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qui, la première, fit un relativement large usage du fer dans la construction. On vit apparaître bientôt dans ce pays de nombreux ponts métalliques à formes d'arcs. Dès le début du 19ème siècle, la France réalisa à son tour des constructions semblables, mais en Amérique du Nord la préférence allait déjà aux ponts suspendus plus facilement calculables.
Peu après les premiers ponts de fer, on commença d'utiliser aussi cette matière pour des bâtiments, surtout pour la construction de toits et, particulièrement, de voûtes à grandes portées. Cette évolution fut favorisée par les progrès du laminage mécanique, qui apportèrent une rationalisation en même temps qu'une économie dans la production du fer forgeable, et d'où naquirent les formes typiques répondant à ses multiples emplois ainsi qu'aux exigences de la statique.
Les qualités particulières de la nouvelle matière devaient amener forcément une révolution non seulement dans les méthodes de la construction, mais également dans le style des nouveaux bâtiments. Les styles historiques sont essentiellement déterminés par l'usage de la pierre, et celle-ci, de même que le bois, se travaille tout différemment de l'acier. Ainsi, dès maintenant, deux principes s'opposent: la construction basée sur le calcul, domaine de l'ingénieur, et la construction traditionnelle obéissant à des considérations tout autant esthétiques qu'architectoniques, domaine de l'architecte. Selon le genre de l'ouvrage à bâtir, l'un ou l'autre de ces principes seront appelés à dominer. Depuis environ deux siècles, le travail de l'ingénieur a évolué du stade empirique et artisanal vers une conception toujours plus mathématique et industrialisée de la construction. Les artistes et les architectes avant remarqué les singulières beautés des constructions de l'ingénieur, celui-ci fut lui-même amené à ne plus en considérer seulement les problèmes statiques et techniques, pour attacher aussi son attention aux aspects esthétiques de son œuvre. L'aspiration des ingénieurs modernes à tirer d'un matériel donné le plus grand „rendement" possible, c'est-à-dire à produire, avec un minimum de moyens, un maximum d'effets utiles, ouvre à la création formelle un champ nouveau constamment nourri par le pouvoir constructeur technique, et conduit, en fin de compte, à une conception régénérée de l'architecture.

L'évolution en Suisse

Au début du 19ème siècle, l'industrie textile était la plus développée du pays. Son équipement technique venait alors encore principalement d'Angleterre. Mais peu à peu se fondèrent, en Suisse même, des fabriques de machines textiles, qui étendirent bientôt leur production également à d'autres branches, et c'est ainsi qu'avec l'industrialisation croissante, la construction de machines prit en Suisse une toujours plus grande extension. La construction en acier trouva là un terrain favorable et se développa organiquement sur ces bases.
La plus forte et durable impulsion lui fut donnée par les chemins de fer, dont le développement commence vers 1850 et se poursuit jusqu'à la Grande Guerre. L'industrie de l'acier put ainsi s'établir solidement pour atteindre, progressivement, toute l'importance qu'elle assume de nos jours. Les chemins de fer amenèrent, en particulier, la construction d'innombrables ponts, dont plusieurs de très grande portée et pour lesquels, jusque vers la fin du 19ème siècle, on ne pouvait qu'exceptionnellement recourir à d'autres matériaux que l'acier. On ne se fait une juste idée de l'importance des ponts métalliques pour le développement des constructions en acier que si l'on considère, d'autre part, la très lente évolution du bâtiment dans la période de 1850 à 1890. Passablement de temps s'écoula avant que de grandes réalisations vinssent faire la preuve des qualités de résistance et d'économie de l'acier également dans ce domaine. La grande halle de la Gare Principale de Zurich (fig. 8) ne fut construite qu'en 1867, celle de la Bourse de Zurich en 1878. A la suite de ces exemples, l'emploi de l'acier dans les constructions urbaines prit enfin son essor.
Si ses débuts dans le bâtiment furent difficiles et modestes, l'acier n'en a pas moins acquis aujourd'hui, précisément dans cette branche, la plus grande importance pour l'industrie de l'acier de construction. Deux circonstances ont particulièrement favorisé ce succès: l'expansion de nos entreprises industrielles d'une part, celle de nos grandes villes — qui est une conséquence de la première — d'autre part. L'acier permettait en effet de résoudre des problèmes auxquels les autres matériaux de construction — du moins avec les moyens techniques de l'époque, ne pouvaient répondre de manière satisfaisante.
A partir de 1890, la construction en acier s'imposa de plus en plus pour les grands édifices, notamment les maisons de commerce et les hôtels. Le premier bâtiment en Suisse à charpente entièrement d'acier fut celui des grands-magasins Jelmoli à Zurich (fig. 10), lequel date de cette époque. Ce genre de constructions se généralisa ensuite pour les bâtiments industriels. L'une après l'autre, les grandes entreprises de l'industrie des machines firent construire en acier leurs fabriques et leurs entrepôts.
L'exploitation des forces hydrauliques du pays vint à son tour ouvrir de nouveaux champs fertiles à l'industrie de l'acier. La construction hydraulique en acier se développa en même temps que celle des ouvrages hydro-électriques et, quand éclata la première guerre mondiale, nos ingénieurs avaient déjà acquis dans ce nouveau domaine de la construction une expérience toute fondée sur leurs propres réalisations, indépendantes de tout modèle étranger, sur lesquelles s'édifia ensuite la renommée dont jouit de nos jours la construction hydraulique suisse dans le monde.

Construction de bâtiments

Les constructions à charpente d'acier sont caractérisées par la différenciation des éléments porteurs d'avec ceux de fermeture et de cloisonnement. Un assemblage d'éléments d'appui entretoisés, de traverses et de solives d'acier constitue le squelette du bâtiment, le plus souvent à plusieurs étages, dans lequel viennent s'insérer des éléments d'autres matières qui forment les plafonds et les parois (fig. 17). Il s'agit donc d'une armature de treillis rigide, dont les appuis et les traverses constituent le châssis principal, et qu'il faut ensuite „habiller" pour le rendre habitable. Le remplissage des parois et des plafonds ferme le bâtiment et transmet la charge de chaque étage à la charpente portante, par l'intermédiaire de laquelle le bâtiment tout entier repose sur ses fondements.
La construction à charpente d'acier, qui ne s'est implantée en Europe que depuis quelques dizaines d'années, est d'un usage courant depuis beaucoup plus longtemps en Amérique où, en raison des prix astronomiques des terrains dans les centres des grandes villes, on fut amené très tôt à bâtir surtout en hauteur, avec un grand nombre d'étages. L'un des premiers immeubles à charpente métallique fut construit à Chicago en 1883. Aujourd'hui, le plus haut gratte-ciel du monde, l'„Empire State Building" de New-York, dont la construction fut achevée en 1948, compte 102 étages répartis sur une hauteur de 415 mètres.
Les éléments de construction en acier pouvant être préfabriqués et simplement montés sur le chantier, il en résulte en même temps qu'une économie. une sensible accélération des travaux, ceci d'autant plus qu'il est possible aujourd'hui de recourir également à des éléments préfabriqués pour le remplissage des parois et pour les parements.
En Angleterre et en Amérique, on évalue l'économie de temps réalisée sur les constructions en acier à 60—70 %. Ce facteur plus encore que l'économie financière explique l'immense succès de ce procédé de construction moderne: dans les grandes villes d'Amérique, par exemple, plus de 50 % de tous les immeubles sont construits en acier.

Construction de halles

Les halles posent d'autres exigences que les bâtiments ordinaires. La partie essentielle de la construction est ici constituée par la charpente à grande portée des toits. Pour les halles industrielles, les constructeurs doivent accorder la plus grande attention à l'éclairage supérieur et latéral, à la conformation de la couverture, au drainage de la toiture, à la suspension des ponts roulants et, avant tout, au dégagement de la surface intérieure qui doit être libre de tous piliers.

Eléments et formes de construction

L'évolution des formes de construction subit depuis peu l'influence d'un progrès technique décisif, qui réside dans la manière d'opérer les joints des éléments d'acier. Alors qu'autrefois les pièces ne pouvaient être assemblées que par des rivets ou des vis, on a de plus en plus recours aujourd'hui à la soudure électrique, qui permet à l'ingénieur de réaliser des formes métalliques plus libres et plus élancées. Ainsi, outre l'économie de matière qu'apporte cette méthode, le constructeur est mis à même de mieux tenir compte des considérations esthétiques auquelles, à juste titre, notre époque attache une toujours plus grande importance.
Les conditions économiques de la Suisse ainsi que la nature de son sol offrent peu d'occasions de réaliser en acier des ouvrages aussi considérables qu'à l'étranger. Nos fleuves ne sont pas larges au point d'exiger des ponts gigantesques et le prix des terrains à bâtir dans nos villes n'est pas encore excessif au point de nécessiter la construction de gratte-ciel. Pourtant, la construction en acier occupe dans notre pays une place respectable aussi bien dans l'économie nationale que sur le plan de la technique, et ceci se comprend — car un grand nombre de problèmes de construction, dans l'avenir comme par le passé, ne pourront être mieux résolus avec d'autres matériaux.

Summary

Mies van der Rohe in Chicago
(pages 3—12; pages 1—2 see number 10)

The Campus of the Illinois Institute of Technology

The plan for a radically new construction of the Campus of the Illinois Institute of Technology under energetic President Henry T. Heald in 1939, brought Mies the task of conducting the construction of a great project. The Campus buildings shall therefore be the principal work on the basis of which van der Rohe's position as a creative architect in America during the post-revolutionary period of modern building shall be discussed.
The task required predetermined initial decisions. Mies stresses the difficulty of such decisions which may be the guarantee of order in the long run. Construction time was originally calculated at ten years. After that period, 8 of the 24 planned buildings have been erected, i. e. one third of the Campus. It is presumed that another 15 years will elapse before everything is finished. A quarter-century is a long time in our fast-moving days.
Mies developed his plan very carefully, knowing that he was not embarking upon ephemeral work. He had to find a suitable basic module for the principal requirements of a school — class rooms, laboratories and work-shops, drawing rooms and lecture halls. The result of his investigations was a module of 24 ft., which closely resembles the modules usually employed in Switzerland and Sweden for similar functions. A network on the basis of this module was drawn over the entirety of the campus site. Every support is situtated at the points of intersection of this network. The determination of a modular basic measure simplifies every subsequent decision and prevents improvisations which might, under the pressure of momentary utility requirements, jeopardize the order of the whole.
It would be wrong to assume that the module of 24 ft. must needs make the Campus monotonous. The variants in height, width and depth of the individual cubes and the varying measurements of the free spaces result in a rich rhythmical play of primary space proportions in relation to the entire site. To this are

added the variants of proportions within the individual buildings resulting from the various functions of the rooms. The inner rooms manifest themselves outwardly in the proportions of the filling structure, window arrangements or brickwork within the framework of the principal structure. In certain cases Mies has used supporting brickwork walls which, as such, are clearly different from the dominating steel structure (e. g. in the machine hall, which is part of the Metallurgy and Chemical Engineering Building). Some buildings have a visible concrete skeleton. The laboratories are distinguished from the school buildings by the different treatment of the steel. In the laboratories and work-shops the steel visible on the outside at the same time constitutes the support of the skeleton. With the school buildings the Chicago Fire Laws prevent the possibility of exposing the skeleton. The steel visible in the façade is a steel-frame facing the fire-proofed skeleton, to which it is similar, and it visually defines the glass and brickwork fillings. The facing steel is not continued to the ground: a detail that Mies has developed as an expression of a subtle honesty in building. The profiled, "hollow", recessed corner follows similar motifs. Stressing the general directions of the façade surfaces, their effect is that of joints. Such details contribute not a little to the elegant effect of the buildings. Seen in their interrelations they are much less static in effect than a photograph might lead one to assume. The wanderer in the Campus enjoys a generous space for roving. The planting of the open spaces has progressed considerably. Bushes were planted, near the lawns, green volumes, and high trees towering above the relatively low horizontal buildings provide a pleasant awning in summer. It can be visualized even now how much the buildings will merge into the greenery. Maybe the loss of the crystalline effect the buildings had at the beginning will later be deplored. The buildings reflect the changes of daylight with particular sensitivity. Night and artificial lighting inside change the buildings into grandiose bodies of light. Day and night, the grassy expanse links up exterior and interior, and gives an insight into the life proper of the school — collective study.

The contrasting effect of the Campus buildings with the immediate surroundings is exceptional. This part of the town is justly notorious as one of the blots on the city's escutcheon. Slums inhabited by negroes encircle the school. Rickety wooden shacks, dirty streets and dirtier back-yards. The stone and brick buildings are in the same state. A large building which was, in its time, exemplary for comfortable apartments with wide green yards and fountains, known under the name of "Mecca", is now crammed with negro families. In less than 50 years a progressive urban undertaking has changed into a ruin and a source of morbid social processes. Crass evidence of the disorganized building activity of the 19th century and the rapid changes in a speculative economy! The Campus project is an attempt at rehabilitating a city district — a heroic venture in view of the general extent of the slums in Chicago.

There are no fewer difficulties arising in the realization of a modern building project if the building is a school. The Illinois Institute of Technology is run on private contributions, i. e. it is not a state institution. Trustees and teachers have their own idea of the face of a college. The clichés of monumental dignity are also demanded of a school. Towers and portals seem to be indispensable and masses of stone are considered a good investment for emotional needs of security. In Europe the American lack of prejudice is often overestimated, and the effects of the Museum of Modern Art in New York, which are also felt in Europe, are apt to lead one to the conclusion that the whole of America is visually progressively educated. It is just the lack of ancient tradition, which often promotes speculative freshness and readiness for the new experiment, which, on the other hand, may create a particularly stubborn attachment to pseudo-values. Thus, certain teachers and trustees did not like the new buildings. The realization of the Campus without compromise must be attributed to President Heald's powers of conviction and the diplomatic attitude of the architect. The dislike of buildings often finds indirect expression in prejudiced criticism of their functional aspects: "In summer one dies of heat in these glass boxes — in winter one catches colds" etc. New buildings of unconventional aspect will always be very critically inspected for defects, and such defects can no doubt also be found in the Campus buildings. The collaboration of the architects and the specialised technicians and engineers in respect of heating, ventilation, lighting and acoustics leaves much to be desired in many instances. The reason lies in the lack of a secure basis for constructive cooperation. Empirical procedure is still unavoidable. Specialists are accustomed to solving their problems more or less correctively. The comparison of the practical success of the new Campus buildings requires a wealth of research which, to our knowledge, has not so far been conscientiously performed on a scientific basis. These problems shall not, therefore, be further considered. In our opinion the buildings function considerably better than the usual.

The old argument against the new architecture without decoration — that it resembles factories too closely — can best be denied on the site where it can be compared with the neighbouring standard factory buildings. Even the best factory buildings of the anonymous Chicago school have nothing in common with the dignity of proportion and the careful construction of the Campus buildings. Even the factory buildings proper of the Campus, the Armour Test Laboratory and the heating building prove the truth of the Rohe principle that good proportions do not cost anything even if the material execution must be simple. The really representative buildings of the Campus have not yet been built. The administration building and the building of the Student Union will differ from the less pretentious school buildings in their larger form, i. e. in comprehensive basic proportions. Unbroken, large-size brickwork fillings will contrast with huge glass surfaces.

The building programme of a school, and in particular of an institute of technology whose growth parallels the rapid development of technics, must needs be subject to changes. Mies realized at the very outset that flexible utility conditions must be reckoned with. The decision in favour of a structurally uniform plan simplified the adaptability of the buildings. The proportions within a structurally autonomous entity can easily be opened wider or closed if the space requirements so dictate.

Reserve, subordination of the parts in favour of the whole — these principles are scarce in a time favouring personal and collective exhibitionism. "Modernistic" architecture is particularly rampant in America. The cliches of modern architecture may be met with everywhere the "publicity" architects have taken them over. The buildings of Mies must look plain and simple by comparison. The absence of astonishing details, dramatic colour in material and pigment may be too dry for many eyes accustomed to the multi-coloured and playful. The sacrificing of all sensation, of everything imposingly theatrical, of the playfully cosy, and the technical clevernesses requires strength and sound knowledge of values.

Apartment Houses in Chicago

A co-operative apartment house of 22 storeys, whose design was entrusted to Mies, has now been in use for a year. The "Promontory Apartments" have been realized as a simple cellular structure. The skeleton is a concrete construction, the fillings are of glass and brickwork. The building is very expressive in its plainness. The regular order of the façade is subordinated to the principal cube of the building, although the vertical supports of the skeleton project from the façade and are carried throughout the height of the building in monumental order. The projecting supports are reduced in four rhythmic sections. The building contains two lift shafts and two separate entrances on the ground-floor, with a spacious lobby between. The play-ground and car park for the inhabitants are placed behind the house. The principal rooms of the apartments face the lake. The horizontal rows of windows admit the distances of Lake Michigan to the rooms and compensate for the comparatively confined space of the flats.

In the same district, in the South part of the town near the University of Chicago, replicas of the same type are planned. These buildings are important as instances for the realization of a bolder plan: a skyscraper dwelling-house made of steel and glass. Since the projects of an open building of the years 1919/21, Mies has had to wait for an opportunity of realization. Two large apartment buildings of this type are now almost finished. A large proportion of the apartments have already been sold; the distrust of transparent, thin walls was less wide-spread than could be assumed. These buildings will determine empirically whether the public will take to the open building. The steel and glass buildings are situated on the lake-side, near the centre of the town. They will be realized in accordance with a co-operative principle like the Promotory Apartments on the Southern side.

So far Mies has not been given an opportunity of realizing his contribution to the detached house within the frame of a town, as a group of differentiated court or straight-row houses with courts (1931). The first detached house Mies could build in America was a country house for a lady doctor. It is a glass house in a wide field with beautiful tress. The house is built and lived in to enjoy the calm of the country and greenery.

A variant of the simple house, consisting mainly of floor and ceiling elements with independent order of the rooms inside and a glass enclosure is now being developed by Mies for the requirements of a large family. The house will also stand in an open field.

Mies was long known as the architect who had built little and whose ideas were difficult to put into practice. The new phase of his work brings a wealth of practical realizations. Mies thinks that he would probably have built in the same manner anywhere, had he not gone to Chicago. But America usually allows a person to tackle problems more radically, and the reality of industrial building methods is more forceful in the scale of this country. It is typical that Mies realizes his large building projects in collaboration with architects and contractors. The individual architect is hardly able to build. Mies may function in the maze of complex building without losing sight of the essentials. His values have not grown on the soil of Chicago. Thus it is of no particular importance that the fundamentals of his values are hardly understood; the certainty of his values is pragmatically realized. Mies has become the conscience of the Chicago school. He is fulfilling Sullivan's heritage by demonstrating the obvious direct. Frank Lloyd Wright has taken over the romantic leanings of his teacher Sullivan, which is noticeable in the ornamental decoration even of his most clear-cut buildings, and he has intensified them into the oppositionally subjective creations of his late period. Mies' attitude points towards the future, in particular through his ability to subordinate space and formal imagination to the essential principles. Thus he paves the way for anonymous building which will enable sensible solutions of modern problems to be achieved and provide a sound basis for the development of really new technical and aesthetic contributions to architecture.

Roma Termini Station (pages 13—14)

The old terminus, which had for a long time been too confined for the ever-increasing traffic, has in recent years been replaced by a series of new service buildings which are among the largest of their kind. The visitor to Rome is received by the symbols of antiquity integrated in the new structures, the Wall of Servius Tullius and the Thermae of Diocletian, the latter forming the horizon of the Square of the Five Hundred, the former the closure of the vestibule whose rhythmically designed ferro-concrete roof takes up the curvature of the wall and transmits it to the engineer's construction.

Foundry at Rho, Italy (page 15)

The peculiar architecture of the building is the result of the necessity of providing even lighting of a large area while the roof must permit free escape of the smoke and vapour generated. This end was achieved by a cross vault spanning the main wing whose arches rest on supports of different size so that roof windows could be arranged to open in the vertical. This solution, which is excellent from the functional viewpoint, creates an arresting architectural effect in the lightness of the free span of the vault over the glass walls. In addition, the main wing vault possesses all the advantages of the old sheds and is, at the same time, considerably cheaper.

Administration Building of the Swiss Association of Fruit Growers, Zug (pages 16—19)

The building is situated on the large arterial road linking Zurich with Lucerne and the St. Gothard. In order to avoid, as far as possible, the noise of traffic in the office rooms, the building was set back from the road and separated from it by a wide green space.
The plan tends towards a clear separation of the room groups according to their purpose, preferably on separate floors. The ground-floor houses the entrance to the rooms of the Association, the post office with its separate entrance, and caretaker's and chauffeur's apartment with separate entrance. The two upper floors house the offices which are arranged facing East and West. They are constructed on the basis of a unitary principle of 3,5 metres distance between axes and 13,5 square metres area. This comparatively small area with a depth of only 4,0 metres was made possible by arranging the heating in the ceilings so that the space usually taken up by radiators could be employed for counters built to the height of the sills. The combination on floors of individual room groups, on which the plan is based, also finds its structural and optical expression in the external appearance: the two office floors with the unitary concrete module of 3,5 metres between axes are clearly defined against the ground-floor, which partly rests on pillars and partly is set back. Unfortunately the solution suggested by the architects concerning a roof terrace and set-back superstructure with conference room and staff rest room was not adopted — it would have been a solution which might have been structurally more correct and architecturally more satisfactory.

Office and warehouse building Allega AG., Zurich (pages 20—21)

The firm Allega, subsidiary company of the Chippis Aluminium Works, required an office and warehouse building suitable for the requirements of the sales organization and the nature of the material to be stored, which was to be built on the outskirts of the City of Zurich within 11 months. The site was an old stone-quarry on the main Zurich-Baden traffic artery. The level of the site was 4—5 metres below that of the adjacent streets, and this difference could be utilized by providing free basements on the rear yard fronts.
The building comprises two principal wings with office and warehouse sections. The former houses a rationalized office organization employing the most up-to-date equipment, and its further growth is allowed for by ample space reserves in every room. Light-alloy profiles are vertically or horizontally stocked, according to sections, in the warehouse, together with light-alloy sheets and Aluman roofing sheets.

New Factory of Suter Biscuit Ltd., Winterthur (page 22)

The factory is situated in the centre of the town. The concentration of the structural volume, the rational utilization of space, and an efficient interior organization (on two and three floors) have enabled a minimum area to be taken up. The silos housing the raw material have been accommodated in the roof superstructure. Automatically, the raw material is fed to the first-floor manufacturing shop crossed by an S-shaped conveyor system. The goods are then, again by automatic conveyors, moved into the forwarding department on the ground-floor whence they are loaded into delivery vans.

Steel Constructions (pages 23—29)
General Development

In 1784 the Englishman Henry Cort first produced useful malleable iron by means of pit coal in a reverberatory furnace by the puddling process. The new building material was not then invented but for the first time produced in greater quantities and substantially improved in quality. The price of this new material was high, a fact which forced engineers to use the new building material most economically.
England was the first to use relatively large quantities of iron in building, and a considerable number of arch bridges were constructed as a result. While such constructions were made in France at the turn of the century, Americans embarked on the construction of suspension bridges which offered greater ease of calculation. The peculiar features of the new material and the manner of working it, which is different from that used with stone or wood, caused the traditional building forms of the historical styles, which were above all adapted to stone structures, to be discontinued. The designing of buildings could be based on but two fundamentally opposed principles: the principle of mathematical engineering and that of the artistically architectural. According to the task set, one or the other of these principles was given preference.
Within a period of approximately two centuries, building has developed from the level of craftsmanship to that of scientifically calculated constructions. After artists and architects had drawn the engineer's attention to the peculiar beauties of his structures, the latter began to set more store by the aesthetic aspect in addition to the principles of statics, construction and economy. The endeavour of the modern engineer to make use of every advantage of the building material and to achieve a maximum of efficiency and usefulness, occasioned a fertile interrelation of constructive principles and creative realization, and has led to novel forms.
Wood has been used for building from time immemorial, steel for the last 150 and ferro-concrete for the past 50 years. Each of the three "rivals" has proved its worth for so long and so convincingly that the three building types may compete, but cannot oust one another. The historical evolution has proved that every new type of building can only increase the efficiency of those already existing, and multiply the variety of their uses. Thus, when ferro-concrete was invented over fifty years ago, steel construction too derived a new impetus.

Development in Switzerland

At the beginning of the 19th century, the textile industry was most advanced in this country. Its machines were first imported from England. By and by textile machine works were established at home. But since the textile industry required a variety of other equipment apart from the textile machines, engineering gradually developed in Switzerland as well. With the advance of industrialization, the machine industry gradually waxed in importance. From this general technical and industrial development, steel construction has emerged.
The building of the Swiss Federal Railways — from 1850 to the outbreak of World War I — constitutes the basis on which the Swiss steel engineering industry could be developed and raised to its present important position. The building of the railway system required many bridges — frequently large ones — for which there was practically no other material, apart from a few exceptions, than steel. The importance of bridge building for steel construction can be grasped to its full extent only when the extremely slow development of steel buildings from 1850 to 1890 is taken into consideration. The large tasks, which would have been proportionate to the efficiency of structural steel, and which would have shown its usefulness and economy, were missing for a long time. Only the erection of the large hall of the Zurich main station in 1867 (Illustration No. 8) and the Zurich Stock Exchange in 1878 caused the use of steel to be taken up in public buildings.
From modest beginnings, steel building came to occupy a position which is now decisive in the steel industry. In particular, two circumstances contributed to this development: the extent of our industrial enterprises and the consequent growth of our principal towns. Steel could perform duties in building which, at least at the stage of development of building technique then attained, other materials could not.
From 1890 onwards, steel constructions became more and more popular for large buildings, above all for office buildings and hotels. One edifice of that period deserves special mention: the Jelmoli Department Store (illustration 10), which is the first instance of an all-steel skeleton structure in Switzerland.
Steel buildings were soon adopted by the industries. One after the other, the large machine works had their workshops and stores constructed in steel.
The era characterized by wider use of steel in building was effectively supported by a new technical development, the exploitation of Swiss water power. The building of power stations produced hydraulic structures in steel. In this field, Switzerland has been largely independent of foreign example, and she has followed developments of her own. Up to the outbreak of World War I the exploitation of Swiss water power had reached major proportions. It is to this development that steel building owes years of practical experience and its present renown far across the frontiers.

Buildings

Steel skeleton structures are characterized by separation into supporting and closing elements. Strictly speaking, a steel skeleton structure is a construction of supports, under-girders and roof bars in steel which constitute the supporting skeleton of a building, which is usually several storeys high and in which walls and ceilings made of other materials are inserted (Illustration 17). There is, therefore, a three-dimensional framework of supports and girders which may be mutually stiffened. The filling system, i. e., the materials for ceilings and walls, assumes the function of closure. It transfers the storey-to-storey stresses to the steel skeleton and, independently of other structural elements, conducts them down to the foundations.
The beginning of this special type of building dates back only a few decades in Europe, while steel skeletons have been common in America for a considerable time, in Chicago since 1883. Owing to the increasing prices of sites, in particular in the centres of the large American towns, it proved necessary to build high on comparatively small areas, and to increase the number of storeys continually. Today, the highest building is the Empire State Building, which was completed in 1948, with 102 storeys and an overall height of 415 metres.
Steel construction also permits of rapid completion of the buildings, since the individual elements can be worked ready for use in the workshop. The short erection times for steel and the dry building of ceilings and wall fillings enable building times to be considerably shortened.
Proof of the popularity of steel constructions in America is given by the fact that up to 50 % of all houses in all the larger towns are built in steel, not only because this is economically more advantageous but also because of the saving of time, which amounts to 60—70 % in America.

Hall structures

Against steel skeleton structures, the wide-span supporting elements for the roofs are the essential features of hall or shell structures. The following points are of importance in the construction of industrial halls: lighting in the roof and walls, execution of the roofing and drainage, crane installations and distances between pillars.

Elements and Building Forms

In the development of steel building forms, a decisive change has taken place of late, which is to be attributed to the manner of joining the structural elements. While rivets and bolts used to be the only connecting means, these are now replaced by electric welding in the workshops. Welding technique allows the engineer greater latitude in form than the former connecting means. Moreover, he is able better to conform to aesthetic requirements, which today are, quite rightly, more exacting.
As a rule, nature and economy in Switzerland do not make great demands upon steel construction as is the case abroad. Our rivers are not so wide that they require bridges of outsize spans, and the prices of building sites in the towns are not yet so high that buildings must be high. Nevertheless, steel building possesses a considerable economic and technical importance, for many building problems would not have been solved in the past and could not be solved in the future with other building materials.

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