



## **USER GUIDE FOR *BRANZ TR8***

**Software for Calculating Fire  
Resistance of Concrete Beams and  
Floor Systems**

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# 1. INSTALLATION

## 1.1 Minimum Computer Requirements

To run TR8 you will require at least a 386 IBM compatible PC running Microsoft® Windows 3.1™ or Microsoft® Windows 95™.

## 1.2 Set-up

1. Insert Set-up Disk in drive a: (or b:).
2. In the Program Manager, choose Run from the File menu.
3. Type a:setup (or b:setup) and press Enter. Follow any instructions given on screen.
4. The setup program will automatically install the program in a separate program group in the Windows Program Manager. Double-click on the BRANZTR8 icon with the mouse to start the program.

## 1.3 Packing List

The following files are installed by the setup program on the user's computer:

TR8.EXE	Executable program file
VBRUN300.DLL	Visual Basic run time module
CMDIALOG.VBX	Visual Basic Custom Control
COMMDDL.DLL	Visual Basic Dynamic Link Library
DENBEAM.CON	Contains beam temperature data for standard fires
DENSLAB.CON	Contains slab temperature data for standard fires
REALBM.CON	Contains beam temperature data for non-standard fires
REALSLAB.CON	Contains slab temperature data for non-standard fires
AQSLAB.CON	Contains slab temperature data for alluvial quartz in standard fires
PUMSLAB.CON	Contains slab temperature data for pumice in standard fires
DACSLAB.CON	Contains slab temperature data for dacite in standard fires
EXAMPLE1.DAT	Sample data file for beam
EXAMPLE2.DAT	Sample data file for double tee floor
EXAMPLE3.DAT	Sample data file for floor slab
EXAMPLE4.DAT	Sample data file for tee beam
TR8.HLP	Windows help file

## 2. INTRODUCTION

TR8 software can be used for the design of reinforced or prestressed concrete floor systems when required to have fire resistance.

TR8 is based on BRANZ Technical Recommendation No. 8 (Wade, 1991) which you should use to gain an understanding of the basis for the software. BRANZ Technical Recommendation No. 8 is referenced by NZS 3101 (SNZ, 1995) as an acceptable calculation method for determining the fire resistance of concrete floor systems. The underlying procedure applies structural engineering principles and material properties at elevated temperature to the calculation of the fire resistance of reinforced or prestressed concrete floor systems.

Standard design fires can be specified as required by most building codes or, alternatively, non-standard design fires can be specified if an alternative solution is required. The technical basis for using non-standard design fires is given by Wade (1994).

## 3. SCOPE

TR8 applies to floor systems:

- which may be rectangular or tapered in cross-section (for beams), or tee-beams, with a minimum width of 100 mm. The width is measured at the centroid axis of the tensile steel;
- which are made with normal-weight concrete (assumed density greater or equal to 2000 kg per m<sup>3</sup>), light-weight concrete (assumed to be less than 2000 kg per m<sup>3</sup>), and the following for slabs only - alluvial quartz concrete (equivalent to NZS 3101 Type A), dacite aggregate concrete (equivalent to NZS 3101 Type B) or pumice aggregate concrete (equivalent to NZS 3101 Type C);
- in which support conditions are assumed to be either simply supported or continuous over the supports;
- where the section includes either prestressing tendons or deformed reinforcing bars;
- which are designed in accordance with the requirements of NZS 3101, New Zealand Code of Practice for the Design of Concrete Structures (SNZ, 1995) and NZS 4203, New Zealand Standard Code of Practice for General Structural Design and Design Loadings for Buildings (SNZ, 1992);
- where it is assumed that the concrete element has reached its equilibrium moisture content, and that the occurrence of concrete spalling during fire will be minimal;
- where the mode of failure for the floor system is assumed to be in flexure; failure is taken as the time at which the reduced moment capacity of the element becomes less than the moment applied to the element;

- where factors of safety are already included into the fire resistance period and with respect to the normal design loads. In fire design it is normal to allow the load factors and design live loads to be reduced.

## **4. WORKING WITH TR8**

### **4.1 Analysis**

It is assumed that a preliminary ambient temperature design of the floor system has previously been carried out, and that the following information is available:

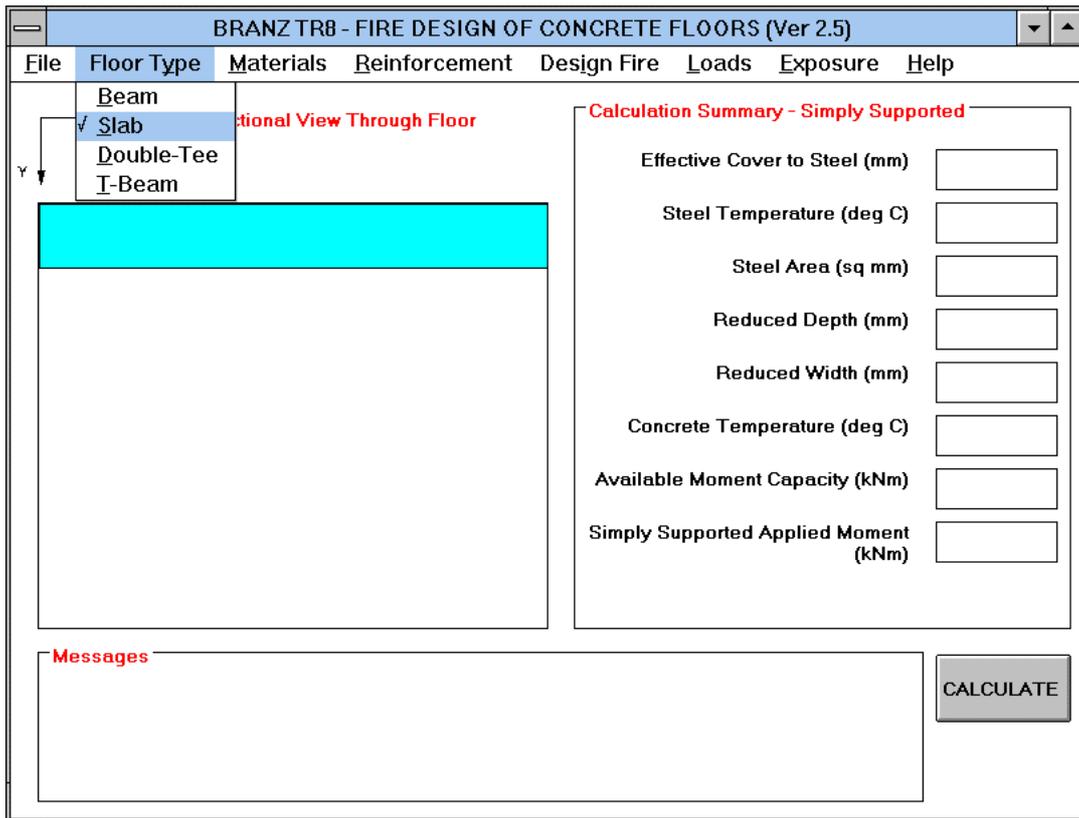
- element dimensions, span and support conditions;
- dead and live loads applied to the element;
- reinforcing type, and its location within the element cross-section;
- yield strength of the reinforcing bars or the ultimate tensile strength of prestressing tendons;
- concrete type, density and 28-day compressive strength;

Once TR8 has been installed on your computer and an initial flexural design has been carried out, a standard procedure with regard to inputting the data should be followed. A suitable procedure follows:

1. Under the Floor Type menu, choose the appropriate section from one of: Beam, Slab, Double-Tee Beam or Tee-Beam, as shown in Figure 1. After choosing the section, in the Dimensions dialog box define the width and depth of the section.

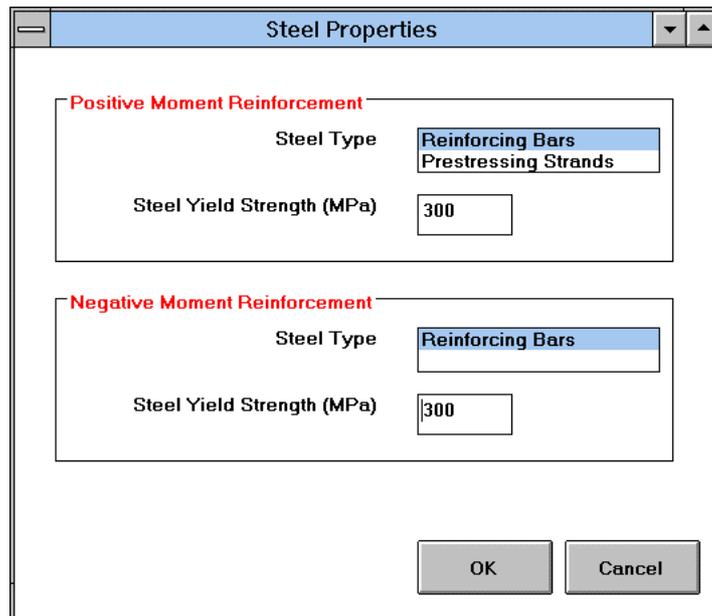
2. Under the Materials menu you can define the properties of the concrete and the reinforcing steel, as shown in Figure 2.

For positive moment reinforcement, define either deformed reinforcing bars or prestressing tendons and the steel yield strength. For negative moment reinforcement, define the yield strength of the deformed reinforcing bars.



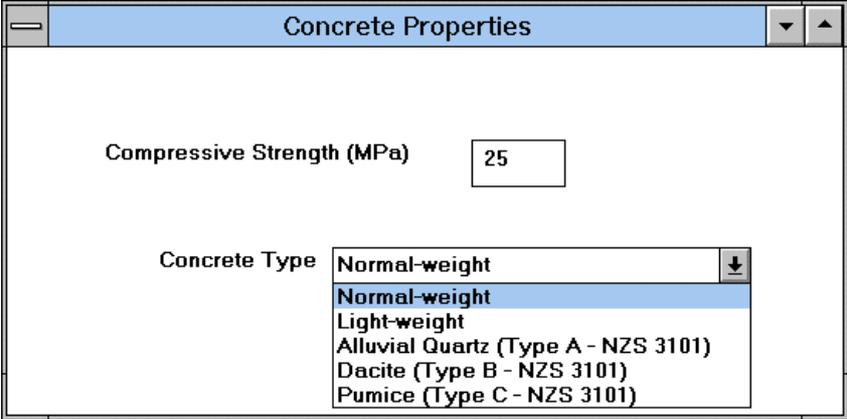
**Figure 1 : The main window of TR8**

*Note: **Floor Type** menu is selected showing the four different types of section available for analysis.*



**Figure 2 : Steel Properties dialog box, under the Materials Menu**

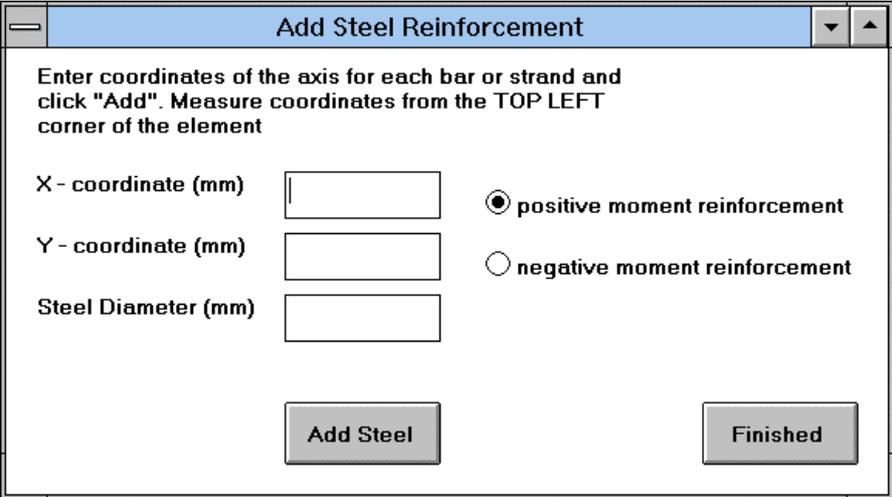
For concrete, define the 28-day compressive strength and choose the appropriate weight concrete (or aggregate type) from one of: normal weight, light-weight, alluvial quartz, dacite or pumice as shown in Figure 3. Thermal data for the latter three aggregates will only be used in calculations for slabs. For beams and tee sections normal-weight data from Wade (1991) will be used.



**Figure 3 : Concrete Properties dialog box, under the Materials Menu**

*Note: Three options of concrete (aggregate) type.*

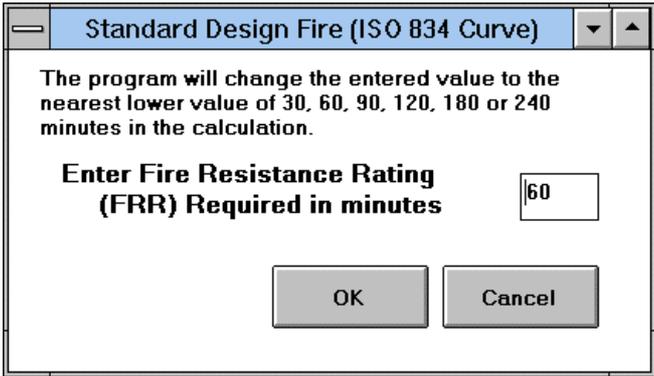
To add reinforcing to the section, go to the Reinforcement menu, as shown in Figure 4. In this menu it is possible to add positive and negative moment reinforcing by defining the location (using x and y coordinates) and diameter of the respective bars. Make sure that the coordinates specified correspond to the location of the centre of each bar.



**Figure 4 : Add Reinforcement dialog box, under the Reinforcement Menu**

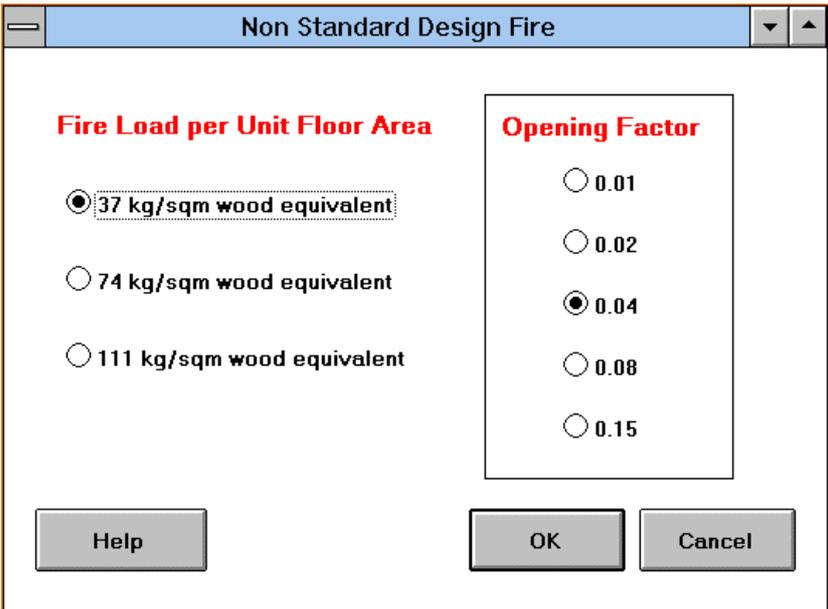
4. Under the Design Fire menu (see Figure 5) it is possible to choose between a standard and non-standard fire.

The standard fire is referred to as the ISO 834 fire (ISO, 1975) and is the same as that in AS 1530 Part 4 (SAA, 1990), the usual fire resistance test method for New Zealand and Australia. You will be prompted to enter the required Fire Resistance Rating (FRR) as one of 30, 60, 90, 120, 180 or 240 minutes. If a different value is entered the program will reduce it to the next lowest value from above.



**Figure 5 : Standard Design Fire dialog box, under the Design Fire Menu**  
*Choose the Fire Resistance Rating (FRR) required by your floor system.*

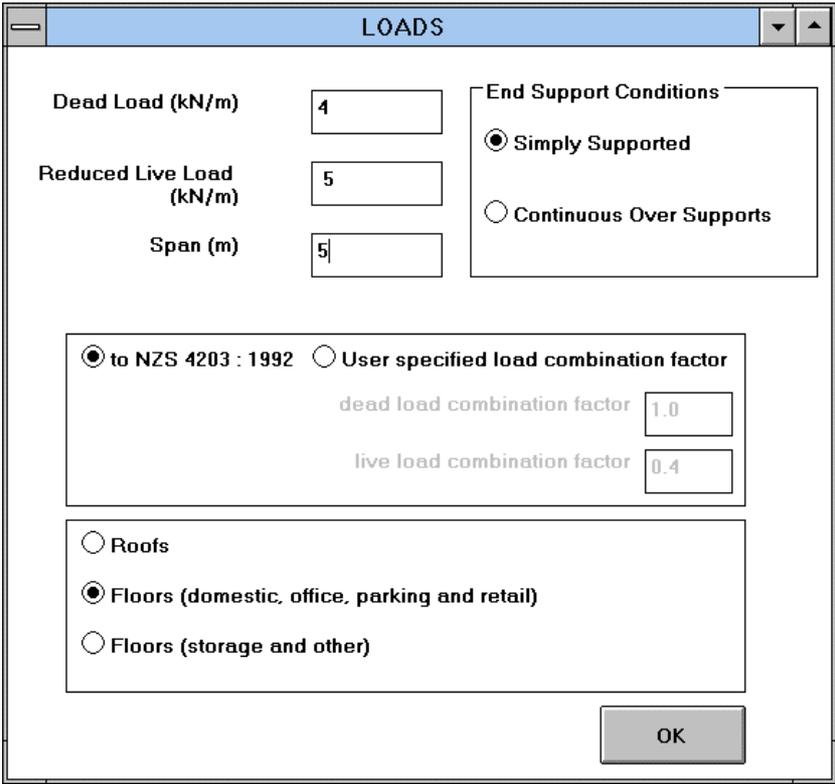
The non-standard fire option (in Figure 6) requires you to define a fire load per unit floor area (either 37, 74 or 111 kg per m<sup>2</sup> wood equivalent) and an opening factor (either 0.01, 0.02, 0.04, 0.08 or 0.15).



**Figure 6 : Non-Standard Design Fire dialog box, under the Design Fire Menu**  
*Choose the Fire Load and Opening Factor to model an appropriate non-standard fire.*

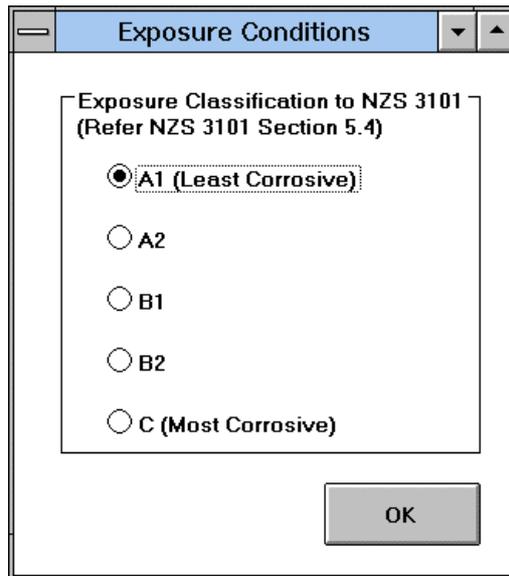
5. Go to the Loads menu (shown in Figure 7) and enter the Dead and Reduced Live Load, Span and Support conditions (these being either simply supported or continuous over the supports). Choose Dead and Live Load combination factors as per NZS 4203: 1992 or from a specific load combination.

If you have selected the NZS 4203 option, define the structural system as either a roof, floor (domestic, office, parking and retail) or floor (storage and other). TR8 will use an appropriate live load combination factor consistent with NZS 4203.



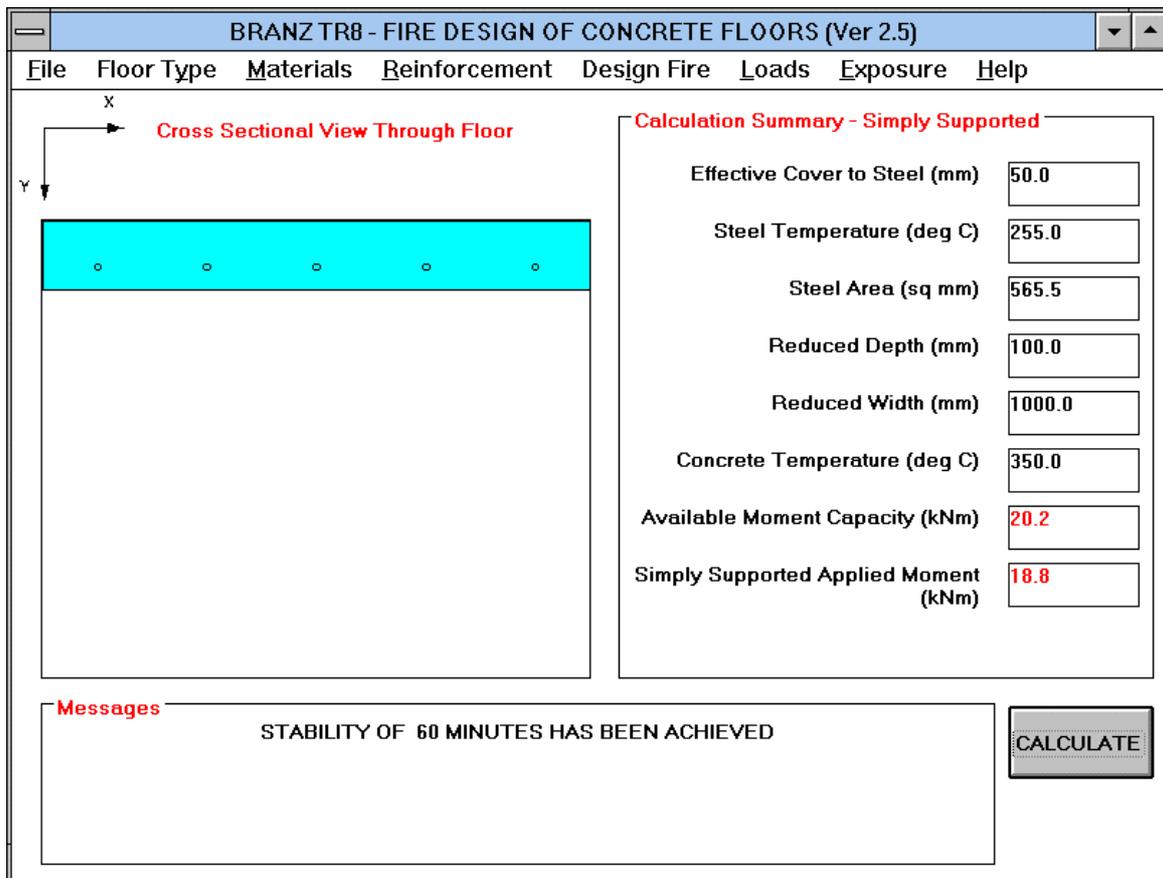
**Figure 7 : Loads dialog box under the Loads menu**

Finally, select the exposure classification from the Exposure Menu (shown in Figure 8). The classifications are taken from Section 5.4 NZS 3101 and represent a range of corrosive environments, and the corresponding minimum steel cover permitted. The exposure classification does not affect the fire resistance calculated but provides a warning to the user if the minimum requirements are not met.



**Figure 8 : Select the Exposure Classification for the Element**

Once you have completed all of the above click on Calculate. TR8 will calculate the reduced strength of the section, and hence the stability of the floor system after being exposed to the design fire. A view of the calculation screen is shown in Figure 9.



**Figure 9 : View of Screen Showing Calculation Results and Messages**

## 4.2 Saving and Printing

The File menu at the top left corner of the screen is used to save your design, or to load existing data files with previous designs.

To print the results of an analysis of your design, select Print from the File menu. The output will include all section, material and loading information that is input at the start of the analysis, and also all data that is a function of the design fire. An example is given in the Appendix.

## 5. SUPPORT INFORMATION

Should any problems be encountered in using the program, or any assistance, advice or comments on TR8 desired, you should contact:

Colleen Wade  
Building Research Association of New Zealand  
Private Bag 50908  
Porirua  
NEW ZEALAND

Phone: +64 (4) 235-7600  
Fax: +64 (4) 235-6070  
E-mail: BRANZCW@BRANZ.ORG.NZ

Latest version software is available on the Internet:

<http://www.branz.org.nz/~fireres/software.htm>

You are encouraged to report errors, bugs and problems with TR8 software to the author. This will enable the software to be corrected where necessary and allow such information to be passed on to any other interested parties.

## 6. REFERENCES

International Organization for Standardization (ISO). 1975. ISO 834 - 1975 Fire resistance tests : Elements of building construction. Geneva.

Standards Australia (SA). 1990. AS 1530.4 - 1990 Methods for Fire Tests on Building Materials and Structures - Part 4 : Fire Resistance Tests of Elements of Building Construction. North Sydney.

Standards New Zealand (SNZ). 1992. NZS 4203 : 1992 General structural design and design loadings for buildings. Wellington.

Standards New Zealand (SNZ). 1995. NZS 3101 : Part 1 : 1995 Code of practice for the design of concrete structures. Wellington.

Wade, C.A. Method for Fire Engineering Design of Structural Concrete Beams and Floor Systems, Technical Recommendation No. 8. Building Research Association of New Zealand, Judgeford, 1991.

Wade, C.A. Performance of Concrete Floors Exposed to Real Fires, Journal of Fire Protection Engineering, 6(3), pp 113-124, 1994.

## 7. APPENDIX

Date is 7-March-1996

### BRANZ TECHNICAL RECOMMENDATION TR 8 (VER 2.4) FLOOR SYSTEM DATA

The floor type is SLAB  
Slab is simply-supported  
Concrete Type is normal-weight  
Concrete Strength (MPa) 25  
Slab Width (mm) 1000  
Slab Depth (mm) 150

#### POSITIVE MOMENT STEEL

Steel Type is Reinforcing  
Steel Strength (MPa) 380

x-coord (mm)	ycoord (mm)	bar dia(mm)	conc cover(mm)
100	100	12	50
300	100	12	50
500	100	12	50
700	100	12	50
900	100	12	50

Total Steel Area (sq mm)	565.5
Effective Cover (mm)	50.0
Centroidal Axis (mm)	50.0
Steel Temp (C)	255.0
Concrete Temp (C)	350.0
Reduced Depth (mm)	100.0
Reduced Width (mm)	1000.0
Reduced Steel Strength (MPa)	375.2
Reduced Concrete Strength (MPa)	25.0

#### LOADS

Dead Load (kN/m)	4.000
Live Load (kN/m)	5.000
Dead Load Reduction Factor	1.00
Live Load Reduction Factor	0.40
Span (m)	5.000

#### DESIGN FIRE

The design fire is ISO 834.  
The FRR required is 60 minutes.

#### RESULTS

Moment Capacity Available (kNm)	20.16
Moment Capacity Required (kNm)	18.75

STABILITY OF 60 MINUTES HAS BEEN ACHIEVED

**Figure 10 : A copy of the output when Print is selected from the File Menu**