International Journal of Civil and Structural Engineering Research ISSN 2348-7607 (Online)
Vol. 3, Issue 2, pp: (52-57), Month: October 2015 - March 2016, Available at: www.researchpublish.com

An Experimental Investigation on the Strength of Concrete by Partial Replacement of Cement with Micro Silica and Natural Sand with Manufactured Sand

[1]Puneeth G T., [2]Mamatha A

[1,2]M.Tech student, Civil Engineering, East West Institute of Technology, Bangalore – 91, India [1,2]Assitant Professor, Civil Engineering, East West Institute of Technology, Bangalore – 91, India

Abstract: **With increase in trend towards the wider use of concrete for pre-stressed concrete and high rise buildings there is a growing demand of concrete with higher compressive strength. Mineral additions which are also known as mineral admixtures have been used with cement for many years. One such material is micro silica which is produced in an electric arc furnace as a by-product of the production of elemental silicons or alloys containing silicon. The aim of the present work is to investigate the possibility of replacing the part of Portland cement by micro silica and fine aggregates by manufactured sand. Due to the storing issues, the waste negatively affects the environment. To solve this problem, an attempt was made to check the effectiveness of micro silica as a partial replacement of Portland cement. In the first phase the feasibility of micro silica with Portland cement was checked by preparing concrete mix of M30 grade and studying the effect of micro silica on mechanical properties of concrete. Portland cement was replaced by micro silica in percentages of 5% i.e., 5%, 10%, 15%, and 20% by weight of cement and evaluating the compressive strength, split tensile strength and flexural strength of concrete. Optimum replacement percentage of micro silica was obtained as 15%. In the second phase the behavior of properties of concrete with optimum micro silica content and various percentage of replacement of natural sand with manufactured sand was studied. Fine aggregate was replaced up to 70% by manufactured sand and evaluating its compressive, split tensile strength and flexural strength of concrete. The optimum percentage of the manufactured sand and optimum micro silica content was found to be 15% Micro silica + 50% Manufactured sand. The concrete with this percentage of micro silica and manufactured sand shows more compressive, tensile and flexural strength compared to conventional concrete.**

Keywords: **Micro silica; Manufactured sand; Partial replacement; Concrete strength.**

I. INTRODUCTION

Cement is the most important material in construction industry as it is used at different stages of construction in the form of mortar or concrete. The large scale production of cement adds pollution to the environment. Each ton of Portland cement production results in loading about one ton of carbon dioxide into the environment. Therefore it is necessary to find an alternative for cement. One such alternative is micro silica which is a by-product in the production of elemental silica or alloys containing silicon. On the other hand the large scale production of concrete has increased the scarcity of natural sand. In order to reduce the dependence on natural sand in concrete, artificially manufactured aggregates and artificial aggregates from industrial wastes provide an alternative for the construction industry. The main objective of this research work is to study the effects of incorporation of micro silica and manufactured sand in concrete mix as a partial replacement of cement and natural sand respectively. Elavenil S and Vijaya B [1] investigated the effect of using manufactured sand as a replacement of fine aggregate on the strength properties. Rajendra P Mogre and Dhananjay K

Parbat A.S [2] investigated on the possibility of using manufactured sand as partial replacement of natural sand in proportions varying from 0 to 100% for M20, M25, M30, M35 and M40 grades with an increment of 20% and in critical zone the increment is of 5%. It was concluded that the optimum replacement of natural sand by manufactured sand was 65% and the increase in strength was maximum for M20 grade and gradually reducing for M40 grade. Shanmugapriya T and Uma R N [3] carried out tests to compare the results when cement was replaced with silica fume in percentages of 1.5%, 2.5% and 5% and manufactured sand replacing natural sand in proportions of 10%, 30%, 50%, 70%. The results revealed that increase in percentage of partial replacement of silica fume, increased the compressive and flexural strength of high performance concrete and addition of up to 50% manufactured sand as sand replacement yielded comparable strength with that of the control mix. Verma Ajay, Chandak Rajeev and Yadav R.K [4] studied the effect of micro silica on the compressive strength of concrete by replacing ordinary Portland cement in percentages of 5%, 10% and 15% by weight of cement. The results concluded that the compressive strength was higher for 15% micro silica replacement.

II. EXPERIMENTAL PROGRAMME

1. Materials used: Ordinary Portland cement (Ultratech) was used for this experimental work. Coarse aggregate used was crushed angular aggregate of size 20mm and down. The fine aggregates used was river sand and manufactured sand. Micro silica was collected from the Sai Dhurga Enterprises, the micro silica manufacturer, Rajajinagar, Bangalore. The water used was available in college laboratory. The super plasticiser used was MasterGlenium SKY 8233.

TABLE I: PHYSICAL PROPERTIES OF COARSE AND FINE AGGREGATES

Particular	Natural sand	Manufactured sand	Coarse aggregates
Specific gravity	2.74	2.55	2.76
Water absorption (%)	1.25	1.13	0.55
Grading	Zone II	Zone II	-

2. Mix design: The mix proportion adopted for this study is M30 grade (1:1.644:2.945) with water-cement ratio of 0.40. Cubes of standard size 150x150x150mm, cylinders of standard diameter 150mm and height of 300mm, prisms of size 100x100x500mm are casted and cured for 7 and 28 days and tested as per code IS: 516-1959 and IS: 5816-1999.

TABLE II: STRENGTH OF CONCRETE FOR CEMENT REPLACEMENT

Mix	% replacement of cement by micro silica	Compressive strength N/mm^2	Split tensile strength N/mm^2	Flexural strength N/mm^2
CM	100% cement	32.14	2.83	4
MS-5	100% cement +5% MS	36.33	2.97	4.21
MS-10	100% cement +10% MS	37.33	3.02	4.34
MS-15	100% cement +15% MS	39.85	3.30	4.5
MS-20	100% cement +20% MS	37.77	2.92	4.26

TABLE III: STRENGTH OF CONCRETE FOR NATURAL SAND REPLACEMENT

Mix	% replacement of fine aggregate by manufactured sand	Compressive strength N/mm^2	Split tensile strength N/mm^2	Flexural strength N/mm^2
MS-15 + M sand-10	15% MS + 10% M sand	40.15	3.44	4.53
MS-15 + M sand-30	15% MS + 30% M sand	40.88	3.67	4.72
MS-15 + M sand-50	15% MS + 50% M sand	42.07	3.77	4.85
MS-15 + M sand-70	15% MS + 70% M sand	40	3.48	4.61

3. Compressive Strength: Uni-axial compressive strength testing was done on 150 x 150 x 150 mm cubes. The procedure is the same as given in IS 516-1959. All the cubes were wet cured up to the day of testing. The cubes are tested for both 7 days and 28 days of curing. Three specimens were made for each age testing and for each mix made with partial substitution of micro silica in the order (0%, 5%, 10%, 15%, 20%).The maximum value of compressive strength was obtained for 15% replacement of cement by micro silica. The variation of the compressive strength is shown in figure 1.

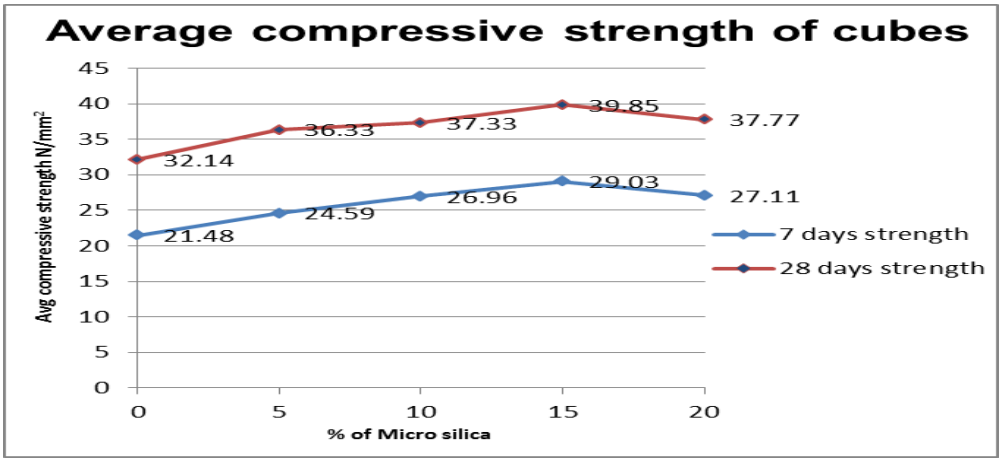

FIG. 1 COMPRESSIVE STRENGTH FOR VARIATION OF MICRO SILICA (7 & 28 DAYS)

Compressive strength test was then carried out on cubes which were cast by fixing the micro silica variation as 15% and replacing the natural sand with manufactured sand in the order (10%, 30%, 50% and 70%). The variation of the compressive strength is shown in figure 2.

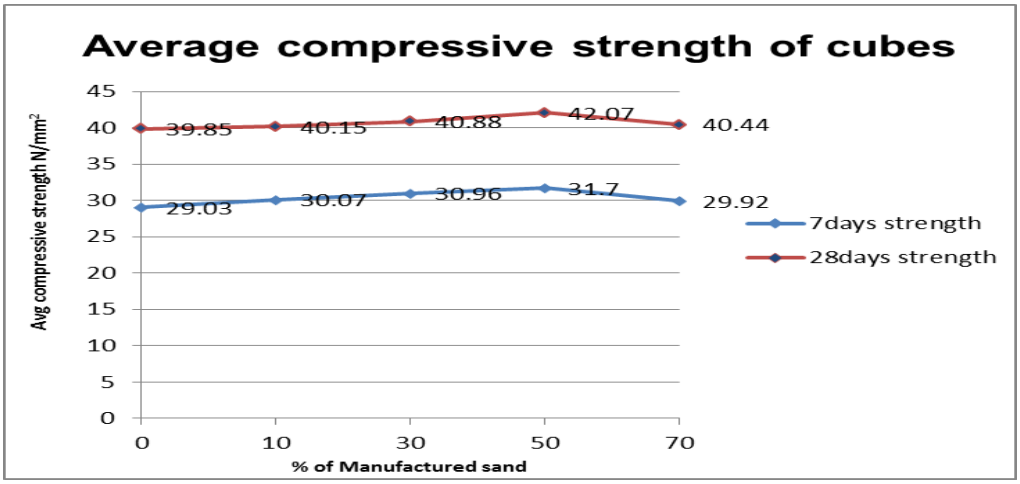

FIG. 2 COMPRESSIVE STRENGTH FOR VARIATION OF MANUFACTURED SAND (7 & 28 DAYS)

4. Split tensile strength: The cylinders of size 150mm in diameter and 300mm in length are casted initially for various percentages of micro silica and then for manufactured sand by keeping the micro silica content constant at 15%. Total 3 cylinders are casted for each trial. Then testing was done on a compression testing machine as per code IS: 516-1959. The cylinders are cured and tested for 28 day strength. The variation in the strength is shown in fig 3.

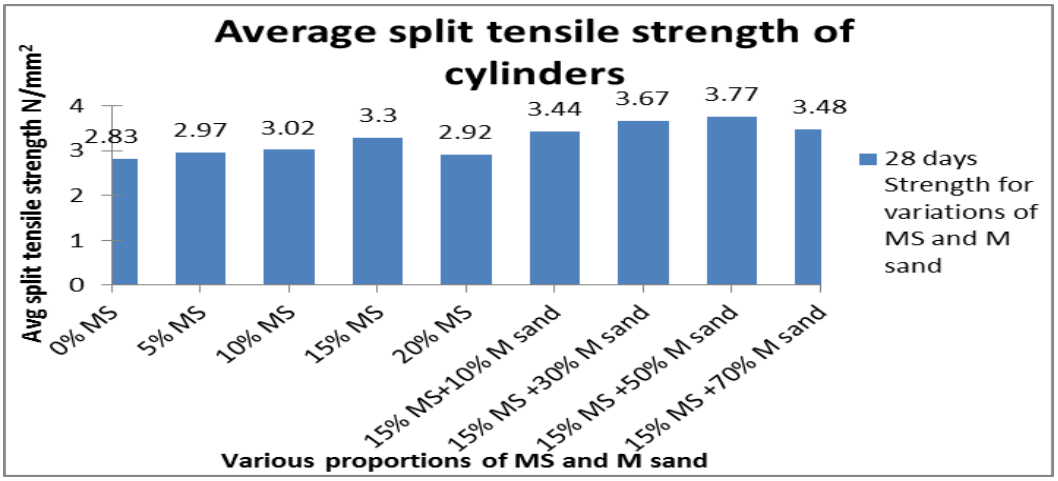

FIG. 3 SPLIT TENSILE STRENGTH FOR VARIATION OF MICRO SILICA AND MANUFACTURED SAND (28DAYS)

Conclusion section is mandatory and contains advantages, disadvantages, review the main part of research paper and use of research work. If author want to acknowledge someone, then acknowledgement section should include in research paper after conclusion. Appendix section (if required) appears before acknowledgement section.

5. Flexural Strength: The prisms of size 100mm x 100mm and 500mm in length are casted for various percentages of micro silica and then for manufactured sand by keeping the micro silica content constant at 15%. Total 3 prisms are casted for each trial. The prisms are cured and tested for 28 day strength. The specimen is mounted on the testing platform of universal testing machine. The specimen is subjected to 2 point loading as per code IS: 516-1959. The variation in strength is shown in figure 4.

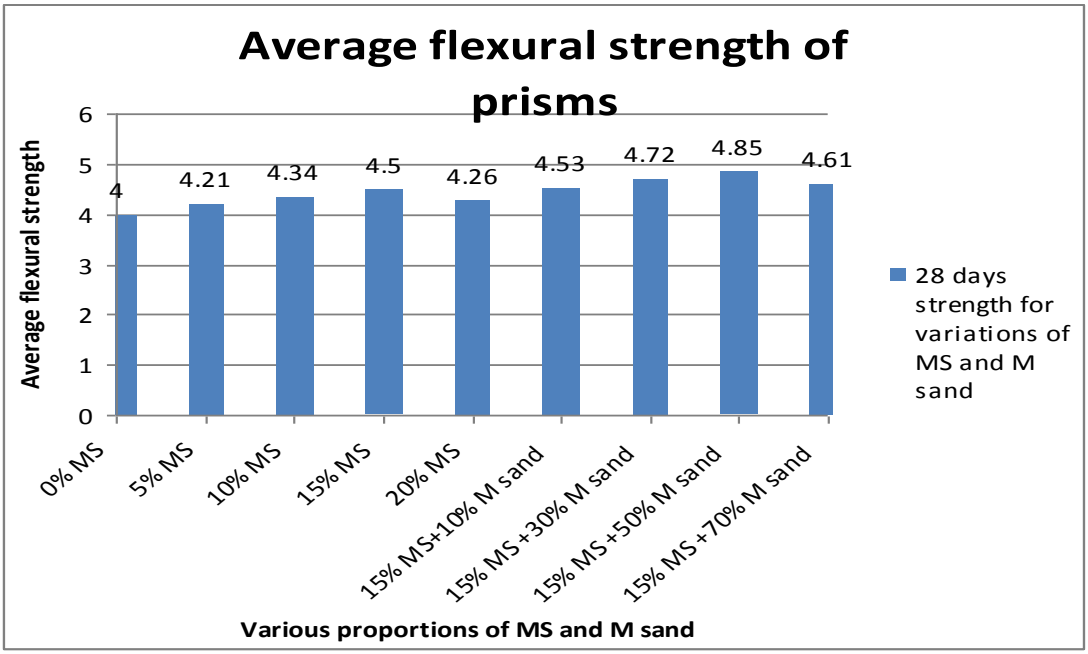

FIG. 4 FLEXURAL STRENGTH FOR VARIATION OF MICRO SILICA AND MANUFACTURED SAND (28 DAYS)

III. RESULTS AND DISCUSSION

1. Load vs Deflection Graphs: The variation of load versus deflection was recorded during the flexural strength test of the prisms. The deflection is recorded using the dial gauge. Figure 5 shows the load versus deflection curve for prism containing 15% micro silica replacing the cement.

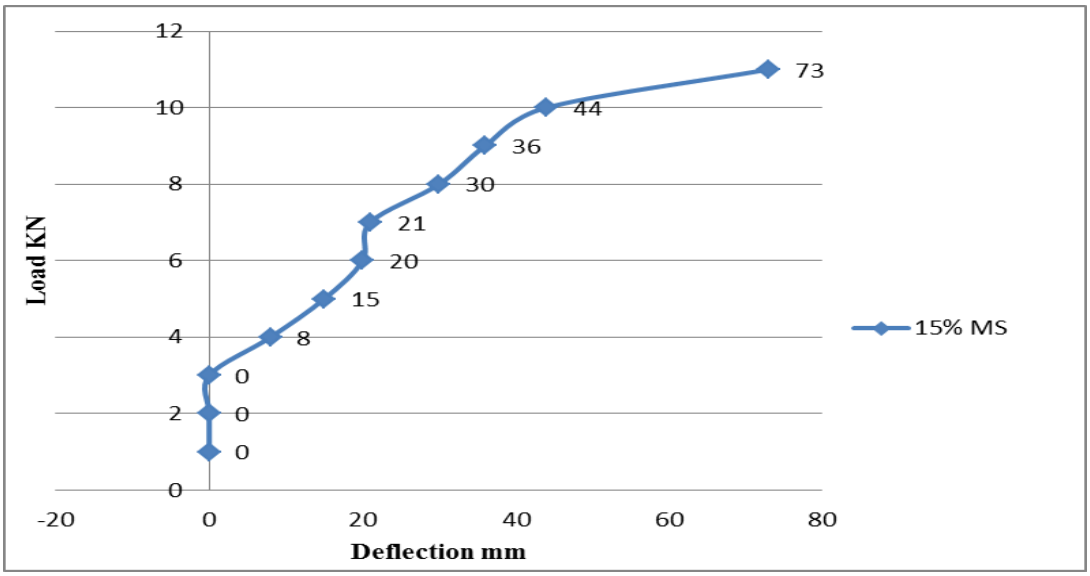

FIG. 5 LOAD VERSUS DEFLECTION OF PRISM WITH 15% MICRO SILICA

Figure 6 shows the load versus deflection curve for prism containing 50% manufactured sand, 15% of micro silica replacing the cement.

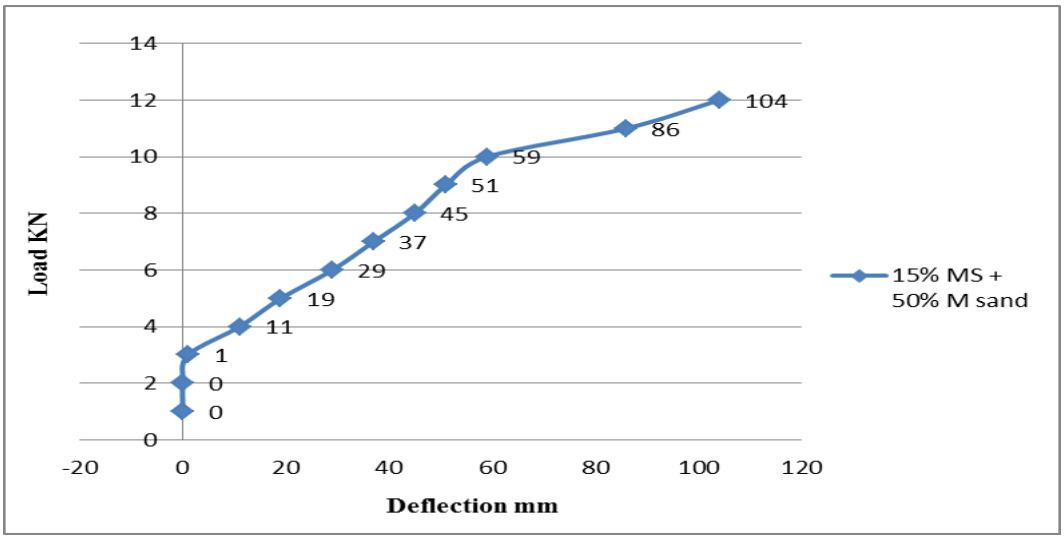

FIG.6 LOAD VERSUS DEFLECTION OF PRISM WITH 15% MICRO SILICA AND 50% MANUFACTURED SAND

2. Compressive Strength: From both the compression test results (7 and 28 days), it is clearly evident that the maximum strength of the cube is achieved at 15% replacement of cement by micro silica. Hence the micro silica content is fixed at 15%. The compression test results for replacement of natural sand with manufactured sand shows that the maximum strength is obtained at 15% micro silica and 50% manufactured sand.

3. Split Tensile Strength: From the test results, it is clearly evident that the split tensile strength of concrete increases to an extent with increase in percentage of micro silica and manufactured sand and then decreases.

4. Flexural Strength: From the test results, it is clearly evident that the flexural strength of concrete increases to an extent with increase in percentage of micro silica and manufactured sand and then decreases.

IV. CONCLUSION

The following conclusions were drawn based on the investigations of present study:

1. After testing the concrete specimen (5% to 20% replacement of cement by micro silica) with an increment of 5%, it can be concluded that the optimum use of micro silica is 15% as partial replacement of cement.

2. The concrete specimen incorporated with 15% micro silica was found to be good in compression which has compressive strength of 23.98% more than that of conventional concrete after 28-days curing period.

3. Better split tensile strength was achieved with the replacement of cement by 15% micro silica in concrete. The strength has increased up to 33.2% when compared to that of the conventional concrete specimen after 28-days during period.

4. The concrete specimen with 15% replacement of cement by micro silica showed higher flexural strength than the conventional concrete. The strength has increased up to 12.5% when compared to that of the conventional concrete specimen after 28-days curing period.

5. The compressive strength of concrete increases linearly and is highest for the cube containing 50% of manufactured sand. The compressive strength then shows decrease in strength for the remaining mixes. Hence it can be said that the optimum use of manufactured sand is 50% as partial replacement of natural sand.

6. The concrete specimen incorporated with 15% micro silica and 50% manufactured sand was found to be good in compression which has compressive strength of 23.9% more than that of the conventional concrete when checked for 28-days curing period.

7. This study proves that the mechanical properties of the concrete are increased by addition of 15% micro silica and 50% manufactured sand as an additive to concrete.

REFERENCES

[1] Elavenil S. and Vijaya A, "Manufactured Sand, A Solution And An Alternative To River Sand And In Concrete Manufacturing", Journal of Engineering, Computers & Applied Sciences (JEC&AS) ISSN No: 2319-5606, Volume 2, No.2, February 2013

[2] Nimitha Vijayaraghavan, " Effects of manufactured sand on compressive strength and workability of concrete", International Journal of Structural and Civil Engineering Research, Vol. 2, No. 4, November 2013

[3] Priyanka A. Jadhav, Dilip K. Kulkarni, "Effect of replacement of natural sand by manufactured sand on the properties of cement mortar", International Journal of Civil and Structural Engineering Research, Volume 3, No 3, 2013

[4] Rajendra P. Mogre & Dhananjay K. Parbat, "Optimum replacement of natural sand with artificial sand in concrete", International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development, Vol. 3, Issue 5, Dec 2013, 91-98

[5] Shanmugapriya T and Uma R. N, "Optimization of partial replacement of M-sand by natural sand in high performance concrete with silica fume", International Journal of Engineering Sciences & Emerging Technologies, Volume 2, Issue 2, pp: 73-80 ©IJESET, June 2012.

[6] Aditya Dhagat, Manav Mittal, "Effect of Micro silica and fly ash on the strength of concrete", International Journal of Scientific & Engineering Research, Volume 4, Issue 8, August 2013.

[7] Arihant S. Baid and Bhole S. D, "Effect of Micro silica on Mechanical Properties of Concrete", International Journal of Engineering Research & Technology (IJERT), Vol 2 Issue 8, August – 2013.

[8] Debabrata Pradhan, Dutta D, "Influence of Silica Fume on Normal Concrete", Debabrata Pradhan et al. Int. Journal of Engineering Research and Applications, Vol. 3, Issue 5, Sep-Oct 2013.

[9] Dilip Kumar Singha Roy, Amitava Sil, "Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete", International Journal of Emerging Technology and Advanced Engineering, Volume 2, Issue 8, August 2012.

[10] Faseyemi Victor Ajileye, "Investigations on Microsilica (Silica Fume) As Partial Cement Replacement in Concrete", Global Journal of researches in engineering Civil and Structural engineering, Volume 12 Issue 1 Version 1.0 January 2012.

[11] Verma Ajay, Chandak Rajeev and Yadav R.K, "Effect of Micro Silica on The Strength of Concrete with Ordinary Portland Cement", Research Journal of Engineering Sciences, Vol. 1(3), 1-4, Sept. (2012).

[12] Sabir B. B, "Mechanical Properties and Frost Resistance of Silica Fume Concrete", School of the Built Environment, The University of Glamorgan, Pontypridd, Mid Glamorgan CF37 lDL, UK (Received 6 November 1996; accepted 18 March 1997).