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symbols of antiquity integrated in the new structures, the Wall of Servius Tullius and the Thermæ 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 distance 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., Winerthur (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 Jelmolli 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 assumed 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 com-

paratively 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.

#### Liste der Photographen:

- Seite
- 1 Mitte und unten, 2 oben  
Williams & Meyer Co., Chicago
  - 2 unten, 3 oben und Mitte, 4 oben  
rechts und Mitte, 6, 7, 8 oben, 9  
und 10 unten, 11, 12  
Hedrich-Blessing Studio, Chicago
  - 4 unten und 5  
Joseph J. Lucas, Jr., Chicago
  - 15 und 14 Jul. Bachmann, Aarau
  - 15 Luciano Bonetti, Milano
  - 16—19 Räber, Zug
  - 22 Moosbrugger, Zürich
  - 20—21 27 unten, 38 Mitte (unten), 48  
Wolf-Bender's Erben, Zürich
  - 23 Fox Photos Ltd., London
  - 24 unten Sport and General Press  
Agency, London
  - 25 Mitte United States Department of  
the Interior, New York
  - 27 oben und Mitte, 28 oben und unten,  
29 oben, 30 oben und Mitte  
Photos V.S.B., Zürich
  - 29 unten, 36 oben, 37  
Photos Ateliers de Constructions  
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  - 30 unten Ernst Willi, Biel
  - 31 oben W. Schoch, Herisau
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  - 32 oben Höflinger, Basel
  - 32 unten, 33, 34, 35  
Beringer & Pampalucci, Zürich
  - 36 unten M. Vuillemin, Lausanne
  - 38 oben  
M. Wolgensinger SWB, Zürich
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