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A REVIEW OF BRANZ FOOD INDUSTRY FLOORING RESEARCH 1975-85

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BUILDING RESEARCH ASSOCIATION OF NEW ZEALAND

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ABSTRACT

Research into the properties and performance of flooring materials used in freezing works (export abattoirs) was initiated in 1975. Since that time a comprehensive programme has included surveys of freezing works and related food processing industries, surveys of flooring material manufacturers, development of laboratory test methods to measure resistance to abrasion, corrosion, impact and slip resistance, development of a design guide and a model specification, and research into flooring material formulation. Each aspect of the programme is briefly described and the main points highlighted.

KEYWORDS

Abattoirs; Abrasion; BRANZ; Case histories; Concrete; Construction; Cracking; Design; Epoxy resins; Fired clay; Floors; Food processing; Impact; Polyesters; Polymer concretes; Resins; Specifications; Standards.

INTRODUCTION

With Britain's entry into the EEC in 1972, higher hygiene standards were required from her traditional meat suppliers. As a consequence, an upgrading programme was required in a number of New Zealand freezing works. Initially, the Meat Industry Research Institute of New Zealand (MIRINZ) surveyed freezing works to identify factors causing damage to flooring. Subsequently BRANZ was invited to develop laboratory tests which could be used to screen candidate flooring materials for freezing works use.

As a first stage, the MIRINZ survey was supplemented by a postal survey, and inspection and analysis of the performance of flooring materials in freezing works. A second survey was made of manufacturers and suppliers to see what range and types of flooring materials were available to the meat industry.

The next stage was the establishment of test methods in the laboratory. These tests were used to measure the abrasion, corrosion, impact and slip resistance of the flooring materials. Concurrently, a further limited freezing works survey was carried out in 1977 , and a limited survey of related industries in 1979.

Following the publication of the test methods and suggestions for minimum performance levels in 1978-82, a number of commercial materials currently available were tested, and the test results on those named materials published. The final phases of the project have seen the publication of a summary of these test results, updating of the directory of manufacturers, and the publication of a design guide and a model specification. Further work, relating to the study of the composition of polymer concretes, will be described by Bennett et al at this Conference.

Methods and, more particularly, results and conclusions from the various project phases are described below:

PRELIMINARY SURVEY OF FREEZING WORKS

(See Sharman 1976 a)

This comprised a postal survey of all the then (1975) existing freezing works, followed by a personal inspection of 15 of them.

The survey results reflected the age of the building stock (only three new works opened between 1960 and 1975) and the consequent condition of the floors, particularly in by-product processing areas. A summary was made of the meat and by-product processing operations, and the mechanical and/or chemical components of them.

The major flooring material in freezing works processing areas in 1975 was concrete. Problems noted included the high incidence of corrosion in by-products areas, impact and abrasion damage, and general problems of cracking, joint failure, and slipperiness. These were due to factors such as: multiple layers of toppings, which made water leaks in multistorey construction hard to trace; an absence of joints or overwide joints damaged by wheeled traffic; hard steel trowelled floors which consequently were slippery; and specification of concrete strengths for flooring which were below the minimum considered necessary for industrial flooring.

Ceramic tiles were not widely used, although a number of freezing works contained some tiled floors. Thin tiles had suffered abrasion or impact damage, thicker ones were more durable. Grooves or ridges on tiles were much less effective than pyramidal patterns in providing slip resistance. There was widespread corrosion of cement-based tile grouts in areas such as pelthouses, and subsequent damage to joint edges by wheeled traffic.

Polymer concrete, mainly as patches on ordinary concrete, was quite widely used on slaughterfloors and in boning or cutting rooms. Performance in the main was good; failures observed were due to poor preparation or installation rather than material deficiencies. In the main, polymer concretes appeared to have been used to provide slip resistance, or a hygienic appearance.

DIRECTORY OF MANUFACTURERS AND SUPPLIERS

(See Sharman 1976 b)

Although the investigation of manufacturers and suppliers of flooring materials with potential for use in freezing works had initially been undertaken with a view to finding out what was available for our own research purposes, in the course of the survey of freezing works it became apparent that the information could be used much more widely. Consequently, a compilation of manufacturers and suppliers of specialist flooring materials was prepared and published in 1976, and updated and re-issued twice - in 1978 and 1982.

DEVELOPMENT OF LABORATORY TESTS

(See Sharman 1978, 1982. Sharman and Cordner 1978, 1979)

The predominant emphasis in the development of laboratory test methods was that they must reproduce freezing works' performance of materials as closely as possible. The test methods used were modifications of other reported methods; and the known performance of some materials, particularly concrete, in the various freezing works processing areas - obtained as a result of the industry survey - were used as an internal standard. The test methods were adapted until a similar performance to that observed in the works was obtained. The test methods which were adopted - namely, abrasion, corrosion, impact and slip resistance, reflected the problems found in the industry survey. The methods and results are described in full in the relevant research reports; a brief summary follows. In general, tests were carried out with the flooring materials installed on a 300 x 300mm concrete base. All the materials tested were commercially available products.

Traditionally, New Zealand freezing works used steel-tyred wheels on gut buggies, hand trolleys, and some fork-lifts. In many processing areas the floors needed to withstand this traffic. Abrasion testing was carried out using a machine comprising four stainless steel wheels running in a circular path and spring-loaded to produce a contact pressure on the floor typical of that found under real conditions. The increase in wear of the material with increasing abrasion time up to a total of 1.45 million wheel passes was measured.

In freezing works there are three sources of corrosive chemicals: blood and wastes from the slaughtered animals; chemicals used in processing, and cleansing and sanitising agents. In simulating their effects in the laboratory, emphasis was on long exposure to weak chemical solutions to try to avoid any corrosion mechanisms which did not occur in practice. Changes in material weight, volume, colour and appearance were monitored over a period of four months.

Two types of impact test were devised, a light one to reproduce the effects of falling carcase hooks or gambrels, and a heavy one to reproduce the effects of falling carcases. Both types of test consisted of monitoring repetitive impacts of a falling weight on the test material.

To measure slip resistance, a method was developed which could be reconciled with the simulated wet or wet plus fat conditions of freezing works floors. A rubber-shod heel was suspended above the flooring material under test and repeatedly dropped onto it, the motion being similar to the placement of a heel during walking. By tilting the test material at a successively increasing angle to the heel its slip resistance was established.

The results of the laboratory tests reflected the general trends expected, but also held one or two surprises.

Concrete abraded rapidly and potholed as expected, it is not recommended as a floor topping subjected to steel-wheeled traffic. Modified concrete toppings were much more abrasion resistant. In general, other wear rates were much as expected: unvitrified tiles and polymer concretes showed very low wear rates. One polymer concrete which had failed in freezing works service showed an abnormally high wear rate under test. Conversely, plasticised PVC sheet flooring had a very low wear rate which would not be expected to be reproduced in service, due to the cutting action of bone fragments and other sharp material being ground into it.

Concrete showed poor resistance to attack by acids, again as expected. The use of simple measures, such as an epoxy paint coating over the concrete, helped reduce the severity of attack, this reproduces works' experience. Ceramic tiles were unaffected. The effect of organic acids on epoxy-based polymer concretes was dependent on the hardener systems used - several failures occurred, some of which appeared to repeat industry experience. Other than corrosion damage, the darkening of several epoxy concretes which occurred on acid exposure was considered undesirable in a material which should maintain a hygienic appearance.

The light impact resistance tests results showed the levels of resistance typical of the various material types. The only outright failure was an unvitrified ceramic tile, which performed as would be expected for this comparatively weak material. The heavy impact tests were unsuccessful due to shattering of the concrete support slabs, and the method was abandoned.

Slip resistance test results reflected the effects found in practice, with concrete and other smooth surfaces being considered unsatisfactory. For ceramic tiles, plain pyramidal patterns gave satisfactory results under wet conditions, which confirmed industry survey results, but the results were unsatisfactory with both water and fat present; flat-topped pyramid profiles were effective under both sets of conditions. The results for polymer concretes were proportional to the degree of surface texture present on the test samples, the more texture the better the slip resistance. Conversely, they would become more difficult to clean.

In the setting of performance criteria, the objective was not to determine which particular material had the best performance. For each test method, minimum performance criteria which materials should pass were suggested, so that selection could be made from a number of suitable materials. The performance criteria suggested were:

Abrasion	maximum limits for abrasion rate, no penetration to the concrete base and no potholing at completion of test
Corrosion	maximum limits for weight loss and volume change (gain or loss). Darkening of colour undesirable in 'edible' areas.
Impact	impact resistance should be 'typical' of material type, no penetration of impact crater to underlying concrete base.
Slip	minimum values of slip resistance separately for wet areas, and for wet plus fat contaminated areas.

TESTING OF COMMERCIAL MATERIALS

(See Sharman 1980, 82, 83a; Sharman and Cordner 1980 a + b)

After the establishment of the test methods and performance criteria as outlined in the preceding section, further commercial flooring materials were obtained and tested using the above methods. The trade names of the materials tested were published, and a separate assessment made for each test parameter of abrasion, corrosion, impact or slip resistance for potential performance in the different freezing works processing departments based on the test result. A later report uses the same data rearranged to make a separate assessment of potential performance in each processing department based on the combined test results for the test parameters.

The objective of publishing the results in these formats was to make the test information more readily available to Meat Industry designers. Obviously, other factors such as local availability, costs, and standard of workmanship must also be considered in the selection of a flooring material.

DESIGN GUIDE

(See Sharman 1983 a)

In the course of background research for both the laboratory tests and field studies described previously, it was found that information on the design and selection of floor toppings for the food processing industry was thinly spread, with no publication providing a detailed source. In an effort to make up for this information lack a design guide based on the results of the BRANZ industry surveys, laboratory work, and the available literature was produced. The guide divides into three sections. Firstly, it discusses factors which are common to many food processing operations and circumstances to be taken into account. Secondly, membranes, joints, drains and service ducts are discussed. Finally, materials and construction methods are reviewed.

SUBSEQUENT RESEARCH

(See MacGregor and Sharman, 1983)

Over the course of the current investigation it has become clear that the predominant specialist flooring material in use in the food industry is polymer concrete. It also became apparent as a result of site visits, and investigations of enquiries about or failures of polymer concrete flooring, that its distinctive properties and requirements were frequently not well understood by the industry or its consultants. In addition, it was felt that improvements could be made to polymer concrete formulations in terms of aggregate utilisation and resin content. Polymer concrete flooring -epoxy, polyester, or polyurethane binder filled with sand to provide a layer 2-12mm thick - first became available in New Zealand in the early 1960's, with its use becoming more widespread in the late 1960's / early 1970's. For more traditional food industry flooring materials, such as ceramic tiles or concrete, years of experience have led to well-documented specification of laying methods.

The experience of polymer concrete has been sufficiently short that specifications of the type used for the other materials have not been evolved. In some installations, the 'specification' has consisted of the manufacturers' technical literature, and a small sample of the material which may or may not have resembled the finished installation.

As an aid to designers and specifiers, a model specification for industrial polymer concrete floors was produced. This is laid out in engineers' or architects' specification format, and covers the basic requirements, materials, mixing and laying, quality control, and safety.

The work on aggregates for polymer concrete is to be described in a paper by Bennett et al later at this conference, and so will not be described here. That work will conclude BRANZ's current formal research into food industry flooring.

COMMENTS IN CONCLUSION

The evolution of this project through industry surveys, laboratory work, site investigations, and background reading has helped to give BRANZ a better insight into food industry requirements for, and expectations of flooring. In turn, BRANZ has been able to provide an independent evaluation of both flooring materials and methods of use. In fact, with time, the subject has grown to cover more than flooring materials alone, enquiries being fielded on building materials used both internally and externally. Although the current formal research programme on flooring has concluded, BRANZ retains a strong interest in the durability and performance of building materials in the food processing environment.

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