bourne, would be cordially welcome to the rooms and meetings of the Institute during their sojourn here. The Joint Rooms Committee, representing the Architects, Engineers and Surveyors, had decided to extend the invitation to all their rooms and all officers.

Professor W. C. Kernot intimated that their newly-elected Vice-President had just been advanced to the military rank of Colonel. He congratulated Colonel Monash on his advancement.

Messrs. G. Lorimer and P. Alexander were selected to act as scrutineers, and after a ballot declared that Mr. A. K. T. Samble had been elected a Member of the Institute.

Colonel J. Monash's paper, "Notes on Building Construction," was further discussed and, after the author had replied, the discussion was closed.

The President called upon Mr. H. J. I. Bilton to read his paper upon "Coefficients of Discharge for Circular Orifices."

After the reading the President said that the paper showed evidence of a large amount of careful original research work, and the results would be of much advantage, but there could not be satisfactory criticism until the paper had been printed and circulated. At the next meeting the matter could be fully discussed.

Professor W. C. Kernot moved a vote of thanks to the author for his paper, which was a fine piece of accurate scientific work.

Colonel Monash concurred, and had much pleasure in seconding the motion, which was carried by acclamation.

At 10.25 p.m. the meeting closed.

DISCUSSION.

NOTES ON BUILDING CONSTRUCTION.

The President said that Colonel Monash's paper was read in November. The recess had intervened, and matters might not be quite so fresh in members' minds as they would wish. Still there were many points in the paper worthy of discussion. He would quote one or two passages that seemed to him to strike a keynote:—"Mr. Anketell Henderson . . . has made out a strong case for the thorough revision of our building laws. Such a revision, however, if confined merely to the correction of anomalies, would proceed but a very little way upon progressive lines, and what has really become a crying need is the entire creation of a comprehensive set of ordinances permitting and regulating the introduction of methods of design and construction, which, when placed in contrast with existing forms, will constitute what may, without exaggeration, be described as a revolution in build-
ing practice.” . . . . “educating the community to a proper understanding and appreciation of, and a confidence in, up-to-date methods; and to this end it is necessary that the professions themselves should take up this subject vigorously, and by means of papers and discussions arrive at a sound basis for future practice.” Another salient point was contained in the following passage: “The keynote, therefore, of the modern principle of building design is the entire abolition of the massive external walls, and all their attendant evils.” These appeared to be some of the leading points.

Since the paper had been read many matters that were advocated had materialised or were materialising. The building regulations were being wholly redrafted and were becoming something in touch with modern thought and practice. The City Council was dealing with the matter, and had asked the Institutes of Engineers and Architects to submit suggestions. Scientific testing of materials, specifications of permissible loads and stresses, rules for statical calculation, determination of internal forces, legislation for steel-framed and reinforced concrete structures, artificial lighting and ventilation, were examples of the subjects referred to the Institute. If the paper were well discussed it would give light to the committee in dealing with further matters they would have before them.

Professor W. C. Kernot said he had expressed his full approval of Colonel Monash’s views on the last occasion on which the paper was before them. An important matter was that fire obstruction should be horizontal rather than vertical. If they put up four massive walls and a series of light, inflammable floors between them, they simply made a very fine furnace. But if they put up a series of horizontal fire breaks connected by columns the fire had much greater difficulty in developing.

Any consideration he had given the matter since the last meeting went to show that the horizontal firebreak was the only effective method of dealing with a fire. If they watched the progress of a fire they generally found it at first spread comparatively slowly until the roof fell in, and then there was a huge furnace. He thought they should not sink their money in enormously massive outside walls, which the fire did not attack very strongly, but rather in fireproof floors. The fireproof roof was an idea well worth consideration. He had known many cases in which fires had spread by working through the roofs of buildings. He saw no reason to object to the contention put forward by Colonel Monash at a previous meeting that they should not put so much fireproof material in the walls, but rather spread it in layers between story and story, and especially in a fireproof roof.

Mr. J. T. Noble Anderson said he would like to express his appreciation of the paper. Colonel Monash had adopted the very wise plan of making one point very strong, and had especially brought out the efficiency of the horizontal fire break. In
the case of a boiler he thought they had the best possible example of the point Colonel Monash had emphasised. Everyone knew that the surface above the fire was four or five times as effective in transmitting heat as that at the side; and a flat surface immediately above the flame was in the position to act as the most effective fire-break.

He might perhaps say there were two points in the proposed bye-laws that seemed to him incompatible. On the one hand they provided for fireproof construction, a measure which would mean more or less of a reformation in the buildings of Melbourne; and on the other hand, they restricted the buildings to a limit which for a climate like this seemed to him to be absurdly low. The remuneration to be obtained from a building in a city, where land was expensive, largely depended on the height to which the building could be raised. He was told by Reginald Bolton, the expert on the lift question in New York, that his clients, who had built eight or ten years ago, and had limited themselves to 20 stories, were now mad with themselves for not going to 30 stories. The remuneration from 30 stories as compared with 20 was almost double. Unless they had the facilities to make money on their land they could not afford to pull down their houses and build better ones. To restrict the height to 90 feet was absurdly low. What reason was there why they should restrict themselves here? In some cities in the north heights of 120ft. or 130ft. did not obstruct the ancient light—eclipse the sun and put the street in shade. We had a brighter sky over us than they had in New York. There they built to 250ft. But they paid no attention to bye-laws. Reginald Bolton had said he had recently designed lifts for a building 750ft. high. That would no doubt be the limit for some years to come, for the simple reason that the lifts took up nearly all the floor space on the ground floor.

The point he wanted to make was that if the bye-laws were adopted and carried out as at present proposed there would not be many improvements to buildings at present in existence in Melbourne. At the same time, such a restriction could not hold for long. Very soon public needs would make themselves known, and the bye-laws would be revised. Melbourne regulations restricted buildings to a similar limit to San Francisco, which was notoriously subject to severe earthquakes. Big buildings should be compelled to have water tanks over the roof; that very simple expedient completely answered all criticism on the fire danger question.

The President asked how the water would be supplied to the tanks.

Mr. Anderson said every building would have its own pumping plant. In New York that was the practice.

Mr. H. Conradi said he thought the time was now ripe in Melbourne for some radical change to be made in the present methods of building to bring us more up to date with other
countries, with better building regulations. He thought we were on the right track. The massive 2f. 3in. wall was doomed, and would have to give way to a lighter 9in. wall and steel framing, where the loading and wind stress could be scientifically provided for. He thought that beyond doubt the safest and best method of frame construction was in steel, where one could be absolutely sure of the material (such as steel stanchions and rolled steel joints) to carry all the loading, with proper wind bracing, all covered in with a coating of cement concrete held in position by expanded metal. Floors of concrete and expanded metal provided an excellent fire-break and gave facility for putting in any necessary bracing. The Author mentioned reinforced concrete as a material for building purposes, and there was no doubt that placed in the right hands it was an excellent one; but the speaker thought, referring more especially to building, that the great danger lay in the fact that the actual work was carried out by unskilled labour. And so much depended on the materials and the mixing, etc., that unless a great amount of supervision was carried out constantly, the designer's calculation would be very soon upset, and that supervision must continue until the whole of the structure was set. Take a case in point. In a four story building in Philadelphia the building was almost completed when a labourer, through ignorance, removed a few struts from a girder which had not set properly, the result being the collapse of the building. He just mentioned this to show how close the supervision must be. Of course unprotected steel in a building was a great danger, as illustrated by the recent fire at Wallach's. Whilst watching that fire he was very much struck with the unprotected nature of the top stories of the adjoining buildings, the windows of which had no shutter or protection of any kind, and should any of them have broken with the great heat the showers of sparks would have set the buildings alight at once.

Mr. R. O. Thompson said he could easily imagine that a company carrying on extensive works would have supervision that a private contractor could not maintain. He had had a great deal to do with concrete, and had found that the difficulty was to get the material properly mixed by the labourers.

Colonel J. Monash, in reply, said he would first allude to the question raised by Mr. Conradi and Mr. Thompson as to the reliability of the structure depending on efficient supervision. Everything they had said was true so far as it went. But it was purely a matter of development. To take an analagous case, they might imagine the case of a man who constructed the first large span bridge—say of 500 feet span. Did they not think that man was there to see every rivet put in and to personally test every one of them? He would do so because he knew the safety of the whole structure might depend on one rivet. To-day he would not have the slightest concern or anxiety on the subject.
In precisely the same way, in the course of evolution, the same thing would come about in connection with those newer building methods. The practitioner of to-day had to waste his time and energies in assuring himself that his designs were being faithfully carried out by men who knew little about it; but the time would come when that knowledge would so permeate the community that the designer of the steel frame or reinforced concrete structure would rest securely without wondering what was going to happen during his absence. It was a necessary stage in a new departure in industrial art.

As Mr. Conradi had so cordially agreed with the broad conclusions of his paper, it might seem ungracious to join issue with him in connection with one of his contentions. Mr. Conradi had said the best material for building was steel frame cased in concrete. With that he agreed. There was no better. Mr. Conradi then proceeded to speak of floors of expanded metal and concrete. What was that but reinforced concrete? Why should they, when they used the term reinforced concrete, say they must be particular about the mixing and gauging of their concrete, whilst if they used the term "expanded metal," by some magic process all anxiety about concrete and its mixing and placing should disappear? He was pointing out an actual fallacy that pervaded the technical community of to-day.

Mr. Conradi’s remarks were perfectly true, but were deserving of a wider application than he gave them. In using the expanded metal they would have to take precisely the same care with their concrete as they would if they used plain round bars or any of the other reinforcing materials on the market. Unless they recognised that they would have failures.

The concrete as now used was a scientific material. It was a different material altogether from that they had been accustomed to ten or twenty years go, and until the technical community thoroughly recognised that fact the whole subject would be surrounded with danger and anxiety.

Referring to the more general remarks which had been made, the paper was written in October for the express purpose of stimulating interest among the professions, because then the proposal to review the building laws both of the city of Melbourne and the Southern Suburbs was under discussion, and the fear was that unless the professions took the lead in discussing the question, the public might be so apathetic that the public officers would not receive sufficient support from public opinion to enable them to carry the matter forward. Since then the matter had been very much before the public. As far as the proposals stood he had in a broad and general way to give them his cordial concurrence and support. They still had not arrived at the point where they had been passed into law, and it was still possible that a conservative public opinion might attempt to upset the passage of the proposals. His purpose was to start a discussion on technical details, so that the professions might be brought to support the
public officers when the matter came up finally for public discussion. At present there seemed to be no likelihood that there would be any objection. He confessed to disappointment that the paper had not been more actively criticised. He had ventured to proclaim opinions which many gentlemen might differ from very materially. As it happened, those members who had addressed themselves to the subject had been kind enough to say that they agreed with him. That left him nothing further to say.

The President said Colonel Monash and those who had discussed the paper had left very little to say in summing up. In regard to building regulations, he thought that all that they desired as engineers was being done.

As to the height of buildings in the wide streets: The fire brigade authorities desired 90ft., the Institute of Engineers considered 110ft. sufficient, and the Architects, he believed, had fixed upon 120ft. There had been a great deal of discussion, and probably some height between 110ft. and 120ft would be decided upon. Melbourne's natural advantages in regard to light and air no doubt might be considered as capital to be fully utilised, but Melbourne could spread indefinitely, whilst New York, for instance, could not, and the balance of opinion appeared to be in favour of building generally to medium height rather than having fewer buildings of a great height.

Discussion closed.

PAPER.

COEFFICIENTS OF DISCHARGE FOR CIRCULAR ORIFICES.

By Mr. H. J. I. Bilton.

The discharge of circular orifices has been, perhaps, one of the most closely investigated subjects in hydraulics, numerous tests having been made by experimenters all the world over. Nevertheless, the information at present available, although sufficiently approximate for ordinary practical requirements, is contradictory and uncertain in its details.

It is known that the coefficient of velocity at the contracted vein is unity within a small fraction of one per cent, i.e., the velocity is as nearly as possible equal to the theoretical velocity \( \sqrt{2gH} \). The coefficient of contraction is usually given as about .62, i.e., the area of the contracted vein is approximately \( \frac{2}{3} \) of the area of the orifice, varying as the coefficient of discharge. The coefficient of discharge is usually given by the text books as .62 (the mean of a large number of experiments), but
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