there some overlap?

Mr. Mara: Yes, there is some overlap, particularly since many of the so-called industrial type of curtain walls are used on commercial buildings. However, in the architectural field, we were considering developing information on such basic anchors as clip angles and other types of fasteners that permit expansion and contraction to take place in the architectural type panels. We felt that there was sufficient difference so that two conferences would be needed, and on the basis of this workshop and its conclusions, I am sure that it was a proper assumption.

J. Pettit, Albert Kahn Associates: It disturbs me a bit to hear you say that we could take these recommendations on the industrial curtain wall and transfer them to use on commercial buildings.

Mr. Wyckoff: I think they could be except for one serious point; the industrial curtain walls we have discussed are generally very flexible walls, of light weight and of rather thin materials. The architectural curtain wall is quite often dependent upon a grid system. Similar fastenings are used, but it becomes a very critical problem, because you cannot tie down a grid system in the same manner that you tie down a flexible wall. This is the big difference between the two.

Mr. Mara: I might mention that about two years ago, BRI had a workshop-conference, as you may recall, on architectural metal curtain walls. As part of that conference there were several workshops doing the same thing we have done. One of them was devoted to erection techniques, another to design. In the design workshop we covered the problem of fastening devices quite extensively and the conclusions of that workshop have been published by BRI.

Mr. Wyckoff: I might add here that this committee is willing to undertake any work in which there is sufficient interest expressed, but that is basically the reason why architectural walls as such, or commercial walls, were not included in this workshop.

A. Gordon, American Radiator & Standard Sanitary Corp.: Is it the recommendation of the committee that preassembled panels be attached only to steel structural members?

Mr. Wyckoff: No, in many instances preassembled panels are attached to wood, concrete, and various other materials; however, the fasteners should be designed differently than those you use with steel. We are not saying that panels should be attached to steel only.

Mr. Gordon: New York City requires 8" of brick behind spandrels, and Philadelphia formerly did. Are there many such cities in the U. S.? If so, what is being done to correct this?

Ted Hunt, Portland Cement Assn.: Some cities require a certain amount of backup, and in other places that has been changed. I understand Philadelphia changed a couple of years ago. I think that is outside of the subject for discussion here, which is fastening devices. It's mainly to prevent fire from traveling from one building to another. In cases where there is no exposure, it is often possible to get permission from the building officials to change that regulation.

S. J. Helene, Veterans Administration: Is this conference confining itself to metal curtain walls only? Fastenings and support for masonry curtain walls, such as precast concrete insulated walls, are a source of confusion, also.

Mr. Hunt: It was confined mostly to industrial metal curtain walls, because that was the way the conference was set up. If we went into the field of concrete or masonry curtain walls, we would have a very wide range to work in, and I don't think we could cover all this in the available time. In the field of precast concrete curtain walls there are a number of different systems. Generally, the best thing to do is to contact a nearby supplier of concrete curtain walls as you are designing, and he can give you some advice. He won't always have just the solution you require, but you can work out a specific solution to your problem jointly. In concrete curtain walls we are not tied down as closely by tolerances in fastening devices as we are in certain metal panels. Generally, the fastening is done by welding or bolting the panel to the building frame. Inserts can be cast in the panel at required load points, and are later bolted to the walls either in a steel frame or in a concrete frame. Then finally, in most cases, the connections are welded. I would consult with an engineer on the situation before you tie it down, to make sure you have sufficient strength. In the concrete panels, probably the biggest problem is the support of the weight, whereas in the metal panels, that is a rather minor consideration.

Mr. Helene: Is there sufficient experience at the present time to indicate what type of fastener is satisfactory?

Mr. Hunt: There is a fair amount of experience in the field, and more and more is being done in that particular line. A large number of panel buildings have been erected lately, and we have had no trouble with the panels falling off. We have some that have been up since the late 1930's and that's about long enough to prove most of them out. Generally, the fastening device gets its greatest stress when the workmen pick the panel up to erect it. If it will hold then, we don't have to worry. They have to pick up panels 31' x 21' in size and 6 or 8" thick. If anything is going to happen to the panel, that's when it happens. It's an almost automatic system of grading out those which are defective.

Mr. Wyckoff: I would like to add a comment or two in clarification. One is that it was not the intent of this workshop to exclude any type of material which fits the scope of industrial curtain walls. As Mr. Hunt said, the discussion centered on the area we have included here only because of time limitation and the seeming center of interest. Also, so far as fastenings and support for this type of wall are concerned, it is hoped that our project of developing a library of data on fasteners to concrete and masonry will help you in the future.

A. Gordon, American Radiator & Standard Sanitary: What is being done to foster the use of curtain walls in residential construction?

Mr. Wyckoff: Several companies, building wall producers, are investigating this area, and the Natl. Assn. of Home Builders is also working on it. Beyond that, at this time, I am not really able to comment.

Warren Hamilton, Modular Corp.: What tests or experience have you had with exterior panels using spring-type molding clips (closure-fasteners)?

Mr. Wyckoff: This is a most interesting question. No one seems to be able to answer, but I am certain we will hear more about it in the future.

A. H. Mack, Rosco Metal & Roofing Products: This question is in reference to the single skin structure. My worry over the last year has been the development of deeper profiles. The question of the importance of designing for the bending stresses of fasteners was brought up earlier. What is the thinking regarding the fastening of a deep profile sheet through the corrugation?

Mr. Wyckoff: There are fastening devices available which, if properly used in accordance with the correct performance standards, would be safe for use in the valley on the roof. On the other hand, to be the safest, to have the least possibility of leakage or of other types of failure on the roof (possibly not due to the fastening but to the workmanship or installation) the best thing to do is fasten in the crown or crest of the corrugation. I don't think that it would be our prerogative to recommend one versus the other, only to discuss the merits of each.

Mr. Pettit: Is the problem the distortion you get in the high rib, or the failure of the fastener?

Mr. Mack: The failure of the fastener.

Mr. Pettit: And when you say high rib, what depth are you talking about?

Mr. Mack: I am thinking of the deeper profile, about 1-3/4".

Mr. Mara: We are old hands at putting fasteners in the crest or crown. I can see no particular problem because, at 1-3/4", this is a rather short fastener. In our experience with curtain walls, using self-tapping screws and self-tapping screw studs, where the shoulder height is as much as 2-1/8" or 2-1/4" we have had no evidence of trouble, and these fasteners have been in use for as long as five years.

Mr. Wyckoff: This would be true either with single skin or curtain wall. In other words, there are certain materials which would perform better in that application, particularly with heavy or denser sheets.

Ed Pairo, Chatelain, Gauger & Nolan, Architects: Do you have any experience with snap-in, clip-type fasteners for attaching panels as versus the screw-type fastener?

Mr. Mara: The only application I can think of offhand is one in which we are using a snap-in glazing bead to hold the glass.

Mr. Helene: Could I get a list of buildings involving the concrete curtain walls and fastening devices previously discussed?

Mr. Hunt: I will be glad to mail you a list of those that have been in existence for a good many years. It would take me a little time to compile an up-to-date list, but I can do so if you wish.

Mr. Mack: When are the standards for the drill size going to be developed? I recall there were about three different drill size recommendations.

Mr. Godley: We attempted during our workshop sessions to determine how long it would take us to get these standards established. No one was willing to set a timetable for it, but I can assure you that at the next meeting of our committee this will certainly be achieved. It would be my outside guess that we will have made a good start on this within a 6-months period.

Mr. Wyckoff: I agree that it would be confusing to receive different drill recommendations from different manufacturers. All I can say is, you might compare the drill sizes and the background information provided with the recommended drill sizes in terms of materials and drilling conditions. You might consider, for example, the amount of information supporting the drill size recommended and, furthermore, by contacting each manufacturer, you can probably reach a judgment as to which actually fills your need the best.

R. Wesson, Wisconsin Bridge & Iron Co.: We have encountered a problem on long areas or large areas of single skin roofing where the fastener was fastened either in the crown or valley.

Mr. Mara: Did this occur as a result of expansion and contraction of the sheets as they lay along the transverse dimension of the building or of the roof?

Mr. Wesson: We think, on the aluminum, it was a combination of vibration, contraction and expansion.

Mr. Mara: How long were the sheets?

Mr. Wesson: On the aluminum job they were roughly 22'; the buildings were 120' long.

Mr. Mara: One of the conclusions that was reached in the workshop was that, where there is considerable vibration in the structural framework, experience is building up to indicate that the blind type of fasteners are not satisfactory.

Mr. Wyckoff: It's difficult, of course, to analyze your problem sitting here. Probably the best way to analyze it would be to know all the conditions, and see the job and study its history. For example, in some cases people have apparently thought they were using 305 when they were not. Another situation I have heard of is where an 18-8 stainless steel was hardened. As you all know, this is an unusual condition and will contribute to a failure.

Another point I would like to bring up is that on a long expanse your expansion-contraction problems are much greater insofar as movement is concerned. Therefore it might be that with this type of condition you would want to go to crown fastening. However, we can only analyze this type of problem in generalities, and make suggestions as to what might be the cause.

Malcolm McKenzie, Johns-Manville Corp.: I would like to know if the workshop discussed field assembly methods that would conceal the fasteners from view?

Mr. Godley: We covered this subject in great detail, because it is obvious that there is a demand for hidden fastening devices. Different fastener manufacturers have different devices that will help this situation, for instance, the common problem of color. A fastening device that had a matching color to that of the walls, it was pointed out in the workshop, would aid at least in camouflaging the fastener and make it virtually invisible a few feet away from the building. We also determined that this question of hidden fasteners was one that largely revolved about the question of economics. I think it was Mr. Pettit who indicated he had had a lot of experience with hidden fasteners, and that his clients are willing to pay more for hidden fastening devices. No one in the meeting came up with any fantastic new devices. However, I know that there is an effort being made by a number of fastener manufacturers to accomplish the thing that you are talking about.

Mr. E. A. Wettengel, Inland Steel Products: We have had quite a bit of experience with hidden fasteners and it seems that, because of the various designs of walls, a hidden fastener has to be accurately specified for that particular wall. Every now and then we get jobs where somebody requires a different type of fastener. That, of course, brings up the point of cost. It would be fine if the fastener people would look into these various things.

Mr. Wyckoff: I might mention, too, that there were several comments concerning fairly standard methods of hiding fastening devices in the so-called prefab panel wall, which nonetheless is still field assembled to a degree. Here, the fastening devices are placed at the laps or joints of the panel and, in such a manner, hidden from view. This includes clips and through-bolting. This was mentioned as a fairly common practice during the workshop.

W. L. Hamilton, Modular Components Corp.: Has there been any experience with bonding a contact strip over the fastener joint?

Mr. Godley: Instead of a contact strip, several years ago we used an aluminum extrusion, because of the type of our fastener. This extrusion was attached to the fasteners. From my own point of view, the building looked uglier with the strip on it than it did with the exposed fastener. I hope you will excuse me, but I think our fasteners are beautiful.

Mr. Wyckoff: It was agreed during our workshop that the majority of building designers and owners across the country are very aware of, and are demanding, better appearance from the fastener, as well as from the entire wall. The fastener industry is working on ways to hide fasteners from view, or to make them invisible to the average eye. It also develops that cost is an interesting variable. Some people are willing to pay more for good appearance than others. Therefore, the industry is developing a wide range of answers, some of which will obviously cost much more, but will be worth it in the particular instance.

Unidentified questioner: Did the scope of the workshop include plastic fasteners?

Mr. Godley: One phase of our discussion included some comment on this which had to do with placement of a thermal block in the fastener to prevent through-conductivity. In this case, it was suggested that a fastener is available with a plastic thermal block in the fastening device. This was the only reference to plastic fasteners. There are several plastic fasteners being introduced on the market but, to the best of my knowledge, these are being used as inserts in concrete masonry construction. They are rather ingenious things, and apparently quite low in cost.

Mr. Wyckoff: In conclusion, I would like to say that I think the committee has taken on quite a job at the suggestion of this workshop-conference to develop performance criteria, nomenclature and glossaries. We will welcome all possible information, suggestions and comments from the industry. I would also like to thank the participants in the workshop-conference. This group was very cooperative. Our thanks are especially extended to William Tyler of ALCOA, Jack Godley of Gregory Industries, and Paul Mara of Kaiser Aluminum who did a fine job of coordinating the information developed at the workshop into the well organized technical report which precedes this discussion.

Appendix

ORIGINAL WORKSHOP AGENDA

BUILDING RESEARCH INSTITUTE
Workshop-Conference on
FASTENERS FOR INDUSTRIAL CURTAIN WALLS

The BRI Planning Committee on Mechanical Fasteners in Building organized this program as a workshop to attempt to establish criteria for the fastening of industrial curtain walls with the wide variety of fastening devices currently available to the building industry.

The scope of the conference is intended to cover any fastening or anchoring device used with industrial curtain walls consisting of more than one thickness or type of material applied on nonresidential or noncommercial buildings.

I. WORKSHOP (open to invited participants only)

1.0 Establishment of Definitions of Various Categories of Fasteners and Nomenclature.

2.0 Development of Consensus on Design Criteria: Expansion and Contraction Problems, Strength Requirements, Sealing Requirements, Thermal Conductance Considerations, Explosion Panels, and other Special Requirements.

3.0 Development of Consensus on Satisfactory Installation Practices for Various Categories of Fasteners.

4.0 Discussion of Fastening Techniques for Preassembled Panels.

5.0 Development of Goals for Fastener Specifications and Standards.

6.0 Discussion of Appearance and Durability Requirements for Fasteners.

II. FORMULATION OF WORKSHOP CONCLUSIONS

III. CONFERENCE FOR PRESENTATION AND DISCUSSION OF WORKSHOP CONCLUSIONS (open to all registrants at BRI 1960 Fall Conferences)

Previously Publisbed BRI Conference Proceedings

ADHESIVES AND SEALANTS

ADHESIVES IN BUILDING, 1960, 106 pp, illustrated, NAS-NRC Pub. No. 830, $5.00.
SEALANTS FOR CURTAIN WALLS, 1959, 82 pp, illustrated, NAS-NRC Pub. No. 715, $3.00.

AIR CLEANING AND PURIFICATION

CLEANING AND PURIFICATION OF AIR IN BUILDINGS, 1960, 62 pp, illustrated, NAS-NRC Pub. No. 797, $4.00.

BUILDING RESEARCH, GENERAL

A LOOK TO THE FUTURE AND BUILDING RESEARCH PLANS FOR THE 60's, 1959, 58 pp, mimeo., $2.00.
BUILDING RESEARCH; INTERNATIONAL, 1960, 41 pp, illustrated, $1.50.
COLLEGE AND UNIVERSITY RESEARCH REPORTS, 1961, 18 pp, mimeo., $1.50.
DOCUMENTATION OF BUILDING SCIENCE LITERATURE, 1960, 46 pp, illustrated, NAS-NRC Pub. No. 791, $2.00.
PROPOSALS FOR NEW BUILDING RESEARCH, 1960, 76 pp, illustrated, NAS-NRC Pub. No. 831, $4.00.

COMPONENT CONSTRUCTION

DEVELOPMENT PROBLEMS WITH COMPONENT CONSTRUCTION, 1961, 22 pp, mimeo., $2.00.
PREASSEMBLED BUILDING COMPONENTS, 1961, 180 pp, illustrated, NAS-NRC Pub. No. 911, $8.00.

FASTENERS

MECHANICAL FASTENERS IN BUILDING, 1959, 26 pp, illustrated, reprint, 25¢.

FLOOR-CEILINGS, SERVICE SYSTEMS

FLOOR-CEILINGS AND SERVICE SYSTEMS IN MULTI-STORY BUILDINGS, 1956, 141 pp, illustrated, NAS-NRC Pub. No. 441, $4.00.

FLOORING

INSTALLATION AND MAINTENANCE OF RESILIENT SMOOTH-SURFACE FLOORING, 1959, 145 pp, illustrated, NAS-NRC Pub. No. 597, $5.00.

HEATING

NEW METHODS OF HEATING BUILDINGS, 1960, 138 pp, illustrated, NAS-NRC Pub. No. 760, $5.00.

ILLUMINATION

BUILDING ILLUMINATION: The Effect of New Lighting Levels, 1959, 160 pp, illustrated, NAS-NRC Pub. No. 744, $5.00.

MASONRY

MODERN MASONRY: Natural Stone and Clay Products, 1956, 164 pp, illustrated, NAS-NRC Pub No. 466, $4.50.
INSULATED MASONRY CAVITY WALLS, 1960, 82 pp, illustrated, NAS-NRC Pub. No. 793, $4.00.

METAL CURTAIN WALLS

ARCHITECTURAL METAL CURTAIN WALL WORKSHOP, 1956, 77 pp, illustrated, $1.00.
DESIGN POTENTIAL OF METAL CURTAIN WALLS, 1960, 84 pp, illustrated, NAS-NRC Pub. No. 788, $5.00.
METAL CURTAIN WALLS, 1955, 190 pp, illustrated, NAS-NRC Pub. No. 378, $4.00.

MODULAR COORDINATION

CURRENT STATUS OF MODULAR COORDINATION, 1960, 30 pp, illustrated, NAS-NRC Pub. No. 782, $2.50.

NOISE CONTROL

NOISE CONTROL IN BUILDINGS, 1959, 150 pp, illustrated, NAS-NRC Pub. No. 706, $5.00.

OPERATION AND MAINTENANCE

PERFORMANCE OF BUILDINGS, 1961, 94 pp, illustrated, NAS-NRC Pub. No. 879, $5.00.

PAINTS AND COATINGS

FIELD APPLIED PAINTS AND COATINGS, 1959, 150 pp, illustrated, NAS-NRC Pub. No. 653, $5.00.
PAINTS AND COATINGS: Field Surface Preparation, Field Application Methods, Water Thinned Materials, 1960, 72 pp, illustrated, NAS-NRC Pub. No. 796, $5.00.

PLASTICS

PLASTICS IN BUILDING, 1955, 150 pp, illustrated, NAS-NRC Pub. No. 377, $5.00.
PLASTICS IN BUILDING ILLUMINATION, 1958, 100 pp, illustrated, $3.00.
PLASTICS FOR ROOF CONSTRUCTION, 1957, 125 pp, illustrated, $3.00.
INFORMATION REQUIREMENTS FOR SELECTION OF PLASTICS FOR USE IN BUILDING, 1960, 40 pp, illustrated, NAS-NRC Pub. No. 833, $3.00.

ROOFING

A STUDY TO IMPROVE BITUMINOUS BUILT-UP ROOFS, 1960, 33 pp, BRI Mono. No. 1, $1.50.

SANDWICH PANELS

SANDWICH PANEL DESIGN CRITERIA, 1960, 228 pp, illustrated, NAS-NRC Pub. No. 798, $8.00.

SPECIFICATIONS

SPECIFICATIONS WORKSHOP, 1957, 28 pp, $2.00.

WINDOWS

WINDOWS AND GLASS IN THE EXTERIOR OF BUILDINGS, 1957, 176 pp, illustrated, NAS-NRC Pub. No. 487, $5.00.
WORKSHOP ON WINDOWS, 1959, 20 pp, reprint, 25¢.

BUILDING RESEARCH INSTITUTE

The Building Research Institute is a unit of the Division of Engineering and Industrial Research of the National Academy of Sciences—National Research Council. BRI was organized in 1952 to meet the need of the construction industry for an organization which could focus the attention of the entire industry on building research and technology. It also acts as an information center and maintains liaison with building research agencies in other countries throughout the world.

The members of BRI are people interested in advancement of the science of building. Among those listed as BRI members are: architects, engineers, contractors, home builders, building owners, manufacturers of building products and materials, distributors, technical and professional societies, trade associations, research laboratories, financial, real estate and insurance firms, trade and consumer publications, professional consultants and technical experts from colleges, universities and government agencies in this country and abroad. Memberships are open to companies, associations, societies and individuals.

MEETINGS

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) Committee, workshop and round-table activities in which members and guests participate by invitation.

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

The Building Research Institute publishes and distributes to members the proceedings of its conferences, technical meetings and study groups. Building Science News, the Institute newsletter, reports monthly on Institute activities, as well as on building research news of general interest, and incorporates a two-page monthly digest of new articles and reports on building research. Building Science Directory, founded in 1956, provides a comprehensive guide to sources of information on research and technical developments in the industry. Supplements to the Directory are issued quarterly with an annual index. All of these services are provided to BRI members without charge. Nonmembers may purchase copies of published proceedings of public conferences and regular issues of the Building Science Directory at nominal cost.