most severe way to accomplish deliberate destruction, and those conditions did not prevail in actual practice.

He would like to put Mr. Fowler right on one point. He did not want the Institute to get the impression that his paper was an unreserved advocacy of reinforced concrete. It was an advocacy of framed structures, no matter what the material. They wanted to get away from the heavy stability walls.

He was bitterly disappointed that there had not been a fierce discussion on the subject. He would like to see a strong discussion, as there was evidence of a wide diversity of opinion. He held strong views on the matter, and was open to conviction that those views were wrong. On the other hand, he would like the opportunity of convincing others who did not agree with him. They all knew that the building regulations of the metropolis were in the melting pot, and the more they discussed the question and arrived at a proper basis for a future standard, the better for the community.

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PAPER.

NOTES ON CURRENT ENGINEERING PROGRESS.

By Mr. J. T. Noble Anderson.

Looking back on recent wanderings extended over fifty thousand miles, and embracing three continents, it is no easy task to select a few notes to fill the very limited time that has been accorded. The temptation is to recite scenes calculated to strike the imagination—the magical crucibles of Niagara. the hot rush of work at Pittsburg, the immense, well-ordered modern workshops which the past few years have conjured into existence on historic sites at Sheffield and Manchester, the architectural growth of Continental European cities, or the sensational growth of Mexican engineering works. Leaving these, I can, however, most usefully fill the time with some brief outline of what is going on in my own line—hydraulic engineering. This is a branch on which I have laboured for a quarter of a century, and besides being myself so familiar with these subjects, they (water supply, sewerage, irrigation and works of hydraulic power) are very live subjects in this community. Incidentally, after sketching out what is doing in these branches, I purpose touching also on the subject which is always in the minds of most of us—namely, the standing and emoluments of our profession.

In the eighties, when I had graduated into the ranks of British hydraulic engineers, we took peculiar pride in the fact that our limited numbers contained all those great men who had so far
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really successfully grappled with hydraulic works in our day, and we believed that our greatest asset was the experience of their methods gained under them.

To a great extent this has changed. It is true that Deacon Hill, and Binnie and Latham, still are at the head, and the vacancies left by such men as Hawksley, Bateman, and Crimp are well filled by their sons or partners, but, nowadays, much which then could only be learnt under them, can now be found in various easily accessible publications, and the thorough methods of outside work which we imagined to be confined to the British school, are now equalled, not only in India and Egypt, but in America.

Further, while British engineers still hold the supreme place in many matters, notably in dealing with the subjects of water purification and sewerage disposal, which modern chemists have made so complex, it has fallen to the lot of American engineers to carry out the biggest and boldest works—passing anything yet attempted, even by the Indian and Egyptian pupils of the British school.

Perhaps nothing is more noticeable than the change which a couple of decades have wrought in American engineering: Formerly American engineers were almost exclusively occupied with railway extensions and transport questions, and America alone employed more railway men than all the rest of the world. Now, though the present year has seen a record in railway construction activity in the States, the greatest demand is for the hydraulic engineer. With this change has come the demand for a higher class of engineering skill, requiring not only greater care and insight into the practical points of construction and qualities of masonry, and an outdoor acquaintance with engineering geology, but also a learned acquaintance with much difficult engineering theory. Hence it comes that to-day every civil engineer is expected to enter his profession through the Universities; and it is almost impossible to meet a successful engineer of less than forty years of age, who has not taken a degree.

Here I would remark that while the United States may not be generally regarded as the place to look for those distinct social grades which form so large a part in the life and work of British communities, yet among no class have I met a more comfortable sodality or more of that true courtesy and refinement which should distinguish the highest rank, than among my brethren in the American Society of Civil Engineers. Like British engineers they have the advantage of a liberal education, but to a far greater extent they are accustomed to a universal regard and respect from the rest of their fellow citizens. There the respect paid to the leading engineer is far more flattering than any paid to judges or senators.

To illustrate what they are doing, I will pick out two or three urban water supply works. These will show the extent to which this class of work is being developed in America. (In the following, gallons are always U.S. gallons, equivalent to .833 of
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an imperial gallon.) Waldo Smith, engineer-in-chief, furnishes the following terse statement of the recently adopted Catskill Mountains scheme for augmenting New York's water supply—

"The City's Need of Water."

"The population of the greater city to-day approximates 4,300,000. The total consumption of water is 500 million gallons per diem, of which the Croton System, when completely developed, in 1910, can be relied on to furnish 325 million gallons. The population of greater New York is estimated 5,260,000 at the end of 1915, and its water consumption, 710 million gallons, or 250 millions above the present available public supply."

The discrepancy between 500 millions and 460 millions quoted above is clearly due to the omission in the latter of private supplies, which will be abandoned when the new schemes are completed.

"In 1930 the population will have increased to almost 7,000,000, and the consumption to over 1,000 million gallons daily."

"Cost of the Works."

"The cost of the Catskill works included in the present project for supplying soft filtered water at high pressure by gravity to all boroughs, is estimated at $162,000,000 dollars. Great as will be the cost of these works, it will not be a heavy burden per capita."

"Experience has shown that the water works of large cities if reasonable rates are charged for water, have sufficient earning capacity to pay for their operation and the investment on construction, so that the city practically lends only its credit for the construction of the works."

The cost of the present Croton scheme to supply 325 million gallons of unfiltered water at a pressure of, say, 100 feet to the Boroughs of Manhattan and Bronx alone will approximate $90,000,000 dollars.

So rapidly have the city and its five boroughs increased their demand for water that it will be seen this new scheme has had to be pushed on before the great Croton scheme was completed. In fact, it was less than two years from the date (1905) when this scheme was laid before the legislature, before the necessary lands have been acquired, and the contracts for the aqueduct let.

There can be no doubt but this is the greatest city water supply scheme ever undertaken. I am informed by Mr. Lewis, the Engineer-in-chief of the Board of Estimate and Appointment (similar to the Board of Works, Great Britain), on whose recommendation this scheme was approved, that eventually, say in 1950, he expects this scheme will supply 800 million gallons towards the needs of a population of ten millions, and will have cost a quarter of a billion dollars (over £50,000,000).
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Such is one example of the energy with which water supply works are being prosecuted, and great as is the commitment of New York, Mr. Benzenberg, the President of the American Society of Civil Engineers, states that in money value at least, the other cities of the States have in the aggregate an even greater commitment.

The map accompanying Mr. Waldo Smith's memorandum shows the latest details of the scheme up to June 25th of the present year. He has marked Contract No. 2 on it. It is noticeable that on plan the general distance from water shed to city and its elevated character bear a passing resemblance to the celebrated Thirlmere works for the supply of Manchester (England). The area of water shed and the capacity of the impounding reservoirs and aqueducts are, however, vastly different. The actual water shed to be acquired in the Catskill exceeds 900 square miles, and the water is filtered, while one reservoir alone, the Esopus, is to hold 170 billion gallons, and it will have a water surface of over 10,000 acres, and a dam of cyclopean masonry 220 feet above the creek bed, and of earth with concrete core 120 feet.

A second work completed, and working satisfactorily for the last three years, is for the rapidly growing city of St. Louis, Mo. While New York's works may be interesting to the Melbournite, these St. Louis, Mo., works will interest the citizens of our inland towns, which can only use water pumped from rivers or irrigation channels.

The works for clarification and purifying by sedimentation (no filtration is resorted to) occupy a little over 30 acres, above the Big Four Bridge—say half a mile up stream from the celebrated Eads Bridge. Here a daily supply of over 70 million gallons is treated. The population of St. Louis was estimated last year at 700,000. The treatment is merely by agitation with lime and sulphate of iron.

Personally, I may say that the water seems very satisfactory, it tastes well, and is clear and pleasant to look at, and bacteriological returns show that it is not much above the 100 bacteria standard, in fact over 98 per cent. of the life of the river water can be relied on to be removed.

Naturally, the inhabitants of the Middle West, accustomed to drink the cloudy and more or less turbid waters of the Mississippi and its branches, are more than pleased.

It is a pretty generally accepted view among American engineers that a great river, or a large impounding reservoir, is the greatest safeguard. But occasional outbreaks of disease on the Mississippi have more than justified the treatment, and the extreme cheapness of the treatment of such waters is a most reassuring feature of the question.

A third city has a water supply which would perhaps be of interest to some places situated in plains, and looking for extension of its water supply, as Christchurch, N.Z., will ultimately
be. I refer to Mexico. Up to now the needs of Mexico (city) population, barely 400,000, were met by such springs as Malinche, where over six million gallons of the purest water rises under artesian pressure and flows from Chapultepec rock, the highest place near the city, and several artesian bores which supply water under varying pressures. These in the past were ample for the not very exacting population, the majority of whom only wash when it becomes a religious duty once a year on St. John's Day. With the advent of modern sanitation, water closets, and such improvements, which the forward policy of the Government introduced along with a complete drainage and sewerage scheme, extensions of water supply had to be sought. These have been got at springs less than twenty miles from the city. Here a series of large wells sunk beside the lakes have struck some fifty million gallons a day, which is pumped to a sufficient pressure (160 feet head) to command the city and suburbs, with a combined population of 550,000.

The works for this are rather more than two-thirds completed. At St. Louis, reinforced concrete construction seemed to have been used everywhere in the water works. But nowhere have I seen so many and varied applications of this modern system as in Mexico, where peculiar pains are taken to avoid earthquake fractures.

Travelling west and south of St. Louis hydraulic works of a different character are met. In the Eastern States and Canada there are many water-power works, but most of them are at lesser heads than Niagara (160 feet). The western works, being in greater mountains, often utilize pressures of many hundreds of feet, and at the same time the irrigation schemes require immense water channels, and impounding reservoirs at a very cheap initial cost. The boldest schemes such as the Los Angelos water supply and irrigation schemes are being vigorously pushed ahead.

The one feature which drew me to these regions was to make myself acquainted with as many varieties of work on "hydraulic fill" dams as possible. So far little, if any, mention of this method has found its way into the leading engineering publications, although it is not altogether novel, having been in use occasionally in one place or another almost as long as nozzle hydraulicicing. Consequently it is only a very familiar subject to a few engineers, and a brief description may not be out of place.

The method is known as the "hydraulic fill," because the material for the dam is not only obtained by loosening it from its original site by the hydraulic jet, but it is conveyed on to the dam site by the gravity channels carrying away this sluiced down material. Of course a sufficient velocity must be obtained in the channels, flumes, or pipes, to transport the heavy stones required for the beaching of the bank. With these large reservoirs, often situated in vast windy plains, an immensely greater quantity of rock is deposited as beaching than in any ordinary dam—some having the heavy beaching extending into the bank.
to a thickness of over 20 yards. To retain the finer material the rock sides of the dam are first constructed of beaching on the water side, and a stone berm on the dry side from the heaviest obtainable rock, and these are always carried up a few feet higher than the rest of the bank, the more fluid material is run into the pond formed between. In this way excellent puddle can be pumped into the "core" and any desirable mixture of puddle clay, sand or gravel, can be deposited in the "selected material" parts of the dam.

The superior nature of this method of construction can be gathered from the fact that after completion there is practically no settlement, such as occurs in dams made by ordinary methods. Relying on this, these dams are being made to heights of 180 feet. Contrary to what might be expected the wastage of material is very slight—some engineers having claimed that 95 per cent. of all material excavated has gone into their dams. But perhaps the greatest feature of this method of construction is its extreme cheapness, the average price being about two pence halfpenny per cubic yard—and obviously the dam need not be made of any greater dimensions than in the old style.

The accompanying photograph will give a fair idea of the usual methods adopted to bring the stuff on to the bank, and the appearance of the bank, during construction.

There is now only time for a few concluding words. In all my travels I have nowhere found a city which has striven to better purpose to establish itself as an empire city than Mel-
bourne. No place else has striven so consistently and to such good purpose to not only fit itself for a leading place in the great competition for wealth, but also to beautify itself and supply all that can contribute to the pleasure and enjoyment of its citizens. With such an example, within easy reach of Sydney, Newcastle and the goldfields, our young engineers need not envy the opportunities of the cadets in Europe nor America. It is true that in America the avenues to employment are so numerous that the young engineer can obtain—during the ten or fifteen years' work before he is fitted for a permanent responsible post, a variety of practice which is now-a-days hardly possible here—but this favourable state of affairs has been due to the steady increase of the demand for engineers, and I prophesy that in the aspect of readily obtaining remunerative work, the young Australian student will be in a superior position to the American, because the flood of young men rushing into the Universities there is amazing. Professor Ira Baker (Illinois) told me that within the last five years his University had increased the numbers in the Engineering School from 600 to 1800 students, and that the majority of these succeeded in obtaining enough outside practical work to pay all their University expenses.

Already the supply of well qualified engineers has exceeded the demand in Great Britain.

This fact does not augur well for the future emoluments of the profession. However, with the greater complexity of modern engineering, with the immense interests which will have to be controlled by engineers, it is becoming more and more necessary for the more responsible posts to obtain men of the highest natural talents and men who can command the greatest possible public respect in their integrity; and the public are more and more realizing that almost no wage is too high to pay the right man for such posts.

The result is that the movement which has generally lowered the salaries of municipal and county engineers has had no effect whatever to touch the emoluments of a few at the head of the profession, and to-day there are quite a large number of engineers in America who earn over 50,000 dollars (£10,000) a year, and in the Argentine I know of a case where one railway expert for giving his services for about one week before the law courts, received a fee of over £1400.

Such emoluments are more in the nature of the great rewards won by our leading songsters, and obviously should have a little concern for the rank and file. Unfortunately the slight concern they have is of a prejudicial nature, because much of the pressure from ambitious young men to enter the profession, which is reducing the earnings of the junior posts to less than a "living wage," is stimulated by the dazzling prospect of such ultimate princely gains. Here in Australia, however, the democratic nature of our governments has prevented this state of affairs. At the same time certain aspects of the local government
Acts have placed many municipal engineers in a position which compels them to become road overseers and works inspectors. The position is unsatisfactory to the country at large, and unfair to men who have been induced to qualify for a difficult profession, only to find the opportunities to practise it prescribed and their acquired and natural abilities thwarted and their proper work usurped by unqualified municipal councillors.

It certainly is good that there should be keen public attention to some matters, and ample restraints on public officers; but a larger and stronger measure of government supervision of works, and such powers of control from a higher Government Department, as will prevent the abuse of the engineer being compelled to do inspector’s work, and to sacrifice the other duties which his council do not understand or appreciate. As things now are, it would be better for all parties for many country shires to have merely a works’ and road inspector and leave all matters of new survey and road location severely alone, and a similar state of affairs exists with larger and more important bodies.
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