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The Steel Skeleton Tier Building

Bâtiments à étages multiples en construction métallique

Stahlskelettbau

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Introduction

It is the intent of this paper to review the principal features of both floors and walls, their relationship to the supporting skeleton, and discuss recent trends and developments. By its very nature, the subject does not lend itself to detailed mathematical analysis; therefore, this paper departs from the usual classical expositions found in contemporary technical journals.

Floor Systems

General Considerations

The apparent primary function of floors in the earlier buildings (50 years old or more) was to supply a base for the support of floor loads. Undoubtedly there were other considerations such as durability, economy, and fire resistance; but, judging from the evidence and with the knowledge that the materials and floor systems available to the early designers were limited, it may be surmised the designer's concern was chiefly that of strength.

Today there are several materials available in many forms. The problem becomes one of selecting the type of floor which appears most suitable for the several considerations that must be satisfied. Strength is, of course, an elementary consideration just as it always has been, but, it is only one factor of the several that need to be resolved.

Today there is a more careful consideration of economy. This factor is not limited to the cost of the floor itself, but includes the effect of floor depth, the effect of dead weight both on the framework and foundations, the effect on construction time, and the effect on the other trades such as mechanical and electrical.

Experience has indicated that the location of the underfloor ducts for electrical circuits and other installations should afford maximum flexibility because office arrangements are frequently changed.

The development of air conditioning has swept the country, except for the northernmost states. It is a *must* consideration for every new office building; in fact, old office buildings are being altered for air conditioning systems in order to avoid obsolescence. Somewhere the rather large supply ducts must be located — usually above the ceiling — thus compounding the problem of the floor design. One might say that it is no longer a floor, but rather a floor system. These requirements are favoring floor constructions with built-in hollow spaces through which electrical wires may run, thus eliminating separate ducts to a large extent.

One may wonder what the effect has been upon overall depth of floor systems and height of stories. A random search through technical journals for data on recent office buildings showed an average floor depth (underside of ceiling to top side of flooring) of 3 ft. 4 in., with the minimum 2 ft. 8 in. and the maximum 4 ft. 8 in. The average story height for 14 buildings located in 8 different cities in United States was 12 ft. 4 in., ranging from 11 ft. 2 in. minimum to 13 ft. 8 in. maximum. Ceiling heights varied from 8 ft. $4^1/_2$ in. to 9 ft. 4 in. with 9 ft. 0 in. fairly standard.

There is some reason to believe that story heights are less today than for the structures built 50 years ago when high ceilings were fashionable. In the case of office buildings, the trend is for larger clear spans. Thirty feet between column centers are quite common. One new San Francisco building nearing completion boasts of 63 feet clear spans — in one direction. Long spans means deep floor girders, consequently offsetting the compaction of the floor system.

The designer has many floor constructions from which he may select the one that best fulfills the owner's requirements. Aside from the many considerations already mentioned is the usual building code (municipal laws) which require some assurance of fire resistance. Such requirements vary, depending upon height, area, type occupancy, and location.

From a design standpoint, all floors take advantage of continuity wherever the type construction permits development of negative moment over supports. Applicable moment coefficients are usually stipulated in the governing building code.

Arches

The oldest system, shown in its simplest application, fig. 1a, is that known as "beam and slab" or "arches", consisting of a reinforced concrete slab supported on steel beams. The beams are called "intermediates" or "secondary" since they are spaced about 8 feet apart, therefore two beams would be intermediate between columns on 24 feet centers. The concrete slabs are usually 4 to 5 inches thick.

In the case of office buildings requiring underfloor electrical services, ducts of metal or fiber are laid on top of the structural slab and embedded in a light weight concrete fill, usually 4 or $4^1/_2$ inches thick including one inch of finish. On some recent installations, metal ducts are embedded in the structural slab which necessitates a slab thickness of about 6 inches to obtain fire resistance and design strength. This method is held to be more economical but has the disadvantage of inflexibility should a change be required in the future. Also, the recent trend towards larger ducts may render this method uneconomical.

Air conditioning ducts are located to clear the steel floor beams; however, in some cases where the beams are deep, it may be feasible to penetrate the beam web, thereby reducing the overall depth. Such large holes are usually reinforced.

Forms for the concrete slab are readily supported on the steel beams, thus the area immediately below is free of construction supports and following trades have complete freedom. This fact has greatly contributed to the speed of construction common to steel-framed buildings.

Furthermore, by forming around the beams, both the slab and fireproofing concrete for the beam can be poured and cast together. Such a beam, wholly encased, will perform as a composite-designed beam.

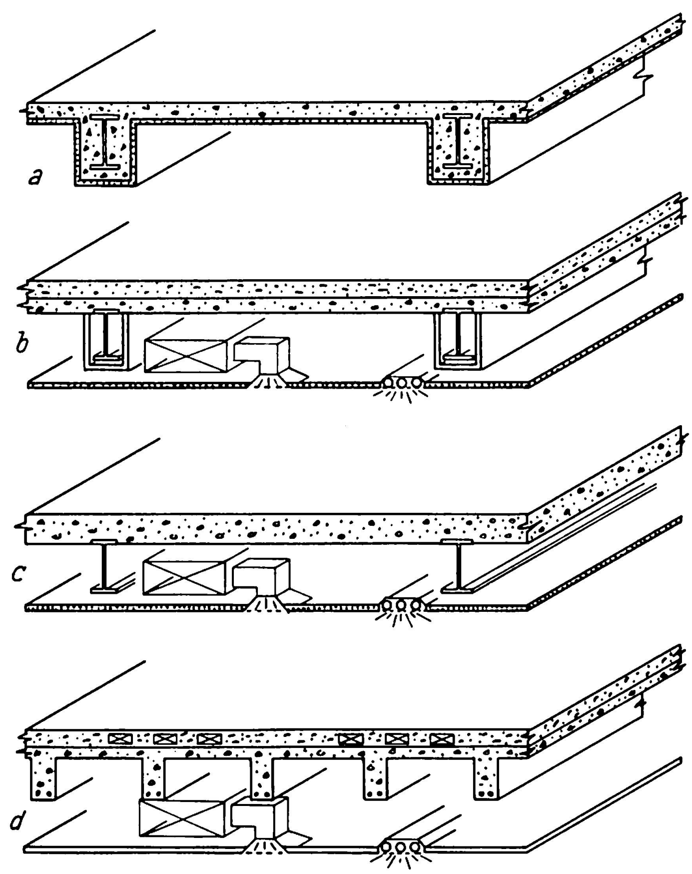

Fig. 1.

However, the trend to light weight membrane fireproofing, fig. 1b, with resulting weight-saving for beam encasement in the order of 15 to 1, has largely displaced the old practice of solid encasement. A smooth finished plaster is required where the slab and beam will be exposed. While this may suffice for a hotel, hospital or apartment house, the usual office building will have suspended ceilings to hide the pipes and ducts. In some instances the ceiling will be purely architectural; in others, it will provide fire resistance for the floor assembly. When it is the latter, the individual fireproofing of beams within the assembly may be omitted, fig. 1c.

This type construction is still popular in some areas, particularly in New York City where traditional practices are rather firmly entrenched. It is also well suited for the lower floors of buildings, even though a different system may be used for the upper floors. The basement, ground, and first floors are often subject to heavy loads, vibrations, and excessive penetration of the floor because of the use of such areas for storage, for dance floors and kitchens.

Concrete Joists

Reinforced concrete joists, shown in fig. 1c, are cast in place by using removable steel pans, so the system is often identified as "pan" floor. Although the method has been employed on steel-framed tier buildings, its heavy dead weight and need for independent shoring has lessened its use except for the all concrete framed buildings.

Steel Joists

Generally acknowledged as the most economical light-weight floor system and satisfactory for many types of occupancies is the open web steel joist flooring, better known in America as the "bar" joist. Many of the early joists, introduced about 30 years ago, were wholly made of reinforcing bars, thus acquiring the name "bar" joists. Improvements in design and fabrication have brought some changes; typical sections produced today are shown in fig. 2. All are widely used except for the section, fig. 2d, which was recently introduced. It is included to illustrate the trend of utilizing floor components for more than one purpose. In this case, the top chord is cellular so that it can serve as a raceway for electrical circuits.

Steel joists are usually spaced not more than 24 inches apart for floors, 30 inches for roofs. A typical floor installation, including the relationship of air conditioning ducts and mechanical piping, is shown in fig. 3. Joists are easily erected, spaced as required, braced with light "bridging", and secured to the steel supporting beams by tack welds.

All joists are prefabricated to conform to a standard loading table, to a standard identification system, and to a design specification that is nationally recognized. Joists are available in depth from 8 to 24 inches, in increments of

2 inches and in lengths up to 48 feet for the deepest section. One reason for the popularity of joists is interchangeability, although each manufacturer produced to a design of his own choice. With few exceptions, bar joists are resistance welded.

After installation is complete, a forming material is placed on top and attached to the joists. Two common materials are shown in fig. 3; a light gauge corrugated sheet steel is illustrated on the left and metal lath on the right. Still another forming material is a heavy paper sheet reinforced with wire mesh shown in fig. 4. The concrete slab for the typical building is $2^1/_4$ or $2^1/_2$ inches thick. In some instances wire mesh or steel rods ("temperature" steel) is added for best results.

Fire resistance and architectural finish is provided by means of a ceiling. Metal or gypsum lath is attached directly to the flange of the joist or suspended slightly below on small cold formed steel channels. Fireproofing plaster of thickness corresponding with the desired fire resistance is then applied.

Steel joists may be considered the number one floor system judging from the widespread usage for such structures as dormitories, apartments, depart-

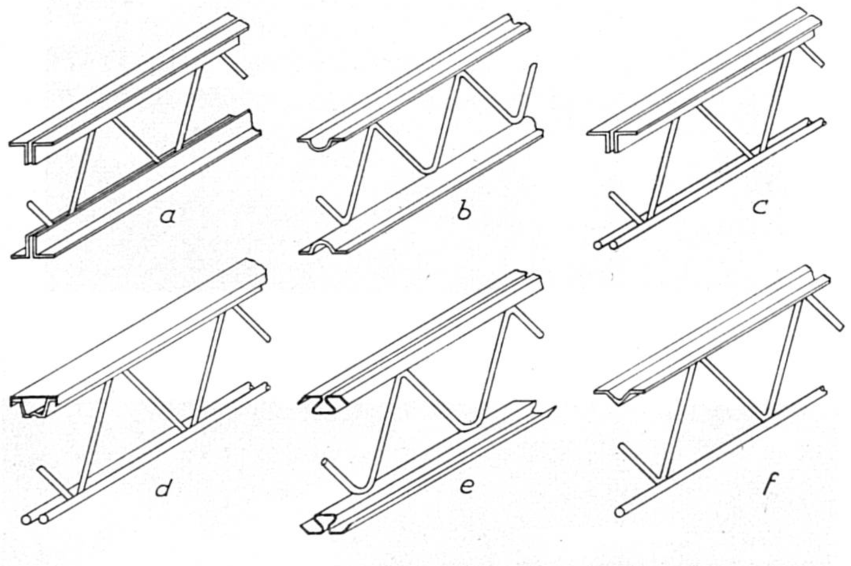

Fig. 2.

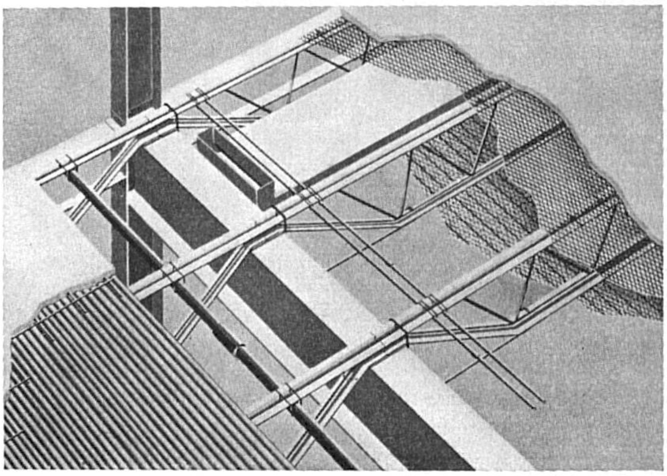

Fig. 3.

ment stores, schools, and hospitals. Its use for office buildings has been rather in frequent.

There is also available in America a solid web floor joist. The greater strength of these light-weight steel beams permits wider spacings than for the open web joists — up to 40 inches is considered economical. Removable plywood forms are supported on the joists. One method is to employ a small cast iron clip, fig. 5, that later can be fractured with a light blow of a hammer and the form stripped.

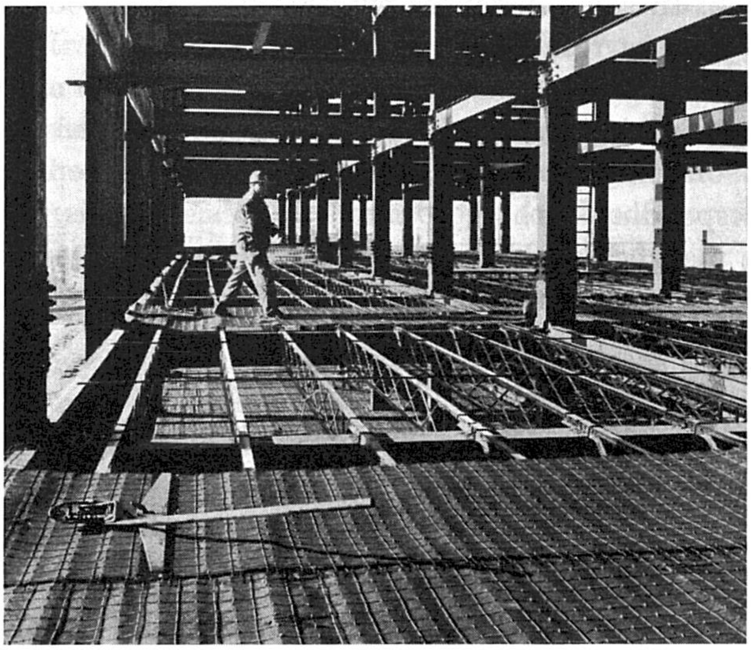

Fig. 4.

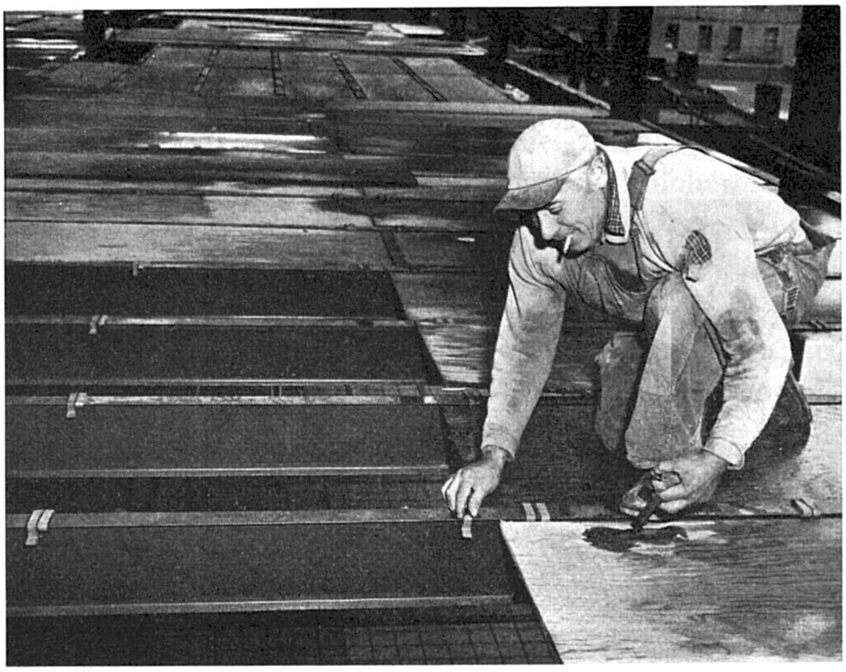

Fig. 5.

Cellular Beams

Light gauge steel building products have been rapidly moving forward. This is true of the so-called cellular steel floors, fig. 6. Its growth is primarily the result of the inherent ability to perform double duty. The structural cells of steel gauge 12 to 18 may be used as raceways, thereby eliminating the fiber or metal underfloor ducts that are needed for the concrete slab floor. A very recent innovation which furthers this principle of double duty is to force conditioned air at high velocity through the cells, hot air through one, cold air through another; the particular cells being enlarged as shown in fig. 6g.

The complete floor arrangement typical of the most recent practice is shown in fig. 7. Obviously, the advantages of this flooring is most apparent for office buildings where the owner's demands for electrification must be satisfied. Since each cell is a potential raceway, this system offers the maximum flexibility for both the present and future needs. However, when a lesser degree of flexibility satisfies a lower building budget, an economical solution is obtainable as shown in fig. 6h. Cells are located at 4 feet or 6 feet, etc., to suit the present needs and the balance of the flooring is left open; that is, the bottom enclosure sheet is omitted.

Cellular steel flooring is easy to handle and erect as shown in fig. 8. They can be designed for clear spans of 20 feet or more, but in the usual case inter-

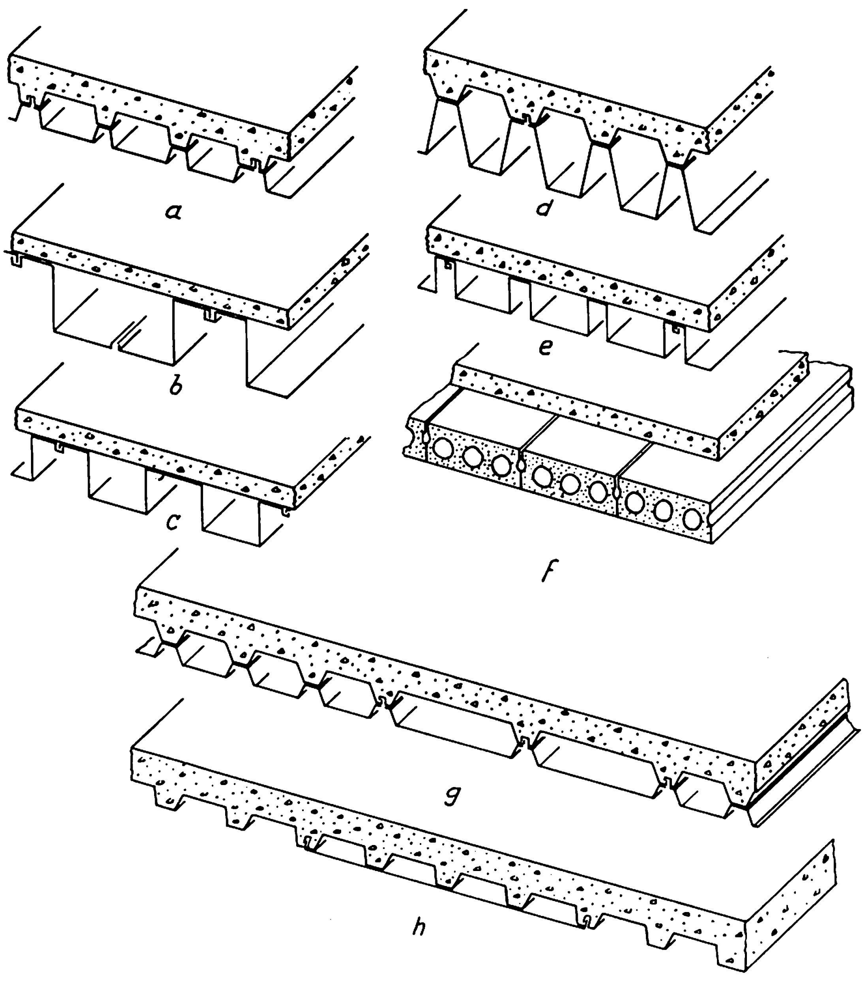

Fig. 6.

mediate structural steel beams are located at about 7 to 10-foot spacing depending on the type and capacity of the selected flooring. It is tack welded to the steel frame. Metal header ducts are then placed on top and access holes cut into each cell through which electrical circuits are to run, fig. 9. Light weight concrete fill is placed on top, usually about $2^1/_2$ inches thick, sufficient to fireproof the top side. The complete floor weighs from one-third to one-half of conventional concrete slab-steel beam construction. Consequently, the overall economy of this floor should include the savings in steel structure and in foundations.

Then, too, its usefulness as a permanent platform immediately upon erec-

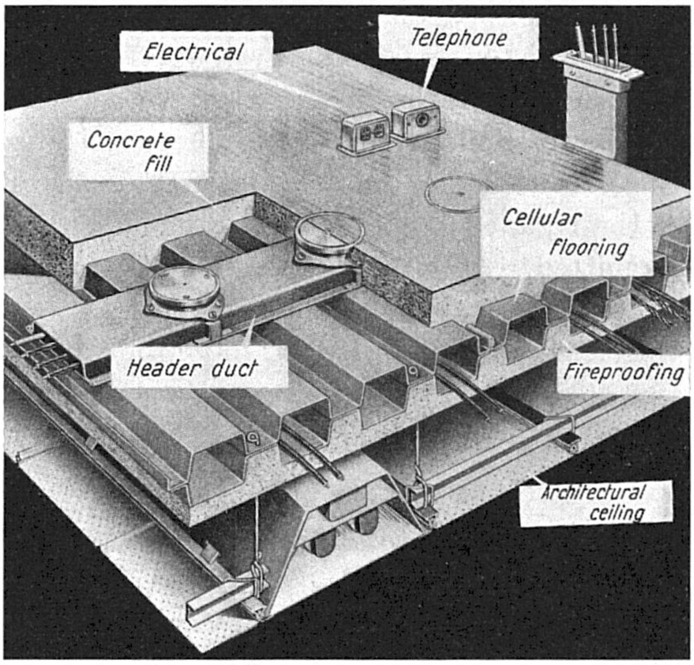

Fig. 7.

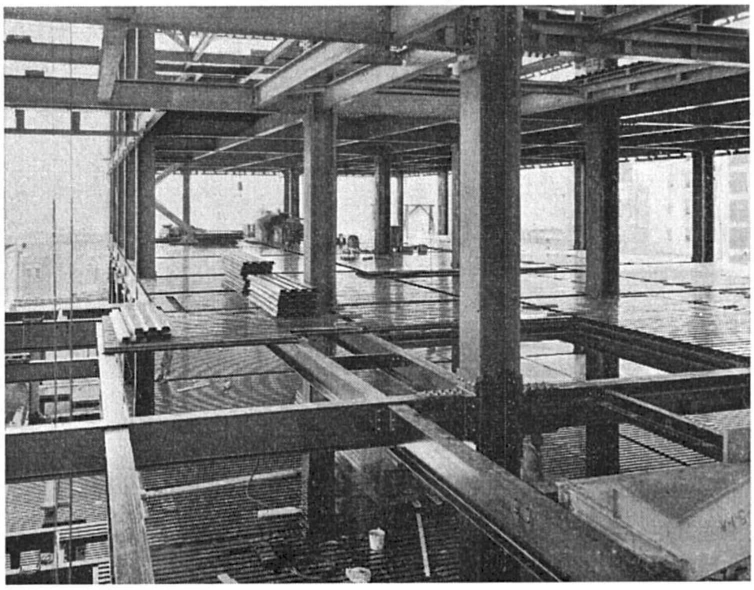

Fig. 8.

tion is of considerable value to the construction trades. When all these cost factors are taken in account, the cellular floor is indeed economical and competitive. Judging from the many installations in office buildings built during the last few years throughout America, this floor system is the popular choice for office occupancies.

The rather recent growth of this flooring, aside from the increasing need for electric floor systems, may be attributed to the developments which have taken place in the field of fireproofing, both as to materials and application. Materials such as vermiculite (expanded mica) and perlite (expanded volcanic deposit) are mixed with gypsum to form an extremely light but highly effective fire resistive plaster.

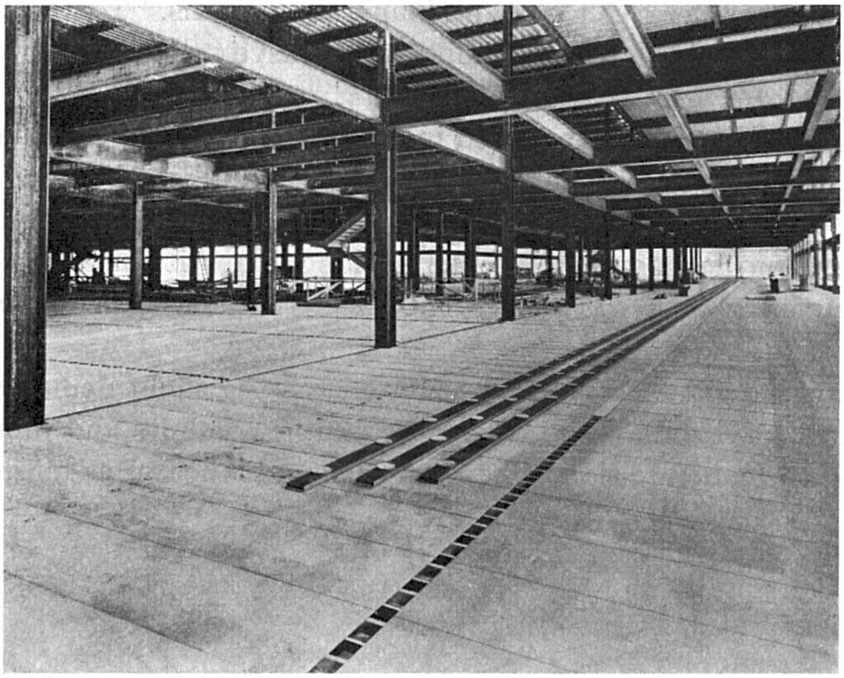

Fig. 9.

It should be observed that these sprayed-on fireproofing materials are applied directly to the floor steel as shown in fig. 7. Appearance is of no consequence because a suspended acoustical ceiling will cover the entire area.

While cellular flooring made of light gauge steel sheets dominates this system, brief recognition should be given to the newest entry in the tier building field, fig. 6f. It is a precast, prestressed concrete slab. Recent fire tests and others underway give promise that this system has possibilities. Like the metal floors, the cells may be electrified. Several new prominent office buildings have this type flooring.

Composite Slabs

Unlike the cellular floor described above, where the concrete topping is only an inert fill, in composite design both the concrete and steel flooring work together structurally. Although the gauge is lighter, ranging from No. 18 to 24, some or all of the metal is considered to be reinforcing for the slab.

The cross-sectional view of three common types of composite flooring is shown in fig. 10. In general, they differ with each other only in detail. For example, 10a includes all area of the corrugated sheet to be effective reinforcing whereas in 10b and c only that part of the steel sheet which is embedded in the slab is figured for reinforcing steel.

The system shown in fig. 10a assures composite action by shop welding steel rods to the sheet, thus the bond is mechanically obtained. Not considered is the probable bond obtained by the mechanical and chemical adhesion of concrete to the galvanized surface.

Additional reinforcing steel bars may be required for types 10b and c, particularly for heavier live loads and longer clear spans. "Temperature" steel is normally furnished — light rods located transversely to the ribs as shown in fig. 11.

The metal units are prefabricated in widths which allow easy handling and placement, fig. 12. Attachment to the supporting steel frame is readily accomplished with welding. The steel sheets are sufficiently strong for supporting workmen and equipment, but on long spans it may be necessary to provide temporary supports to prevent excessive deflection under weight of wet concrete.

In buildings such as hotels, apartments, etc., the slight demand for underfloor electrical service may be satisfied by simple conduits and junction boxes embedded in the concrete slab. Where this demand is heavy, as for office spaces,

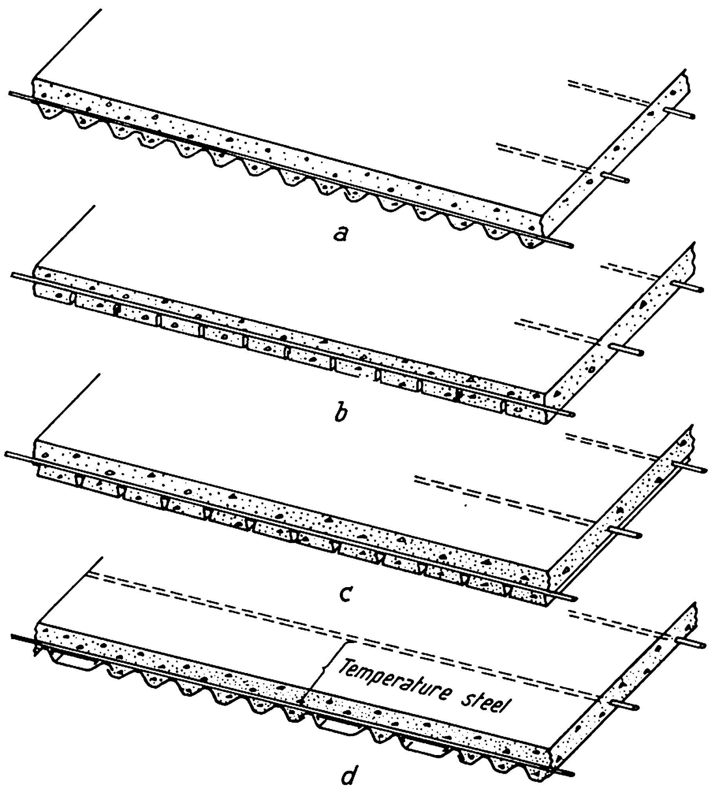

Fig. 10.

the metal or fibre ducts may also be embedded in the slab, up to the point where the strength of the slab and fire resistance is not reduced. However, where the demand is for maximum flexibility, at least three lines of electrical services every four or six feet, then it is better to select one of the cellular types or a modification of the composite system. The manufacturer of 10a has recently combined the two ideas as illustrated in 10d — a fine example of how competition spurs on development.

Floor Costs

So many variables enter into the cost problem that it is impossible to make any kind of comparison unless one establishes a particular situation and conditions, and even then it is speculation. At the best, one may generalize based on various cost studies that have been published. If, for example, the requirement is for a minimum type floor, the open web steel joist is generally the

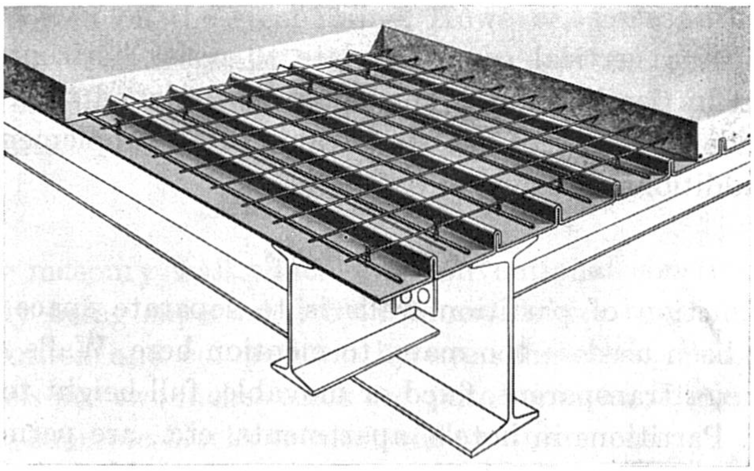

Fig. 11.

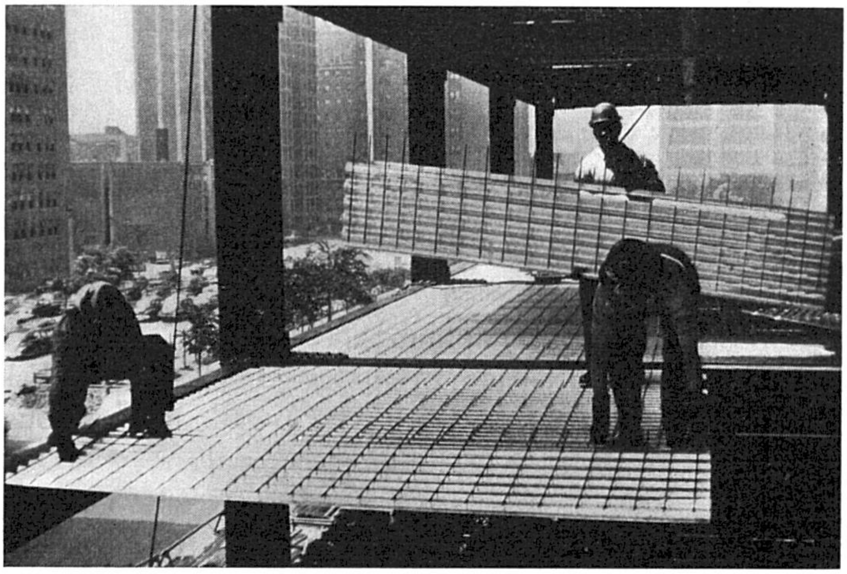

Fig. 12.

least costly. On the other hand, if the need for efficient electrical services is great, then a cellular steel floor could be the most economical.

The problem of costs is perhaps not too important. What is important is that the designer has *many* floor systems from which to choose the one he thinks will serve the best and give his client the most for his money. Competition by the producers will keep the costs down.

Walls

Classification

Walls for tier buildings may be classified into three groups according to their utility: (1) shear walls, (2) partition walls, and (3) exterior enclosure walls. Of the three, exterior walls are the most important to the steel frame, therefore, this paper will be largely devoted to a review of exterior walls with just a brief description of the other types.

Shear Walls

Shear wall — a vertical concrete plate to resist horizontal loads — is sometimes used in tier buildings. They may be designed to transmit all the lateral loads independently of the steel frame or to supplement the framing in the role of additional bracing.

Partition Walls

Principal function of partition walls is to separate space. A variety of materials have been used — too many to mention here. Walls may be hollow or solid, opaque or transparent, fixed or movable, full height to the ceiling or only part way. Partitions in hotels, apartments, etc., are permanently fixed, while those in many new office buildings are demountable to satisfy the occupants' frequent rearrangement of office space.

Enclosure Walls

Prior to the invention of the steel skeleton in the early 1880's, exterior walls were load-bearing. One famous 16-story Chicago building has a bearing wall whose base at the widest point is said to be 15 feet thick. The introduction of steel columns capable of supporting 50 times the load that the same masonry on unit-area basis could accomplish virtually revolutionized building construction. Exterior walls, relieved of supporting loads, became nothing more than a skin or curtain to keep out the weather.

An early building code regulation, originating in the pre-steel skeleton era, required the wall to possess a fire resistance of four hours. Obviously this was intended to prevent collapse of the building's principal support. Unfortunately, this requirement was carried over to apply to the new curtain wall even though the load-carrying chore has been transferred to the steel framework.

Progress has also been hampered for 50 years by a code provision that required a fire-resistant rating for solid walls *but not for glass window openings.*

Recently there has been substantial progress in building code modernization. At this writing, about 80 percent of the important building codes (those for major cities and so-called "model" codes) have revised their codes to permit the use of thin curtain walls.

While the foregoing code revisions have rapidly advanced the use of thinner walls, the greatest stimulant for metal walls can be attributed to the switch from a rigid specification type of code to that of performance standards — a basic philosophy agreeable to all code writers. Instead of specifying that a wall shall be 12 inches of masonry, the newer performance code may simply state: "non-combustible construction" — with fire resistance of zero to two hours as the case may be. This regulation has given impetus to the amazing development of thin *metal* curtain walls and to the free architectural expression of materials and colors which we see today in buildings all over America.

In the broadest sense, a curtain wall is any wall, thick or thin, whose dead weight is supported on the steel frame. However, some authorities seem to think appelation "curtain walls" should apply only to the thin panels, fully insulated and finished on both surfaces, shop fabricated and shipped to the job in large units.

Masonry Curtain Walls

The heavy masonry wall which was conventional construction for many years is largely being superseded by thinner, lighter types, all the result of code modernization and competition between materials. Precast concrete or limestone panels but two inches thick are quite common. These are also backed up with tile or concrete blocks to meet code requirements.

Fig. 13.

Even thinner walls are being developed and installed, probably spurred on by the rapid progress of metal wall construction. These take the form of "sandwich" walls, fabricated in large panels. For example, a 3×9-foot panel, 3 inches thick, consists of a one-inch-thick ceramic veneer (modern architectural terra cotta) backed with two inches of light weight aggregate reinforced concrete. A finish coat of plaster may be applied to the inside face. This wall panel weighs but 30 pounds per square foot. A typical installation on a steel frame office building was recently completed in California, fig. 13.

Metal Curtain Walls

The use of metal for exterior walls is not new; cast iron was used more than fifty years ago. What *is* new is the use of metals in thin sheets of gage thickness — ranging from 0.010 inch (32 gage) in stainless steel to 0.125 inch thick bronze sheets.

Many metals have been used; the most prominent are steel, stainless steel, aluminum, copper and bronze.

Basically the thin metal curtain wall consists of a metal sheet backed with insulating materials to form a prefabricated sandwich. One pioneer installation consisted of $^1/_8$-inch-thick aluminum weighing 2.4 pounds per square foot, 4 inch perlite (lightweight aggregate) concrete backup and a plaster finish, the total weighing 40 pounds per square foot. In a more recent installation, also using $^1/_8$-inch-thick aluminum facing but backed with fiber-glass insulation and an aluminum foil vapor seal, the thickness totalled $1^1/_4$ inches and the wall weighed 4.5 pounds per square foot.

Another type of sandwich wall as actually used consisted of a laminate of three materials — an exterior facing of porcelain enamel on 18 gage steel sheet, a $^1/_8$-inch-thick asbestos cement board, and a 20-gage steel sheet — a $^7/_8$-inch thickness of fiber glass insulation and a second asbestos cement board. This wall is $1^3/_4$-inches thick. In still another building the panel of 22-gage stainless steel was secured to a paper honeycomb filled with phenolic foam and enclosed with galvanized sheet steel. This panel, $1^3/_4$-inches thick, weighed 3.5 pounds per square foot.

The story of thin metal walls and the many variations and materials being used today is most fascinating. One cannot possibly do justice to this subject in a brief review. Suffice to say that this development has given color to the American skyscraper, opening a new vista for architectural expression. The widest selection of color is afforded by porcelain enamel on a steel or aluminum base. Anodized aluminum comes in gold, black, blue-grey and natural. Stainless steel is obtainable in black, although gold and bronze are being developed. Thin hollow glass units, 2 inches thick, are produced in eight standard colors. Just as colorful are the new ceramic veneers. Truly we are witnessing a building renaissance.

Field Adjustments

The recent growth of thin panel walls has focussed attention on the permissible deviation of the vertical alignment of steel columns in tier buildings. For the many years during which masonry walls were dominant, the usual steel specification simply considered exterior columns plumb if error was less than 1 : 1000. Evidently this rule, without explicit interpretation, was compatible with the inherent flexibility of unit masonry construction practices.

The advent of rigid panel walls, prefabricated in units of one to two stories high and up to 10 feet in width, brought forth numerous inquiries for a clearer interpretation of the old 1 : 1000 rule. Wall erectors were discovering that the deviations were often more than they had anticipated and corrections were difficult for them.

In March, 1959, the American Institute of Steel Construction, the national association representing the structural steel fabricating industry, issued the following revision to their Code of Standard Practice:

"In the erection of multi-story buildings individual pieces are considered plumb, level and aligned if the error does not exceed 1 : 500, provided that:

1. The displacement of the center-line of columns adjacent to elevator shafts, from the established column line, is no more than 1 in. at any point in the first 20 stories. Above this level, the displacement may be increased $^1/_{32}$ in. for each additional story up to a maximum displacement of 2 in.
2. The displacement of the center-line of exterior columns from the established column line, is no more than 1 in. toward, nor 2 in. away from the building line at any point in the first 20 stories. Above this level these limits may be increased $^1/_{16}$ in. for each additional story, but may not exceed a total displacement of 2 in. toward, nor 3 in. away from, the building line."

In addition to the variation in plumbness, there are the permissible dimensional variations in the steel shapes as rolled by the steel mills and the inaccuracies of fabrication. Both are duly limited by nationally recognized specifications. To these structural variations may be added the dimensional deviations of the wall panels themselves, although these products are precision-built in shops. Therefore, to allow for the possible accumulative effect of all variations, wall connections to the structure should permit adjustment in three directions: up and down, in and out, and laterally along the face of the wall.

Some experts in the curtain wall industry have recommended a clearance of not less than 2 inches, preferably 3, between the wall and the structural elements. Since this thought follows closely the newly established criteria for plumbness of multi-story columns as stated above, it follows that the wall is independent of the steel frame insofar as plumbness is concerned. Offhand this seems to be unnecessarily exacting, particularly on taller buildings where natural movements due to wind and sunlight will cause deviations from true vertical. It would seem more logical for the skin to be shaped to its supporting frame. Undoubtedly, a specification for curtain walls will eventually include a tolerance for plumbness that will recognize the reasonableness of this thought.

Panel Attachments

Connections may be made to the spandrel as shown in fig. 14, to the columns, and in some designs to a secondary system of steel members — usually vertical mullions extending from floor to floor.

A variety of attachments have been used; no one detail or practice is either typical or standard. Short angle "clips", bent plates, hook bolts, and brackets are a few of the types that have been used. They all have adjustability in common for reasons previously given. Such adjustment, however, is only for erection. Bolted connections in some installations have been welded to prevent the connection from ever working loose.

These attachments may be fastened to the steel spandrel beams or columns with bolts, welds, explosive powder-driven pins, or automatic welded studs. Similarly, connections may be attached to the concrete slab or to concrete fireproofing encasing the spandrel with powder-driven pins or by use of cast-in-place anchors and inserts.

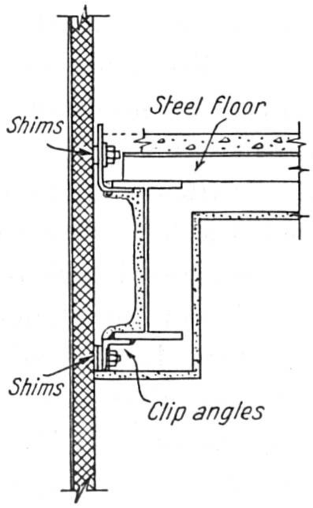

Fig. 14.

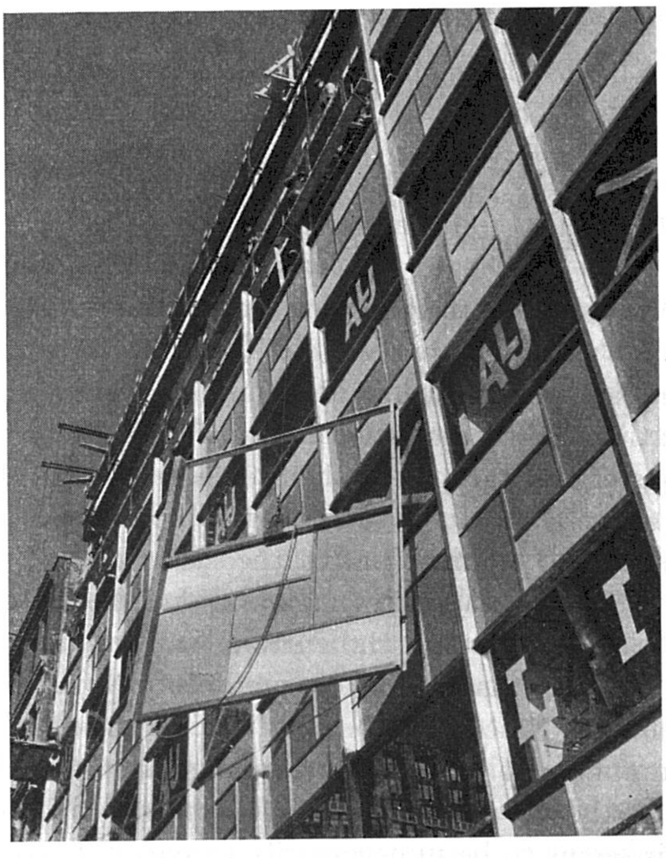

Fig. 15.

Here again, drawing from those experienced in wall erection, it is often better to start erection after floor concrete has been poured for several floors above. This, they say, adds considerable rigidity to the steel frame and enables the wall erector to hold the alignment better.

There also seems to be a preference by some erectors of wall panels to install their own connections rather than have them preset by others. This, of course, would be satisfactory to the structural supplier since it relieves him of the task of providing holes or attaching clips to the beams in the shop. Whatever the arrangement, it should be clearly stated and all construction trades fully informed.

Since practices are still far from standardization in this period of development, it behooves the structural steel designer and fabricator to be familiar with the design features of panel wall attachments. Quoting from a recent research report prepared at Princeton University, attachment devices should meet the following requirements:

1. Strength — sufficient to support panel loads independently.
2. Permanence — must not loosen as result of building movement or thermal expansion of wall panels.
3. Adjustability — in three directions.
4. Corrosion resistance — equal to life of building.
5. Fire resistance — sufficient to ensure that wall panels will stay in place in event of fire.
6. Erection from interior.

One of the major advantages of panel wall construction on steel tier buildings is the elimination of scaffolds needed for unit masonry wall construction. As shown in fig. 15 the panels may be completely installed from the interior of the building and work may proceed in almost any kind of weather short of hurricanes. Thus, the panel wall has joined its bosom companions — the skeleton steel frame and the newer floor systems — by freeing field construction from such costly items as shoring (falsework) and scaffolds. Field labor is gradually giving way to shop labor and the efficiency of pre-fabrication. Clean, fast, efficient field construction is the order of the day.

Conclusion

Light weight walls, light weight floors, and light weight fireproofing have reduced the gross weight of structural steel in modern tier building construction. To this may be added the influence of higher unit stresses (12,000 to 18,000 pounds per square inch prior to 1936, 20,000 since then), and that of refined design analysis.

No one, to the writer's knowledge, has undertaken the survey of building construction to determine how much steel has been saved over the years. Several years ago, when the Alcoa building with its then revolutionary thin aluminium walls was built in Pittsburgh, the following item appeared in a technical journal:

Pittsburgh Office Building	Year Built	Stories	Rentable Area	Structural Steel
Oliver	1911	24	317,000 sq. ft.	10,000 tons
Gulf	1932	38	304,000 sq. ft.	12,700 tons
Alcoa	1952	30	310,000 sq. ft.	6,500 tons

Source: Engineering News-Record, April 3, 1952.

While this brief comparison is not entirely conclusive, the fact is rather obvious that modern steel framed tier buildings weigh considerably less than those of 30 years ago. The resultant economy forecasts continuance and even extension of the use of steel frames in American building construction.

Summary

The purpose of this paper, one of a trilogy on steel tier buildings, is to review the current designs of floors and walls, the two principal building components, with relationship to the supporting steel framework.

Floors and walls are classified for convenience of review, are described in detail, and are illustrated for clarity.

Résumé

L'auteur passe en revue les divers types de plancher et de paroi utilisés dans les bâtiments à étages multiples; il montre les rapports qui existent entre ces deux éléments du bâtiment et l'ossature métallique.

Les planchers et les parois sont groupés par types décrits en détail et illustrés.

Zusammenfassung

Der Autor untersucht die verschiedenen Typen von Decken und Wänden, die im Stahlskelettbau verwendet werden, im Zusammenhang mit dem Tragsystem.

Die Decken und Wände werden in Typen eingeteilt. Es werden detaillierte Beschreibungen und Illustrationen gegeben.