FIRE WASTE AND ITS PREVENTION
BY BETTER METHODS OF BUILDING CONSTRUCTION

BY

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THESIS

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Harold Vater Hill

ENTITLED Fire Waste and Its Prevention by Better Methods of Building Construction

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Bachelor of Science in Architectural Engineering

Approved:

HEAD OF DEPARTMENT OF

197638
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In the present age of prosperity and business activity, men seek, as in all such periods, lucrative and moderately safe investments in which to put their earnings. To-day, men with large capital are realizing more and more the sound reason of investing their money in real estate. This is especially true in cities, where every day business is becoming more concentrated and where varied industries which depend upon the support of a thickly populated community tend to increase the value of land and buildings. While most investments are more or less speculative, the conservative capitalist reduces the margin of chance to a minimum, and that is why, with modern methods of construction and the present need for office room in a city, investments in mercantile and office buildings are being made to a great extent, as they yield constant returns on the capital invested.

Assuming we have a man with money which he wishes to invest in an office building, he naturally studies three factors which govern the economy of the structure:—the safety of the original investment or initial outlay, the interest bearing ability of the building on its original cost, and running expenses.

There are, in general, only two ways in which a building may unwittingly be destroyed. These are, earth-quake and fire. Besides these, while never alone destroying, yet a destroying agent, is depreciation. Though slow, it is sure and is governed
by well defined laws, everyone knowing that the depreciation of an article varies inversely as its durability. Of earthquakes, however, man seems to have no control, in that he does not know their cause and so cannot prevent them, and on account of the rarity of their occurrence he usually takes a chance and neglects them.

Of all the causes of the destruction of property, fire is the most malignant. Our national government is hedged about by constitutional restraints, leaving it to the different states to legislate on fire waste and fire control. There are as many sets of laws as there are states regulating fire insurance, but very few effective laws for reducing fire waste itself. In Europe, fire waste is guarded and controlled, while fire insurance is permitted to work out its own ends. In this country it seems that fire insurance is hedged about with multitudinous restrictions, while fire waste is permitted to work at its will. In other countries, they seem to realize that fire emanates to a great extent from either criminal indifference or criminal intent and that to this extent it is preventable by laws which hold the individual citizen to a rigid accountability for every act of commission or omission which tends to increase the danger.

The relative fire loss in the United States and Europe may be shown by the following table taken from a report of the U. S. Geological Survey.

Figs 1a and 1b give a comparison of fire loss in some of the principal cities of the United States and Europe for the year 1910 as gathered by the Committee on Statistics and Origin of Fires of the National Board of Fire Underwriters. As a re-
PER CAPITA FIRE LOSSES FOR 1901
IN THE
UNITED STATES
(U.S. Geological Survey)

Geographic Division

South Atlantic: - Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida 2.19
North Central: - Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas 2.37
South Central: - Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas 3.66
Western: - Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, California 2.65

FIRE LOSSES IN SIX EUROPEAN COUNTRIES

Country Years Annual Average Population 1901 Loss per Capita
Austria 1899 - 1902 $7,601,389 26,150,391 0.29
Denmark 1901 660,924 2,688,919 .26
France 1900 - 1904 11,699,275 30,595,500 .30
Germany 1902 27,655,600 36,367,178 .49
Italy 1901 - 1904 4,112,725 32,449,754 .12
Switzerland 1901 - 1903 999,364 3,328,023 .30

Fig. 1.
<table>
<thead>
<tr>
<th>Place</th>
<th>Population</th>
<th>No of Fires</th>
<th>Per cent of Fires Confined to Bldg. or Place of Origin</th>
<th>No. of Fires to 1000 Population</th>
<th>Loss per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Haven</td>
<td>133,605</td>
<td>885</td>
<td>99</td>
<td>6.25</td>
<td>3.68</td>
</tr>
<tr>
<td>Karlsruhe</td>
<td>133,932</td>
<td>99</td>
<td>100</td>
<td>100</td>
<td>1.20</td>
</tr>
<tr>
<td>Christiania</td>
<td>244,000</td>
<td>294</td>
<td>99</td>
<td>97</td>
<td>1.25</td>
</tr>
<tr>
<td>Bremen</td>
<td>246,872</td>
<td>612</td>
<td>100</td>
<td>2.48</td>
<td>2.38</td>
</tr>
<tr>
<td>Kansas City, Mo.</td>
<td>248,381</td>
<td>2249</td>
<td>97</td>
<td>9.04</td>
<td>4.66</td>
</tr>
<tr>
<td>Stuttgart</td>
<td>286,289</td>
<td>414</td>
<td>100</td>
<td>100</td>
<td>1.45</td>
</tr>
<tr>
<td>Frankfurt</td>
<td>414,000</td>
<td>226</td>
<td>100</td>
<td>100</td>
<td>1.34</td>
</tr>
<tr>
<td>San Francisco</td>
<td>416,912</td>
<td>1461</td>
<td>91</td>
<td>3.30</td>
<td>2.81</td>
</tr>
<tr>
<td>Detroit</td>
<td>465,765</td>
<td>2162</td>
<td>77</td>
<td>4.64</td>
<td>2.18</td>
</tr>
<tr>
<td>Lyons</td>
<td>472,144</td>
<td>194</td>
<td>99</td>
<td>99</td>
<td>1.41</td>
</tr>
<tr>
<td>Marseilles</td>
<td>517,498</td>
<td>493</td>
<td>98</td>
<td>98</td>
<td>3.79</td>
</tr>
<tr>
<td>Dresden</td>
<td>386,000</td>
<td>406</td>
<td>100</td>
<td>100</td>
<td>1.33</td>
</tr>
<tr>
<td>Baltimore</td>
<td>558,485</td>
<td>1554</td>
<td>99</td>
<td>2.78</td>
<td>1.29</td>
</tr>
<tr>
<td>Cleveland</td>
<td>560,663</td>
<td>2164</td>
<td>93</td>
<td>3.86</td>
<td>1.19</td>
</tr>
<tr>
<td>Birmingham</td>
<td>570,113</td>
<td>671</td>
<td>98</td>
<td>1.10</td>
<td>1.43</td>
</tr>
<tr>
<td>Boston</td>
<td>616,585</td>
<td>1554</td>
<td>99</td>
<td>2.78</td>
<td>1.29</td>
</tr>
<tr>
<td>St. Louis</td>
<td>687,029</td>
<td>3415</td>
<td>99</td>
<td>4.97</td>
<td>1.68</td>
</tr>
<tr>
<td>Hamburg</td>
<td>934,820</td>
<td>1268</td>
<td>99</td>
<td>1.35</td>
<td>0.31</td>
</tr>
<tr>
<td>Berlin</td>
<td>2,064,153</td>
<td>2002</td>
<td>98</td>
<td>1.00</td>
<td>0.14</td>
</tr>
<tr>
<td>Chicago</td>
<td>3,185,485</td>
<td>10490</td>
<td>95</td>
<td>4.80</td>
<td>2.16</td>
</tr>
<tr>
<td>Paris</td>
<td>2,763,393</td>
<td>3584</td>
<td>1.30</td>
<td>4.83</td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td>14,766,883</td>
<td>14405</td>
<td>3.02</td>
<td>1.78</td>
<td></td>
</tr>
<tr>
<td>London</td>
<td>4,872,710</td>
<td>3941</td>
<td>.80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1a.
COMPARISON OF PER CAPITA LOSS
IN
CITIES OF EQUAL POPULATION
IN
GERMANY AND UNITED STATES
(See Fig. 1a)

New Haven
Kerlsruhe
Kansas City
Bremen
Baltimore
Dresden
Chicago
Berlin

Fig. 1b
suit of this year's United States census, the population of the 297 cities of 50,000 inhabitants or over which reported fire loss is 29,996,723, with a total loss of $71,559,057, giving a per capita loss of $2.39 as against 278 cities with a population of 29,686,754 and a per capita loss of $2.21 in 1909. For the whole country in 1910 with a population of 31,272,266 and a per capita loss of $2.33, there was in 1909, a population of 88,257,957 and a per capita loss of $2.14, showing a disproportionate increase in fire waste.

According to this report there were in 1910, thirty conflagrations in the United States involving losses of $500,000 or over, making a total of $22,532,000. In comparison with this, it is found that out of 43 European cities of 20,000 population and over, there are only three whose annual loss exceeds $375,000.

The year 1907 may be taken as a normal year, in that there were no great conflagrations, and yet in that year in this country, buildings and property contained in them were destroyed to the value of $215,000,000. This amount of money was practically burned up. Besides this, there was spent in the maintenance of fire departments, apparatus, and so called preventative agents and in premiums paid in excess of losses paid in return, $241,400,000. That is, the cost of fire in the United States in 1907 was $456,400,000. It is hard to realize the amount of this loss, but some idea of its enormity may be had when one finds that it is more than the total value of gold, silver, copper and petroleum produced in the United States in that year. Besides this, according to the information gathered by the U.S. Geological Survey, fires caused the death of 1,449 persons and the injury of 5,629 and these figures perhaps do not represent
three-fourths of the actual number (U.S. Geological Survey Bulletin, 418). In the most active building year the country has ever had, new buildings and alterations cost $615,000,000. So it is safe to say that the fire loss per year exceeds, by far, two-thirds of the value of the buildings erected during the year. In January 1903, the national loss by fire was $24,000,000 and during that month only $16,000,000 was spent for new buildings and repairs. This great loss every year may be graphically shown by a few appalling comparisons.

The fire losses in the United States in 1910 would build the Panama Canal in less than two years.

They exceed the total cost of the Army and Navy for the year.

They were greater than the annual expenditure for pensions or the annual cost of the United States postal service.

If all the buildings burned last year in the United States were placed close together on both sides of a street, they would make an avenue of desolation reaching from Chicago to New York City. At each 1,000 feet there would be a building from which a severely injured person had been rescued and every three-fourths of a mile there would be the blackened ruins of a house in which some one had been burned to death.

And thus we might pile up figures upon figures showing the awful waste by fire in the United States. So it seems while we assume that danger by fire is not imminent, it really is an ever present demon of gigantic size which is waiting for the chance to feed itself upon anything it can touch. Europe has .86 fires per 1,000 people; we have 4.05 fires per 1,000 people. What is the cause of this great difference in fire
waste? There are three principal reasons:-- the difference in the point of view and the responsibility of the inhabitants of Europe and those of the United States; the difference in the regulations governing hazards and hazardous materials and conditions, and in the enforcement of such regulations; the difference in the construction of buildings.

Of these three, by far the most apparent and important is the difference between our faulty, inflammable construction and the few frame buildings, especially in cities, which are found in Europe. For instance, looking at Fig. 1a, we find that in 1910 Bremen, Germany, had 581 fires in brick buildings and 15 in frame structures, while Kansas City, Mo. had 666 fires in brick buildings and 879 in frame buildings. The reason for this is simply that there is not nearly as large a per cent of frame buildings in Europe as there is in the United States. Looking at the per cent of fires confined to the building, or place of origin, we find that the values for the United States are only a trifle lower than those for foreign countries, speaking well for our fire departments and so called fire protection. But again, the total number of fires and the per capita loss in this country exceeds shamefully those of any other country, which shows painfully, their efficient fire prevention measures and our deficiency as embodied in good construction.

In every investment, the first consideration is that of safety for the amount invested, and next the amount which can be earned. Investment in buildings is subject to hazards, principally fire and loss from repair. From the foregoing figures does it seem that the office building or any building as generally constructed in the last ten years, is a safe investment?
Hazard, danger and loss smack of speculation and the average builder to-day is a speculator. He is taking long chances in hope of greater gain. How can a conservative man reduce the margin of chance to a minimum? It may be accomplished in two ways; he may erect a building in the ordinary manner, just within the limits of the building laws, carrying co-insurance and thus insuring his building for 90 percent of its value or he may make his building fire proof.

In other words, under modern methods of construction, hazard from fire can be eliminated and it rests with the builder whether he assumes this danger or not. He can have an absolutely fire proof building or he can gamble on the eventual loss of the building,—making it safe and an investment or a risk and a speculation. Which of these courses he pursues depends mainly on the first cost and the relative profit bearing or earning ability of the two buildings.

The money which the building brings in, depends directly upon its "Rentability". If the owner can keep it filled with a desirable class of tenants, it is bearing good interest on the money invested. Its rentability however, depends largely upon its inherent qualities;—convenience, adaptability, comfort and safety. These depend almost wholly on the construction of the building. When built of steel, and terra cotta or reinforced concrete, its adaptability and safety are at as nearly a maximum as can be attained with present methods of construction. It is sanitary, rat proof and vermin proof, which greatly add to the comfort and convenience of tenants. Also in buildings of this type, floor space may be adapted to varying needs by moving partition walls. Again, the fire insurance rates on contents
owned by tenants is reduced. The people that are occupants are willing to pay a higher rent for these advantages, but the question arises, are they willing to pay enough that, when expenses are deducted, the construction of such a building is warranted?

In any building, depreciation has constantly to be met with repairs, taxes are to be paid, and fire insurance must be maintained. The depreciation of a fireproof building is about one-fourth that of a non fireproof building. This means a great saving when the inconvenience and expense of constant repairing and up-keep is considered. A building which is always being repaired, full of cracks and patches, is a nuisance to tenants. And so this saving of three-fourths is most important, to the tenant, a saving in time, convenience and comfort, to the owner, a saving in dollars and cents. On the other hand, fire proof construction is not encouraged by a decreased taxation. To-day the man who builds such a building is virtually taxed upon his self-imposed tax. There is no law compelling him to build perfectly, he does it of his own volition. It is of advantage to him, but also to the city, yet his tax is assessed upon the value of his property and he therefore pays a great deal more than does the man alongside of him with a fire trap. It seems there should be a sliding scale of taxation, regulated with regard to the class of building owned. The expense of fire preventative measures and safeguards is incurred by the municipality for the protection of the cheap inflammable buildings, therefore the owner of such buildings should pay a higher rate on the value of his property than does the man for whom these expenditures are not incurred.

In making these comparisons, we are considering merely a
fire proof and non-fire proof building. A mixture of the two is as worthless for checking and preventing fires as a wholly non-fire proof building. "A chain is as strong as its weakest link" or, in other words, a building is as fire proof as its most vulnerable part. The present day necessity is for absolute elimination of combustible material in the structure, and the thorough protection of materials, which, though incombustible, are damaged by heat. An absolutely fire proof building is not a dream never to be realized; it is essentially the product of good materials put together in a sensible manner. In this day of concrete, terra cotta, brick and metal, such a building is possible.

The Baltimore and San Francisco conflagrations have brought out many faults and advantages in present day construction. Following is an item from the report of the Baltimore fire issued by the National Board of Fire Underwriters. It represents the average of the eight most important so called fire proof buildings which were burned. A study of this fire and the San Francisco conflagration discloses the following facts;-- The contents of so called fire proof buildings were a total loss. The buildings themselves suffered an average damage of over 60 per cent in Baltimore and about 75 per cent in San Francisco. From the table above, it is seen that the two largest items are the mason work and trim and finish. If the fire proof building problem is to be solved in such a manner that conflagrations will not cause serious loss, it seems that a radical revision of the method of finish is necessary. The question arises, what is this revision? What constitutes a fire proof building? How is one to be built?

Great advances have been made toward realizing the ideal fire proof structure. Two great conflagrations have furnished
### Average Building Loss on Eight So-Called Fireproof Buildings (Baltimore)

<table>
<thead>
<tr>
<th></th>
<th>Per Cent of Total Sound Value of Building</th>
<th>Per Cent of Damage to Item</th>
<th>Per Cent Damage to Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundations</td>
<td>5.38</td>
<td>2.5</td>
<td>0.134</td>
</tr>
<tr>
<td>Steel Frame</td>
<td>13.10</td>
<td>12.93</td>
<td>1.69</td>
</tr>
<tr>
<td>Mason Work</td>
<td>29.30</td>
<td>53.125</td>
<td>15.55</td>
</tr>
<tr>
<td>Equipment</td>
<td>19.26</td>
<td>62.52</td>
<td>12.00</td>
</tr>
<tr>
<td>Trim and Finish</td>
<td>29.91</td>
<td>84.18</td>
<td>33.50</td>
</tr>
<tr>
<td>General Expense</td>
<td>3.05</td>
<td>61.39</td>
<td>1.88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>64.75</strong></td>
</tr>
</tbody>
</table>

Fig. 2
an opportunity for the study of fire proofing, its faults and advantages and the relative efficiency of different types of protection in a building. After these two great fires the National Fire Protection Association and the U. S. Geological Survey, sent committees, consisting of the most eminent structural engineers in the country, to the devastated cities to examine minutely the effect of the fire on the different types of buildings. These men, after making most careful investigations, set forth their conclusions in reports, which I have at hand. The results of the investigations have led to the framing of a building code, which tries to eliminate all the faults found in the buildings which went through the Baltimore and San Francisco fires. So it is here that we will find the closest definition of a fire proof building. It is a standard code which may be taken by both engineers and insurance men. It is issued by the National Fire Underwriters and represents the height of fire proof construction to-day. A building erected according to these specifications would be one advocated by insurance Companies. If it receives the seal of their approval, should they not show it to the extent of lowering the rate enough to provide some incentive for erecting such a structure? Will they not, in the end, be benefited?

The following standards are taken from the National Board of Fire Underwriters and represent the basis upon which insurance rates are made on fire proof buildings of the mercantile class.

The construction specified in this code varies greatly from current practise in some cases, mainly in the manner of fire proofing. There has been comparatively little change made in steel design in the last five years, investigation having
shown that the fault generally lies with the fire proofing and not the steel. In document 719 U.S. Geological Survey, a report on the San Francisco fire, the following statement is made:—

"Structural steel in the steel frame buildings subjected to the terrific heat of the conflagration behaved satisfactorily when it was properly and amply protected by any method adopted for fire proofing. In no instance that has come under the observation of the writer has the steel been injured or deformed where such fire proofing was of the proper kind and remained intact after the earth-quake." However one point is mentioned in the report on the Baltimore Fire (National Fire Protection Association) on the DESIGN of COLUMNS, as follows:— "To resist distortion, steel columns should be so designed as to practically equalize the transverse strength of the material in all directions from the axis of the column". Fig. 3 shows a poorly designed column in the Maryland Trust Company building in Baltimore while Figs. 4 and 12 show a well designed column in the Bullock and Jones Building, San Francisco, and the Calvert Building, Baltimore.

Another requirement, often neglected, is that "Pipes or electric wire conduits should not be located inside the column covering." Often the covering is slighted in order to accommodate the pipes and wires. This makes the column more liable to exposure and failure due to the bulging of the pipes. Fig. 5 shows such a case in Baltimore.

Regarding COLUMN COVERINGS, the Baltimore report says:— "Well burned ordinary brick of good quality, properly laid in cement mortar, is the best material now in use as a fire protective covering for steel or iron columns." The four inch brick
protection used on the exterior columns and also on some interior columns, made a remarkably good showing and practically without exception was intact and firm as before the fire." JOHN S. SEWEL, UNITED STATES ARMY, in the report on the San Francisco fire says, "In my judgment columns should either be covered with four inches of brickwork, laid in Portland cement mortar, and have all the interior space filled with concrete, or else they should be inclosed in an expanded metal jacket and the entire interior filled with concrete, so that the minimum thickness of the concrete would not be less than four inches." Figs. 5, 6 and 7 show the failure of hollow tile and wire mesh and plaster fire proofing. Terra cotta in itself is a good protection, but as ordinarily used as a fire protective covering for columns, it lacks stability, and breaks when exposed to heat. However, the standard fire proofing is by brick, tile, cement or terra cotta of sufficient thickness to insulate the metal properly, depending upon the load carried and in no case to be less than a minimum of four inches for columns; for trusses and girders, four inches on exposed sides and two inches on bottom and top plates and flanges; for beams, two inches. An efficient column covering in one in which the concrete is anchored to the columns by means of Number Ten gauge galvanized steel wire wound spirally around them at twelve inch to fourteen inch centers. The wire is sufficiently stiff to spring away from the plates or flat sides of the column and affords a key for the concrete. In all cases, column protection should be independent of partitions and floors as these are liable to fall away from the column, leaving it partially exposed.

Regarding EXTERIOR WALLS, the Baltimore report says, "Stone of any kind is especially susceptible to damage when exposed to
severe heat. Good terra cotta wall trim when reasonably plain
and free from ornamentation involving irregular shapes is superior
to stone but not so desirable as brick. Ordinary well burned
brick of good quality is the most satisfactory fire resistive
material now used in building construction." On the manner of
bonding, the statement is made that wall facings should not be
tied to the wall with metal bonding clips, and all walls should
be bonded with full brick headers, at least every fourth course.
Figs. 3, 8 and 9 show the effect of fire on stone piers and finish.
Fig 10 shows the facing and curtain walls in the Continental
Trust Company building, Baltimore, fallen off on account of buck-
ling spandrel beams and failure of bonding clips. The standard,
with regard to exterior curtain walls is that they shall be of
brick, twelve inches thick at any part, or of reinforced concrete
of eight inch minimum thickness.

As a suggestion for wall treatment, John S. Sewell, Corps
of Engineers, United States Army, in bulletin #324 of the U. S.
Geological Survey, says: - "It would seem that for the exterior of
the structure, walls well built of good, common brick, laid in Port-
land cement mortar, or else of reinforced concrete, could be fin-
ished on the outside with stucco, pebble dash, or some similar
material. The opportunity for the effective use of colors here
would be very great. If the buildings were exposed to a fire,
the exterior finish would probably be a total loss, but its value
in dollars and cents is small. The fire might even strip it off
and cause serious spalling to the main walls underneath, but
even so, the operation of renewing the finish would furnish ade-
quate opportunities for repairing the main wall itself."

HOLLOW TILE PARTITIONS should not be less than six
inches thick, the tiles having webs at least one inch thick. The tiles themselves should be carefully laid in Portland cement mortar, with all joints absolutely filled. Any timber studs should be absolutely prohibited. Still more satisfactory than tile, are REINFORCED CONCRETE PARTITIONS. In all instances where it was used in San Francisco, it gave entirely satisfactory results. It is more expensive than tile, but also more dependable. The standard in partition construction seems to fall short of the best construction, allowing plaster on both sides of expanded metal lath; tile, terra cotta or its equivalent, to be without combustible studding or framing, to rest directly on fireproof floor and to be anchored at the top. Figs. 11 and 12 show failures of plaster block and thin terra cotta tile partitions.

In regard to WALLS AROUND VERTICAL shafts, such as stairs and elevators, Mr. W. C. Robinson of the Underwriters Laboratories Chicago, says, "I am inclined to believe that brick or reinforced concrete, with the reinforcement properly anchored at each floor level, are the materials best suited for elevator enclosures in fireproof buildings". This opinion is somewhat at variance with current practice, which uses terra cotta tile almost entirely, but judging from the results of fires, it seems correct. The standard in this case is brick wall or reinforced not less than four inches thick, well burned tile or terra cotta not less than six inches thick, and if hollow, so constructed that at least two hollow spaces intervene between the two exposed faces with standard doors and no wired glass.

There are in general, only two systems of FLOOR CONSTRUCTION in use in fireproof buildings to-day; concrete and hollow tile. The two conflagrations indicated that commercial methods
of applying both materials are inadequate but also that successful results can be attained with both materials. Where the trouble with tile is that the lower webs spall off, the drawback to concrete is the dehydration of the cement. Tests recently made of a pattern of tile used at the War College indicate that floor tiles subjected to a fire test will stand better if there is but one interior hole through the tiles, all the material which would otherwise be used in the interior webs being concentrated in the outer webs, and the opening in the tile being of circular or elliptical shape, depending on the height and width of the tile. Such a tile would require end construction. According to the standards, floors and roofs should be constructed of brick, tile or terra cotta or concrete properly reinforced. Reinforced concrete and brick floors to be not less than four inches thick if adequate for their load. Tile or terra cotta floors to be not less than six inches thick if adequate for their load. Wood floor surfacing, if any, to be laid on wood nailing strips inbedded in fire proof materials; space beneath wood flooring and between nailing strips to be solidly filled with fire proof materials. With due respect to this standard, wooden floor finish should not be allowed in any portion of the building. Figs. 13 and 14 illustrate the spalling of tile floor arches when subjected to great heat. At the present time, it seems that reinforced concrete is the more advantageous in floor construction and when laid between steel beams at five to seven foot centers, they develop excellent fire resistance.

For LIGHT SHAFTS, the standard is brick, reinforced concrete, tile or terra cotta walls with windows of approved wire glass in stationary or approved automatic closing iron frame.
SKYLIGHTS should be provided with metal frames and sash with approved wire glass or quarter inch thick glass protected by wire screens of Number 12 B. and S. gauge, not over one inch mesh, preferably galvanized, set six inches above glass on substantial iron supports.

ROOF COVERING should be gravel, slag, metal, tile, slate or composition.

STAIRS should be of non-combustible construction. Stone, marble, or slate treads, to be supported upon metal sub-treads.

METAL DOORS and TRIM should be provided, eliminating as far as possible, all combustible material. From Fig. 2, it may be seen that the loss of trim and finish furnished by far the largest item in the per cent of damage, being over one-third of the total loss. In the light of this fact, the tendency is to make all trim as light and as plain as possible and absolutely incombustible. In the Kohl Building, San Francisco, the metal trim and finish resisted and retarded the spread of the fire, frequently confining it in the same room containing the windows through which the flames entered the building.

All these measures will prevent the spread of fire in the structure, but it is not enough that architects and engineers design fire-proof structures to resist fire originating within themselves. Underwriters estimate that fully 60 percent of the danger by fire is from without the building itself. This means that all exterior walls and openings, being often fatal points of weakness in office buildings, should be strictly fire proof and fully protected, always using standard wire glass windows.

So, summarizing these standards, there is only one object in view in recommending them, and that is the absolute
fire-proofing of the building,—a saving in the country's fire waste by preventable measures,—by making it impossible for a fire to start or spread; in short to prevent instead of cure. To repeat, this may be accomplished by the use of good materials, conscientious workmanship and the adoption of methods of fire-proofing which have been tried and tested and found efficient.

The prospective builder will argue that this is too expensive, meaning too great an outlay for the additional safety and economy. It is not enough to tell him that he will be having a great share in the reduction of the fire waste of the country; will be the means, possibly, of saving lives and his neighbors' property; will be building his house on a rock instead of sand. He is not interested in such heroics, but in the investment of his dollars and cents. It is hard to quote to him figures that will show the relative saving in building a fire proof and a non-fire proof structure. There is however, a definite saving in depreciation and insurance. The approximate depreciation of a fire proof building is one-fourth that of a non-fire proof structure. No definite figures can be given, however, as this depreciation cannot be analyzed, but depends upon a great many conditions which are not twice alike. With fire insurance however, given charges are made for given faults in construction and are worked out on a mathematical and analytic basis.

The proper business of insurance companies is not the prevention of fire, but the assumption of risk. Through an insurance policy the risk to which the property of the insured is exposed is assumed by the insuring company. In the ordinances of the guilds of the Middle Ages, we find regulations for the payment of a certain amount of indemnity to any member who suffered loss of
property by fire. This amount bore no relation to the amount of the loss and was taken from no special insurance fund, but was either raised by assessment or was paid out of the general funds of the guild. Then, later, insurance companies were organized which charged a certain sum for assuming the risk. This rate did not vary much and did not attempt to measure the fire hazard. The first application of schedule rating in the United States as far as is known, was in Philadelphia in 1782, when the single company doing business suddenly decided to prohibit the insurance of houses "having a tree or trees planted before them." This action resulted in the formation of a new insurance company by those that had trees planted in front of their houses. This company, of course, also carried insurance on houses without trees and the hazard of the shade trees was covered by a higher rate.

Today, shade trees are a minute part of the complicated hazard. There are schedules of rating which make charges or credits for every tangible thing about a risk that can in any possible way affect the fire hazard. Under the Analytic System of measuring fire hazard which is used at the present time, there are three general classes of hazard to be recognized. The first class takes care of those hazards inherent in or about the building itself, such as construction, occupancy, public and private protection and exposure. The second class, the element of place, has to do with the different amount of losses on the same classes of risk in different localities. The third class, the element of time, covers the changing experience from year to year.

The builder has direct control of the first element of hazard, i.e., the construction, occupancy, protection (public and private), and exposure. When the type of building is selected and
the approximate site known, the occupancy and exposure hazards are out of the hands of the builder, but the construction and private protection are left with him and insurance charged will be made on these parts according to their quality and efficiency charges and credits consisting of percentages of the basis rate are made according to the under standard or over standard condition of the building. Each structure is "surveyed" and the results tabulated as shown in the accompanying "Fire Restrictive Survey." Following are some of the charges for under standard construction.

WALLS:--

For each deficiency in average thickness, add One per cent. If glass not backed up solidly with brick, tile, terra cotta, or concrete, i.e.; when all space between wall columns or supports, with the exception of "apron" wall below windows, is glass and (or) iron, add six percent.

SKYLIGHTS;-- (not standard)

For largest or worst opening of 40 square feet or less add three percent. Increase charge for each additional 40 square feet or greater part thereof, one percent. For each additional skylight, add two percent. Maximum skylight charge, 25%.

FLOORWAYS;--

Thickness less than standard add ten percent. Wood floor surfacing not laid on wood nailing strips imbedded in fire proof materials, for each flooring add five per cent.

STAIRS;--

Not standard, add two percent.

FIREPROOFING;--

Columns, (supporting), all metal not properly covered, add 18 percent. Trusses, girders, beams, floor and roof slabs (support-
# FIRE RESISTIVE SURVEY

## Table of Contents

- **Tariff No.**
- **MAP, Vol., Page, Lot, Block.**
- **Date.**
- **Surveyor.**
- **Town, State, Owner.**

<table>
<thead>
<tr>
<th>Height</th>
<th>Stores, basement, sub-basement, Basis, $</th>
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</thead>
<tbody>
<tr>
<td>Area</td>
<td>Floors, % - (for)</td>
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</tbody>
</table>

- **Walls (occupancy light, ordinary), Construction:**
  - Right, Indpt, party, non-supporting, thickness
  - Left, Indpt, party, non-supporting, thickness
  - Front, Indpt, party, non-supporting, thickness
  - Rear, Indpt, party, non-supporting, thickness
  - Supporting party, right, left, rear, minimum thickness
  - Building communicated with building on right, left rear. Openings protected, unprotected
  - Frame, IC., BV., Sk. IC., iron or glass, right, left, front, rear, stories
  - Tile, terra cotta, HCB, right, left, front, rear, stories
  - Bay Windows (wooden frames), right, left, front, rear, stories continuous
  - Ceilings and Walls, sheathed with wood, strawboard, paper, canvas, stories
  - Non-combustible finish with combustible supports, stories

- **Skylights, No., Size and Description:**
  - Wired, not wired

- **Roof, combustible over fire resistive floor, top story retinue:**
- **Floor Surfacing (wood), nailing strips not imbedded in fire-proof materials, space beneath flooring not filled, floorways:**
- **Floor Supports, roof supports, construction, stories:**

## Memoranda of Floorways and Their Retinues

**Designated Fully Arrangement and Protection of All Vertical Openings**

- **Cockloft or Roof Space, open, closed:**
- **Floorways:**
  - Chutes, Dumb Waiters or Ventilating Shafts
  - Hatchways
  - Stairways

- **Elevators:**

- **Well Holes or Light Shafts:**

## Miscellaneous Floorway Openings

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<th>Floorways</th>
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<th>B-I</th>
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<th>9-10</th>
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<th>12-13</th>
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- **Partitions, non-combustible, combustible, studding, framing, resting on wood wearing floor; stories:**
  - Areas over 2,000 square feet; stories
- **Decks, galleries, platforms, construction:**
  - Area for storage of goods
- **Stairs, construction:**
  - Metal sub-treads
- **Heating, stoves, hot air, water, steam, location:**
- **Lighting, gas, kerosene, gasoline, acetylene, electricity:**

## Exterior Attachments

- **Siding, awnings, stairways, open, boxed:**
  - Bridges, enclosed, open, sides
- **Roof, monitors, roof houses:**
- **Additions (not fire resistive), brick, HCB, tile, Sk. IC., BV., frame, IC., communicating (not cut off), height:**
  - Area = % of combined area, increased, decreased
- **Roof area:**
  - % of combined area, + 2

## Fire Proofing, beams, trusses, girders, posts, columns, reinforcing members

- **Power, see fourth page:**
- **Occupancy, see schedule third page:**
  - Charge and credit totals
  - Balance of percentages extended

**Carried forward**

**Total**
ing) all metal not properly covered, add twelve percent.

The builder knows of these deficiencies and their charges and, if wise, builds up to the standard. But this standard is not an absolutely fire proof building. It could not come through a conflagration with a much better showing than did the so-called fire proof buildings of San Francisco. Our need is for a non-combustible building; - one without a weak or vulnerable point, an over standard structure. There is fire insurance economy in erecting such a building, for a lessened hazard is realized and rates are lowered. Certain features are credited as follows:

**STRUCTURAL FEATURES.**

The following credits are percentages of Occupied Building Estimate and should be deducted before giving credit for protective features.

- Interior finish, entirely free from stone or marble veneering and decorations other than unfinished terra cotta, deduct three percent.

- Building entirely free from wood floor surfacing deduct seven percent.

- Building entirely free from combustible frames, sash, doors, base boards, chair rails and mouldings, deduct five percent.

When the total floor area of all rooms and hallways or corridors, with stone or marble veneering or decorations other than unfinished terra cotta or with wood floor surfacing or combustible frames, sash, doors, base boards, chair rails or mouldings, does not exceed one-tenth the total floor area of building, half of these credits may be allowed. If such floor area does not exceed one-twentieth the total floor area of building and does not exceed 600 square feet, the full credit may be allowed.
Building occupied exclusively by light Occupancies entirely free from combustible furniture and fixtures deduct three percent.

PROTECTIVE FEATURES:

Inside standpipes and hose attached (approved arrangement and water supply) deduct five percent. Under certain conditions this may be raised to eight percent.

Automatic Fire Alarm System (approved) connected with paid fire department with permanent men and horses constantly on duty deduct ten percent.

Chemical extinguishers, one to each 4000 square feet of floor area deduct five percent.

Watchman with approved system reporting to central station deduct ten percent.

A comparison of the structural credits and protective credits shows that a great deal more stress is laid on protection than prevention. There is greater advantage in building standard and applying protective features than in building "over standard" without protective features. In other words, it is considered more important to have a cure at hand in case a fire starts than to have a permanent preventative. We have not yet come to the European point of view and our fire waste still increases. Millions of dollars are wasted annually and hundreds of lives are lost.

The fact remains, that the logical method for reducing our fire waste is by preventing fire loss by better construction. A fire-proof city is far in the future but inevitable as we can see our lumber resources rapidly decrease each year. The man who builds a fire proof building is not rewarded proportionately to his increased expense, but he is reducing the
margin of chance on the burning of his structure. At additional expense, he has made his investment safe and he is sure to reap his satisfaction from knowing that his building is safe from fire; is not a menace to his neighbors' property; is not a trap for his tenants; but is one step in the direction of the prevention of our national extravagance and shame,—our annual $200,000,000 bonfire.
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