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# 6<sup>TH</sup> INTERNATIONAL FIBRE RECYCLING SYMPOSIUM

7-8 JUNE 2017

MANCHESTER METROPOLITAN UNIVERSITY

## **REVIEW OF TEXTILE WASTE RESEARCH AT UNIVERSITY OF BOLTON**

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- Acoustic underlays made from carpet tile wastes
- Reinforcement of clay soil with carpet waste fibres
- Low grade composites made from plastic and fibrous waste
- Plaster boards reinforced with fibrous waste
- Containment of concrete blocks using carpet wastes



## Acoustic underlays made from carpet tile wastes



(1) Carpet tiles fed into granulator

(2) Tiles shredded in granulating chamber and conveyed by suction through screen



(3) Waste separated into fibrous and granular components

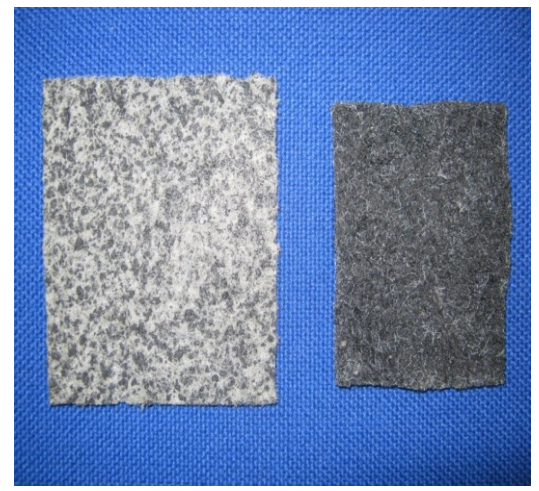
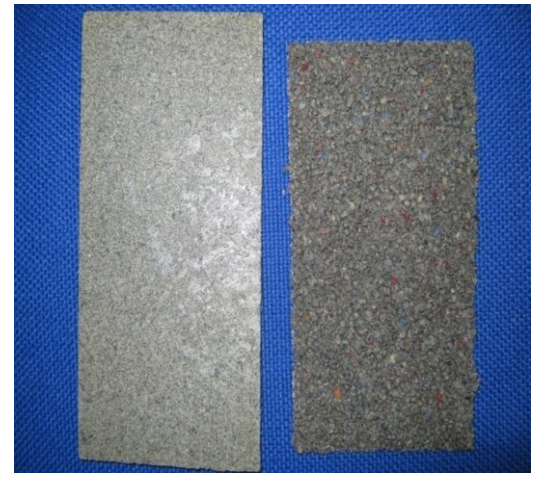
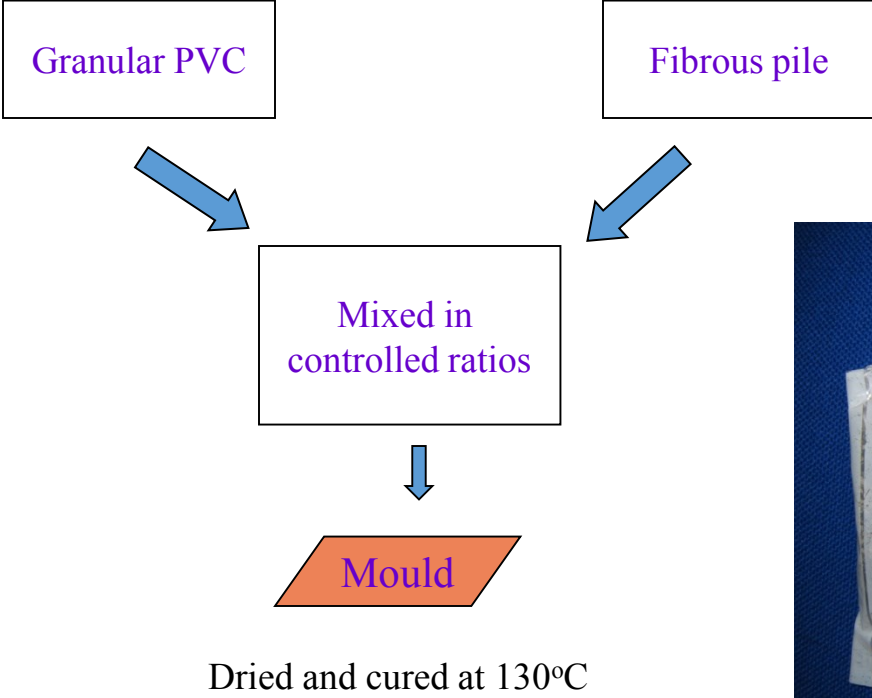
Cyclone system

Rotating blade

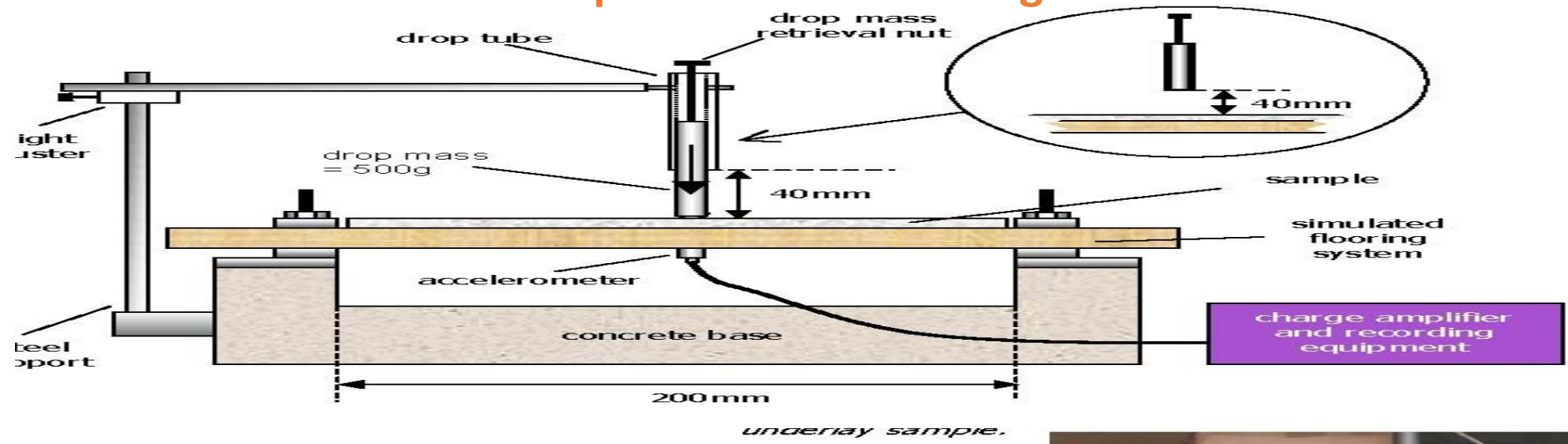
Fixed blade



6mm-aperture screen (raised up for illustrative purpose)



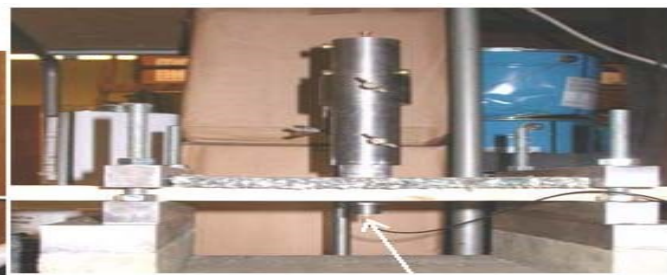
## Impact Transmission Rig



Underlay sample mounted on timber 'floor'



Drop tube containing impact cylinder

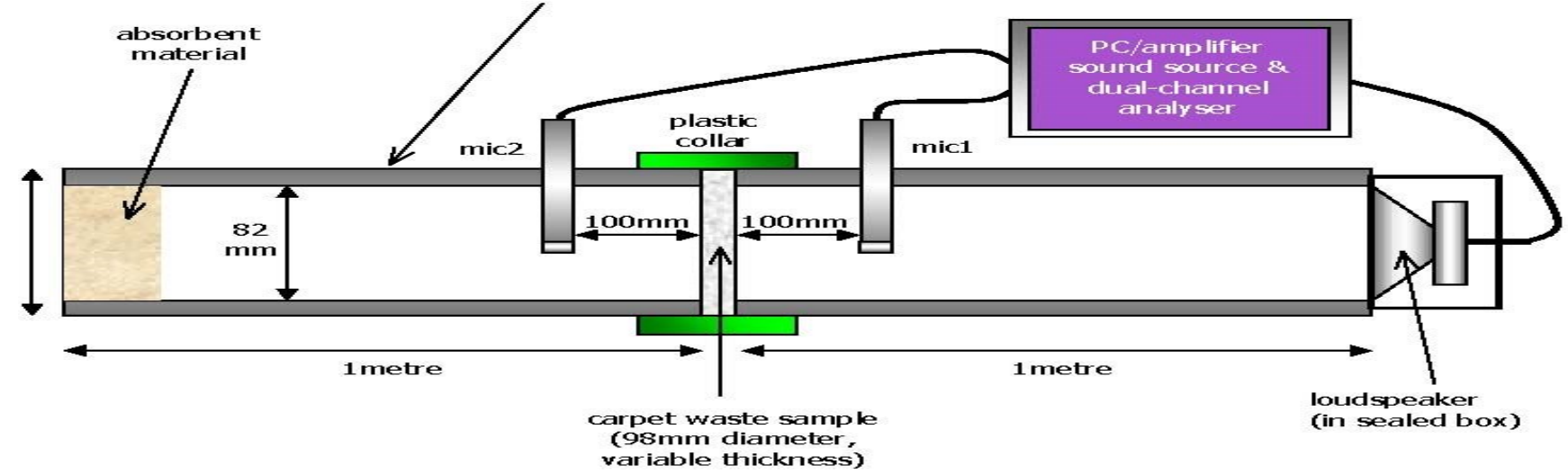


Accelerometer



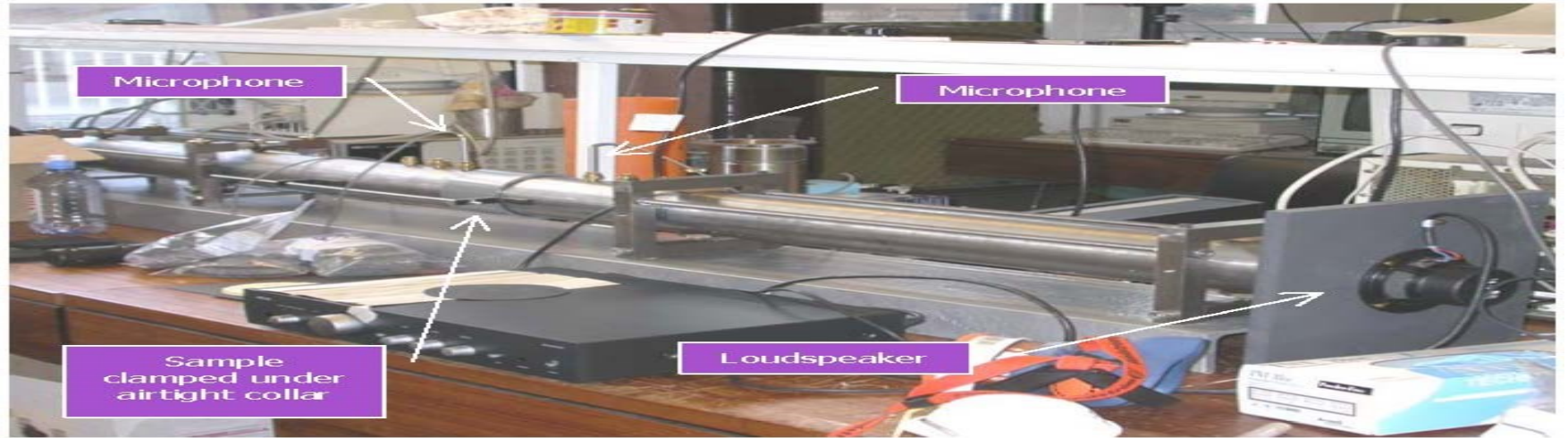


## Airborne Sound Transmission Loss



$$TL = SPL_1 - SPL_2 \text{ (dB)}$$

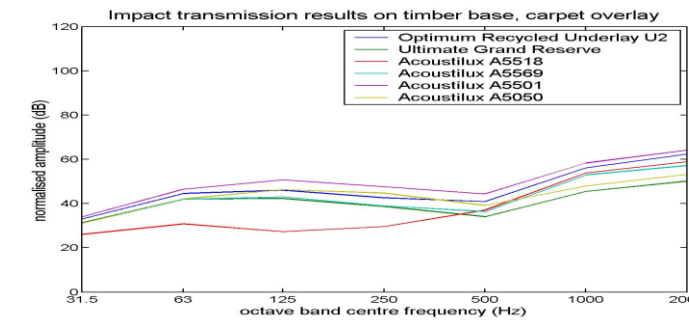
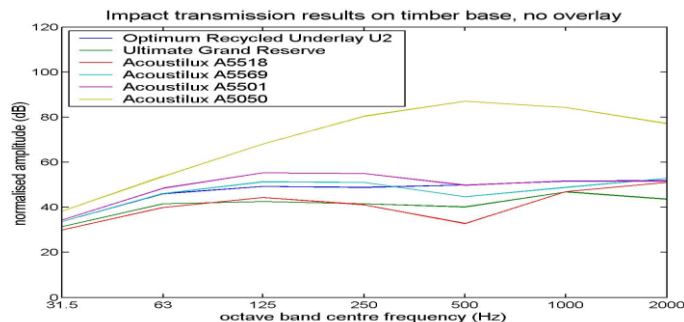
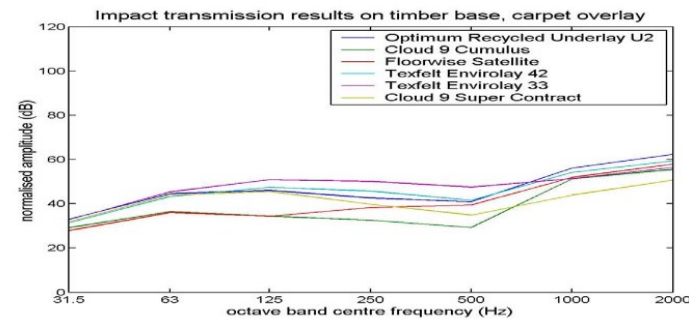
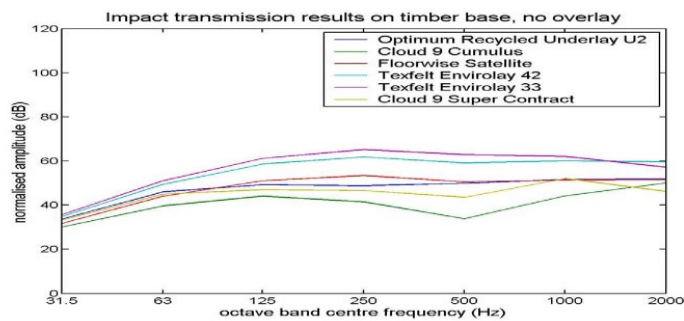
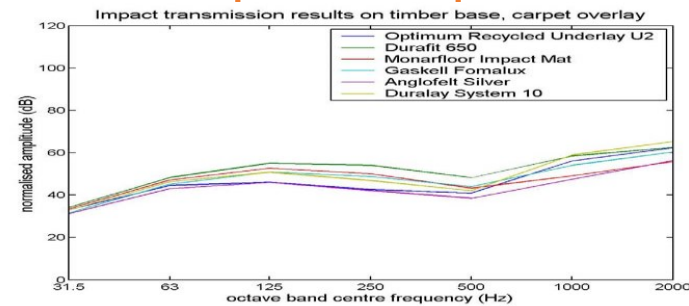
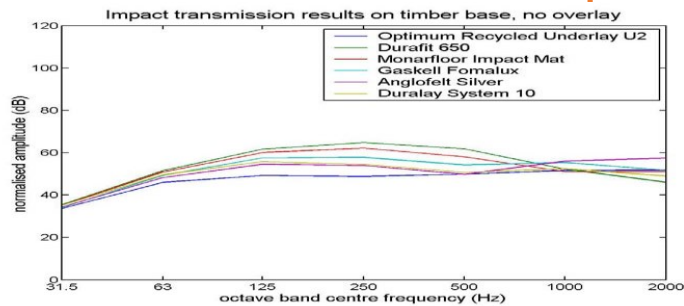
$SPL_{1,2}$   
(Sound Pressure level,  
Mic.1&2)



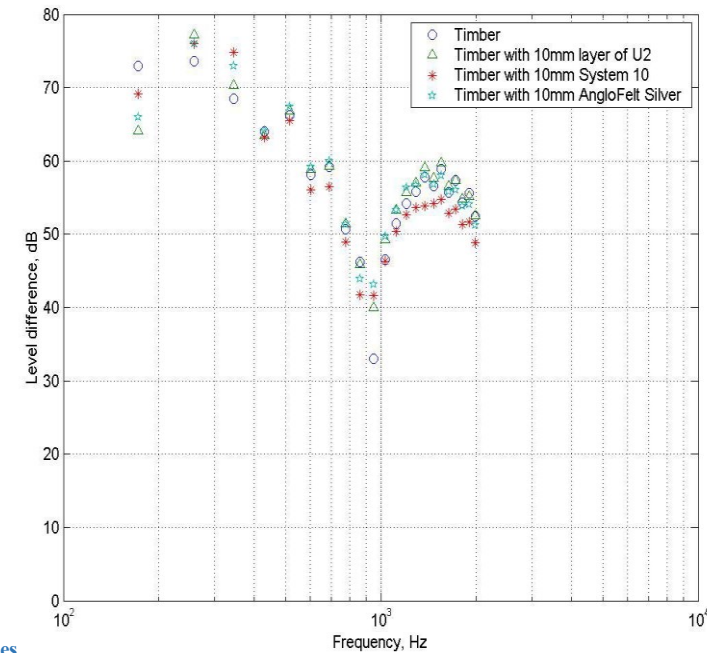


## Impact Transmission

### Commercial samples .v. Developed sample



## Airborne Sound Transmission

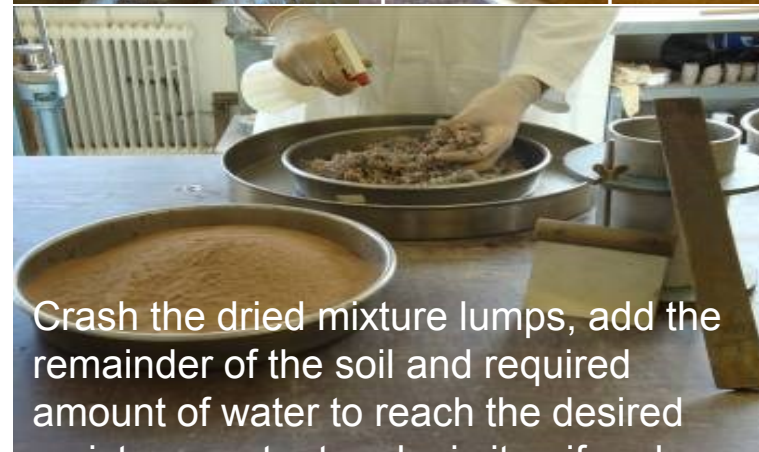
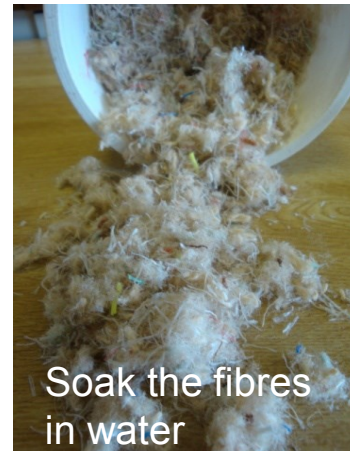


### References

1. Acoustic damping properties of recycled carpet waste, Rushforth, I., Swift, M. Horoshenkov, K. Miraftab, M, Acta Acustica (stuttgart), Volume 89, Issue SUPP., May 2003, Pages S46-S47.
2. Taylor, A.: "Novel underlays from carpet waste", Ph.D. thesis, University of Bolton, U.K., 2005.
3. Impact Sound Reduction and Visoelastic Properties of Underlay Manufactured from Recycled Carpet Waste, Rushforth, I.,Horoshenkov, K., Miraftab, M., andSwift, M. *Applied Acoustics*, 66 (2005) 731-749.
4. Acoustic underlay manufactured from carpet tile wastes; Part 1: Effect of variation in granular/fibre dry ratio, binder concentration and waste particle size on impact sound insulation of the produced underlays, Mohsen Miraftab, Ian Rushforth and Kirill Horoshenkov, *AUTEX Research Journal*, Vol. 5, No2, June 2005.
5. Acoustic Underlay Manufactured from Carpet Tile Wastes; Part 2: Comparative study of optimised underlay with commercial products of similar calibre in accordance to universal standards M. Miraftab, I. Rushforth and K.Horoshenkov, *AUTEX Research Journal*, Vol. 6, No.1, March 2006.

## Reinforcement of clay soil with carpet waste fibres

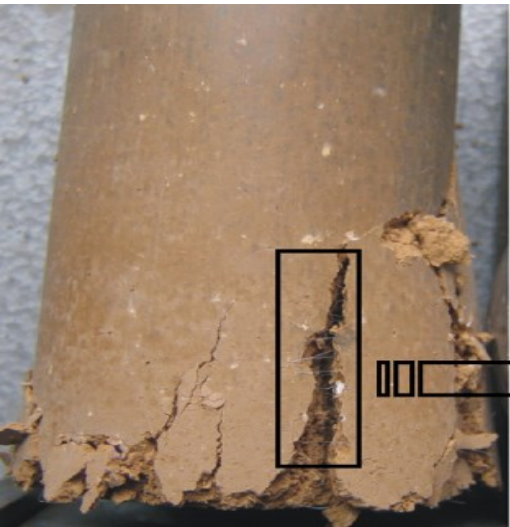
- Internal Cohesion
- Shear Strength
- Compressive Strength
- Load bearing capacity
- Post-peak strength retention





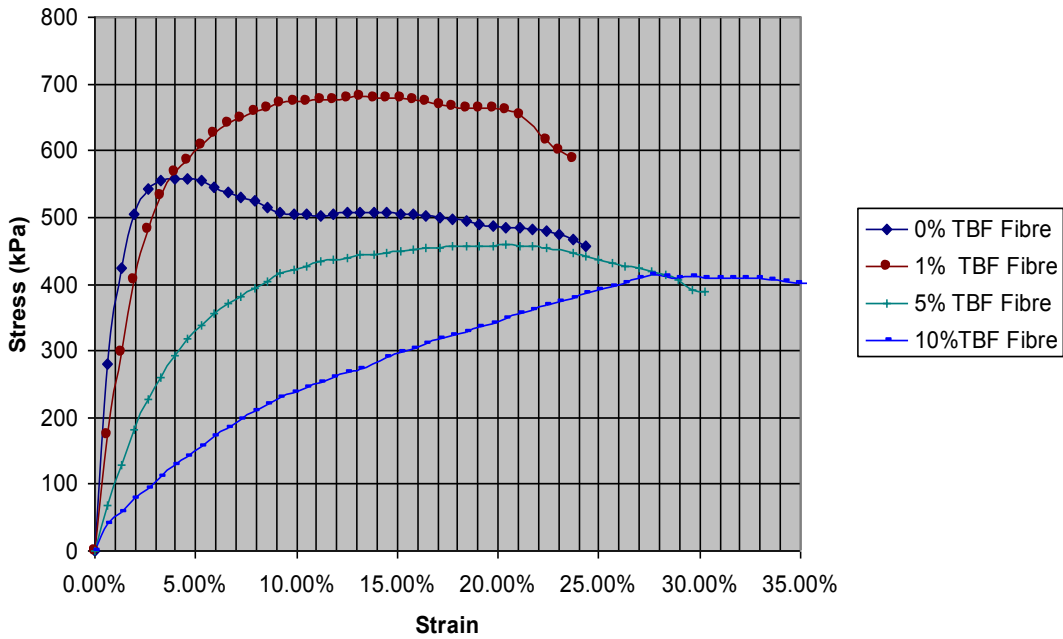


### Triaxial Test

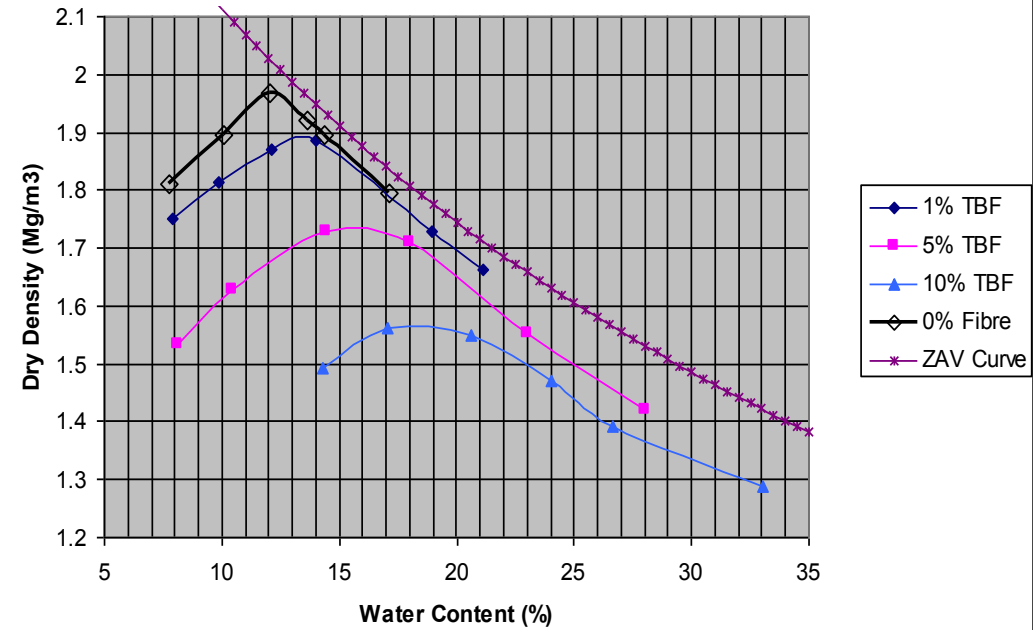




**Stress-Strain**



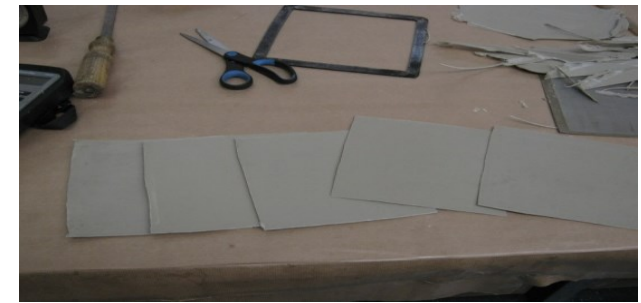
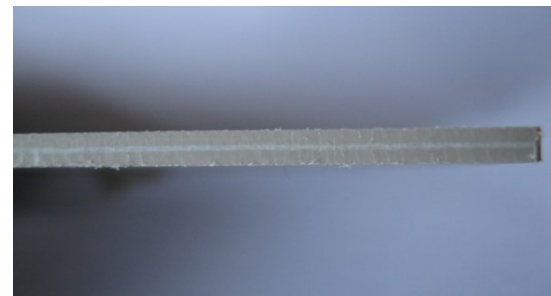
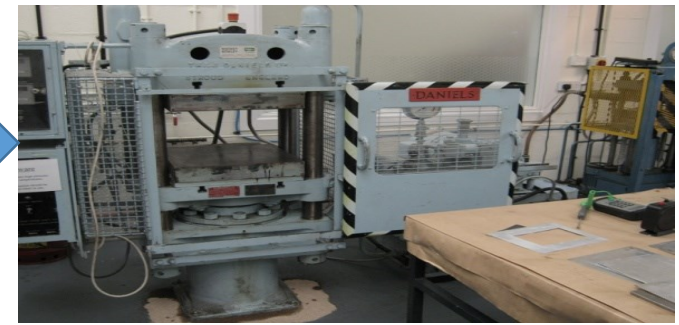
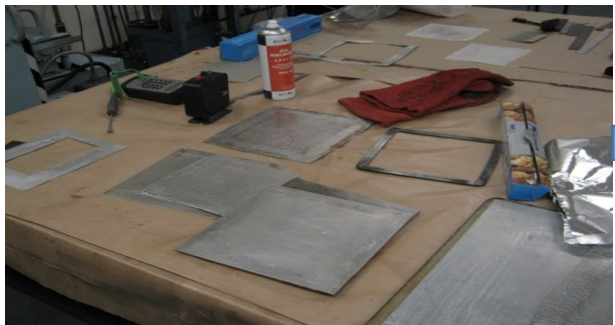
**Compaction Curve**



**References**

1. Utilisation of carpet waste in reinforcement of substandard soils, Mohsen MirafTAB and Ann Lickfold, University of Bolton, UK, *Journal of Industrial Textiles*, Volume 38, Number 2/October 2008, p167-174.
2. Impact of waste fibres on swelling properties of compacted clays, M. Mirzababaei, M. MirafTAB, P. McMahon and M. Mohamed, *Journal of Geotextiles and Geomembranes*, Geotech Geol Eng (2013) 31:173–182.
3. Unconfined compression strength of reinforced clays with waste carpet fibres, M. Mirzababaei, M. MirafTAB, M. Mohamed and P. McMahon, *Journal of Geotechnical and Geoenvironmental Engineering*, March 2013, 483-493.
4. Behaviour of Strip footing on fibre-reinforcement model slopes, Mirzababaei, M., Inibong, E., Mohamed, M. and MirafTAB, M., *Geotechnical Special Publication*, 2014.

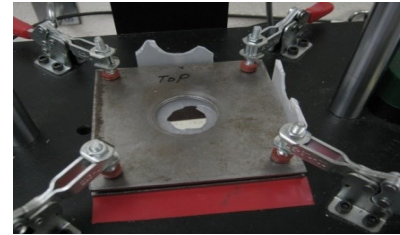
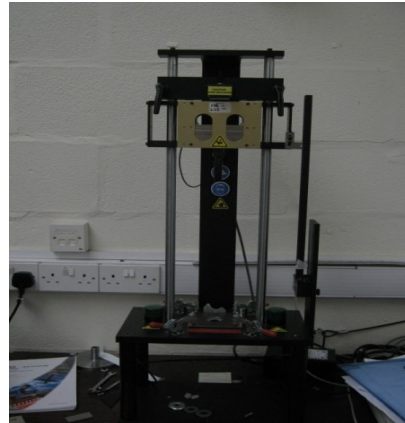
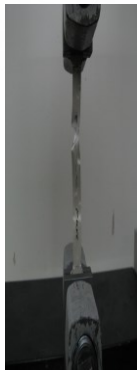
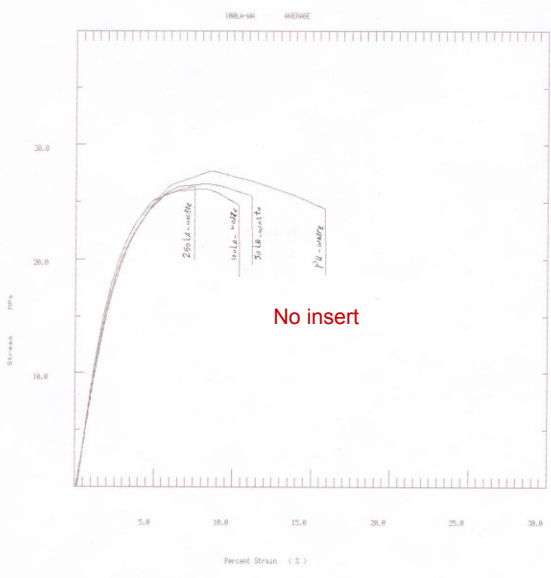
# Low grade composites made from plastic and fibrous waste





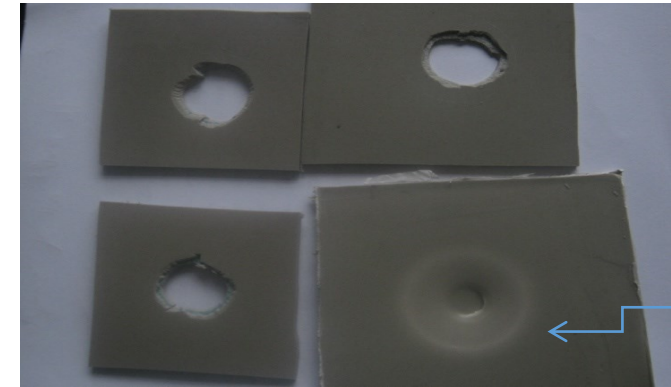
# Impact testing of sheets/ composites

## Tensile testing



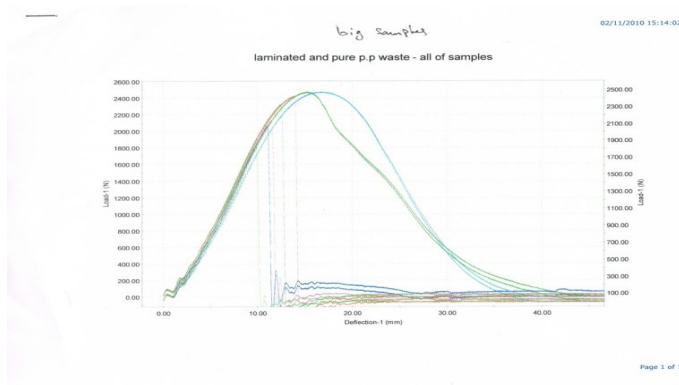
Sample holder arrangement

Impact testing machine, ASTM D7192, for testing plastic film at the minimum speed (2.5 meters/sec)

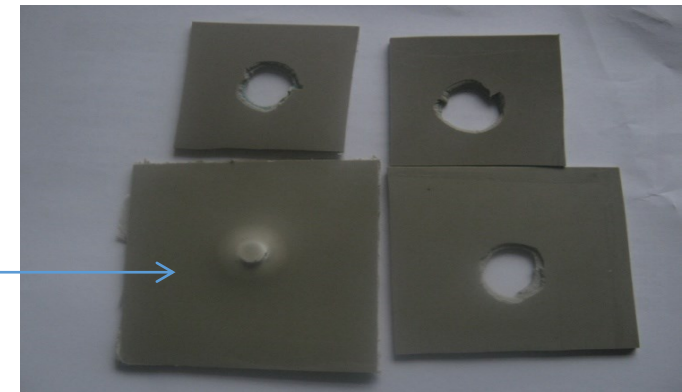


Face

Sample with no insert



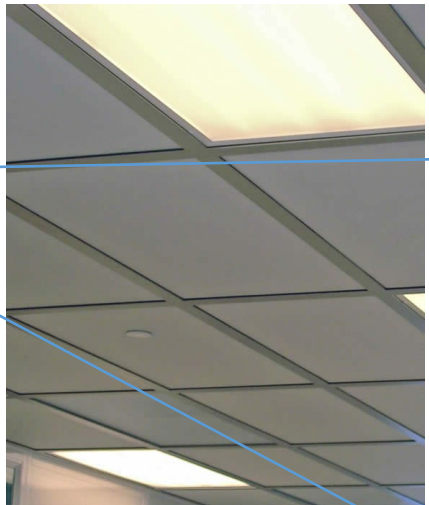
Sample with no insert



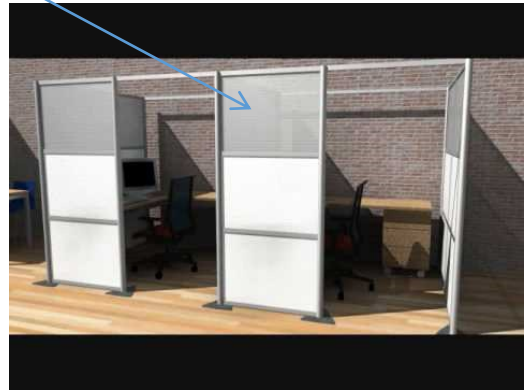
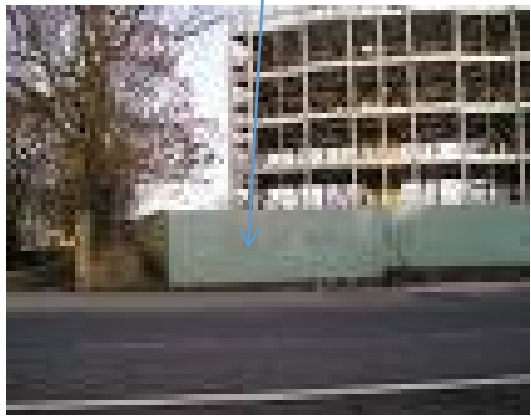
Back



False ceilings panels  
 Temporary wall panels  
 Boarding up panels  
 Building site boards



Possible Application Areas for these Composites!?



**Reference**  
 Objective Study of thermoplastic laminate sheets from plastic and fibrous wastes, M.Miraftab and Saeed Hamzeh, Third International Symposium in Fibre Recycling, Bolton, UK, June 2011.



## Plasterboards reinforced with fibrous waste

Before the 1950's houses built in the UK rarely used plasterboard, instead lath and plaster or just plaster was the tradition.



Plasterboards today are used for partitions and the lining of walls, ceilings, roofs and floors

### Advantages:

- Good for cutting down noise transmission/fire
- Easy to install
- Easy to cut to size
- Reasonably cheap
- Easy to wall paper/decorate





## Typical plasterboard composition

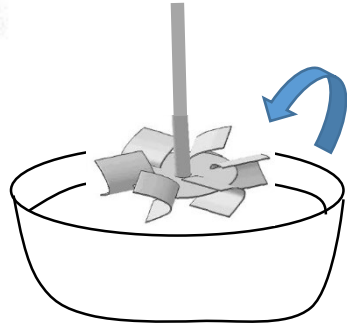
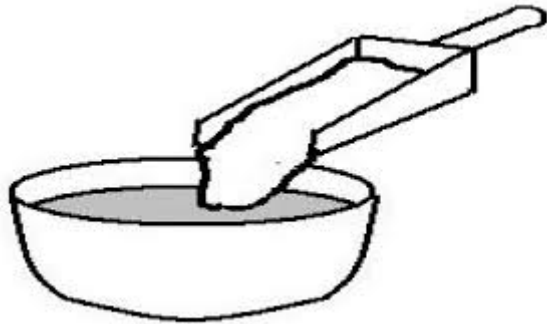
Chemical Name	CAS Number	Proportion
Calcium sulphate dihydrate	10101-41-4	>95%
Paper facing (cellulose)	9004-34-6	4-9%
Paraffin wax	8002-74-2	0-6%
Clay		0-8%
Vermiculite (mica)	12001-26-2	0-4%
Starch	9005-25-8	<1%
Paper pulp (cellulose)	9004-34-6	<1%
Continuous filament glass fibre	65997-17-3	<0.2%



### What does the paper do ?

- ❖ Maintains integrity of the structure
- ❖ Unsupported plaster is brittle and prone to fracture
- ❖ Creates a smooth surface

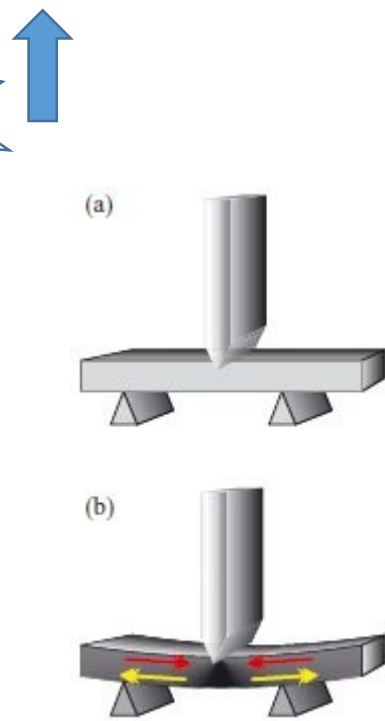
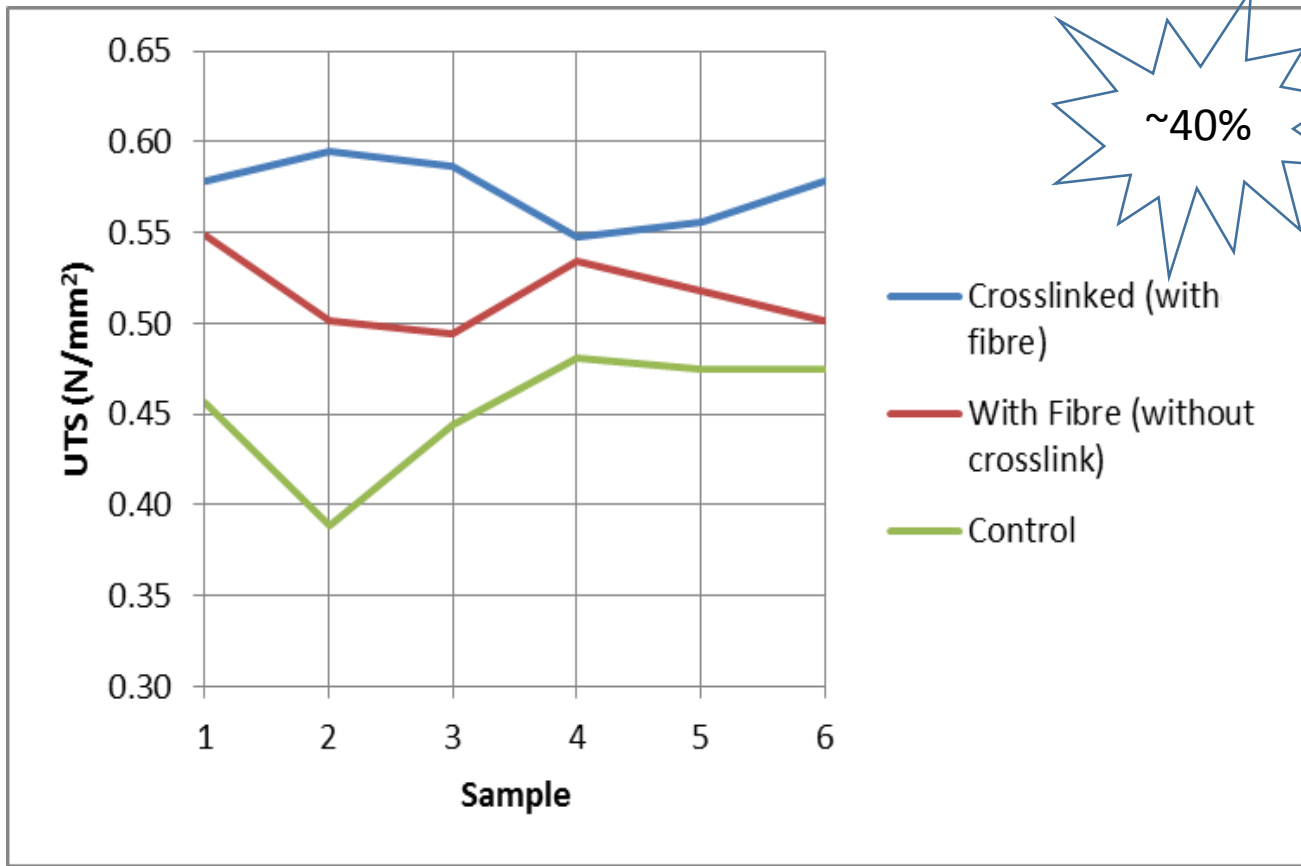




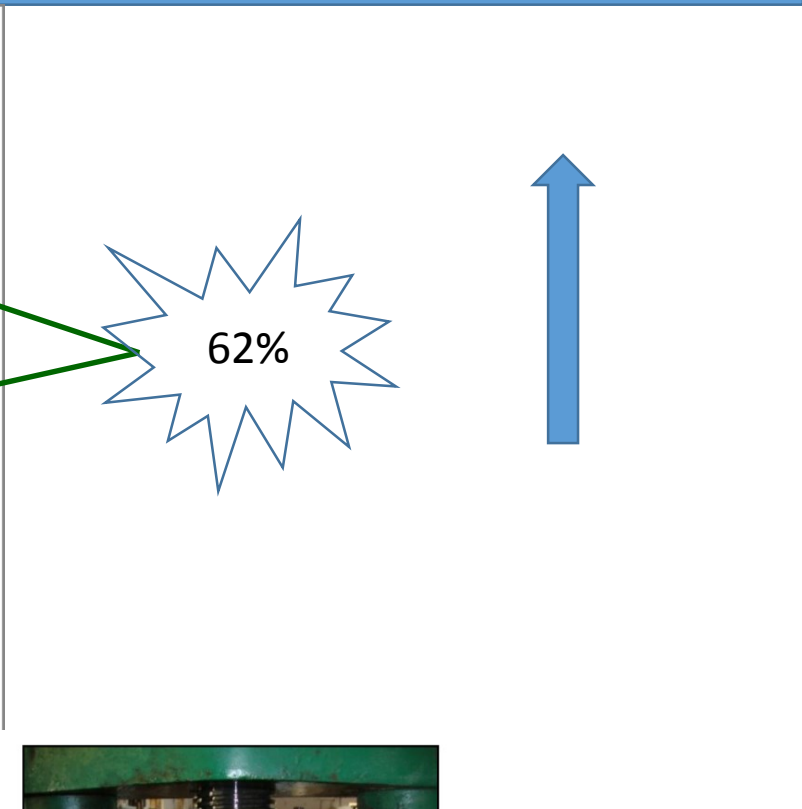
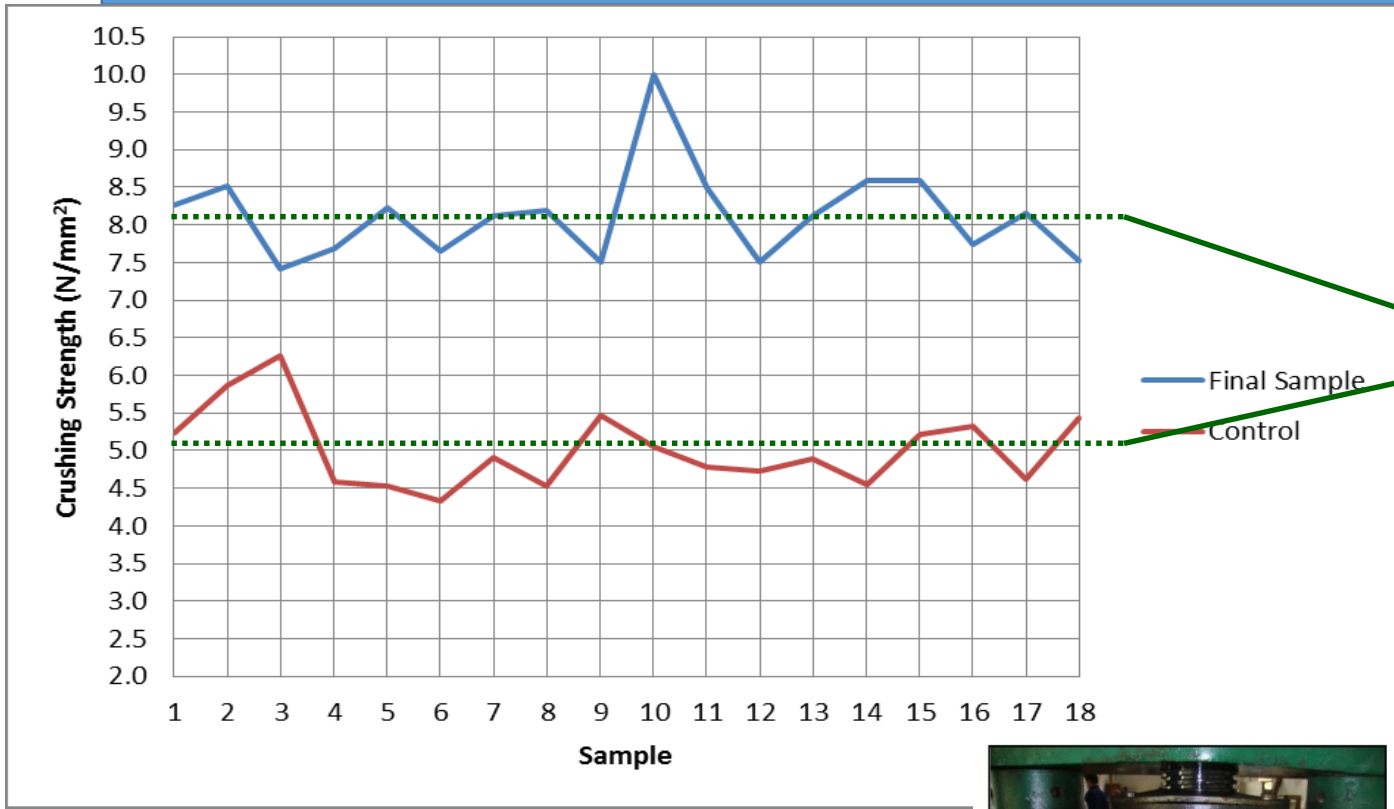
Fibres







Impact of Crosslinking on Ultimate Tensile/Bending Strength



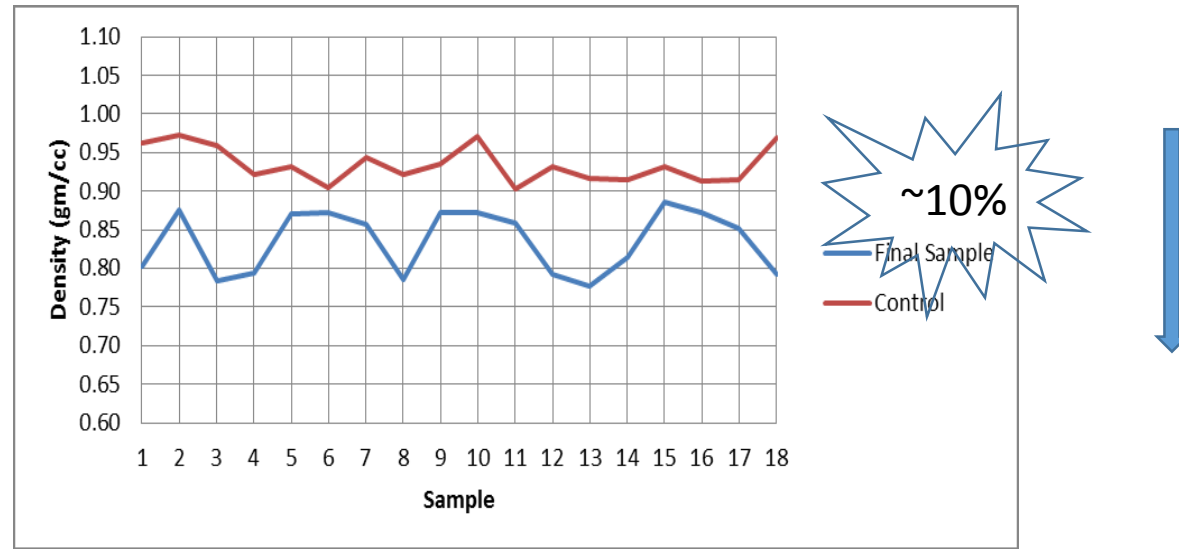
Comparison of Crushing Strength between Control and the Optimised Sample





Control		Final Sample	
Sample Code	Density (gm/cc)	Sample Code	Density (gm/cc)
1706-01	0.963	2406-01	0.802
1706-02	0.973	2406-02	0.876
1706-03	0.959	2406-03	0.783
1706-04	0.922	2406-04	0.794
1706-05	0.931	2406-05	0.870
1706-06	0.905	2406-06	0.872
1906-01	0.943	2706-01	0.857
1906-02	0.921	2706-02	0.786
1906-03	0.935	2706-03	0.872
1906-04	0.971	2706-04	0.873
1906-05	0.903	2706-05	0.858
1906-06	0.931	2706-06	0.792
2106-01	0.916	2806-01	0.777
2106-02	0.915	2806-02	0.815
2106-03	0.931	2806-03	0.886
2106-04	0.913	2806-04	0.873
2106-05	0.915	2806-05	0.852
2106-06	0.969	2806-06	0.793
Average Value	<b>0.934</b>	Average Value	<b>0.835</b>
Std. Deviation	0.0227	Std. Deviation	0.0392

Table-10: Comparison of Density between Control and Final Sample.



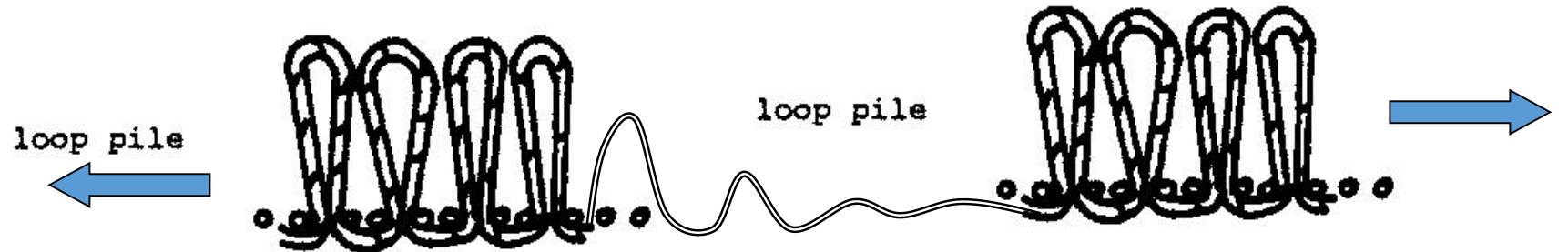
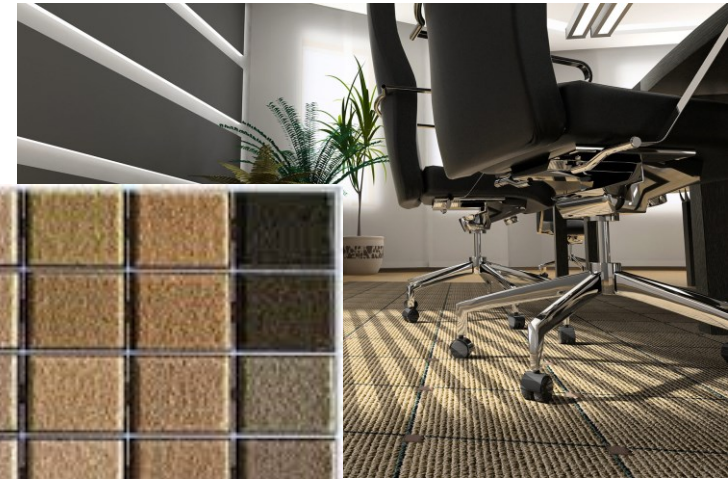
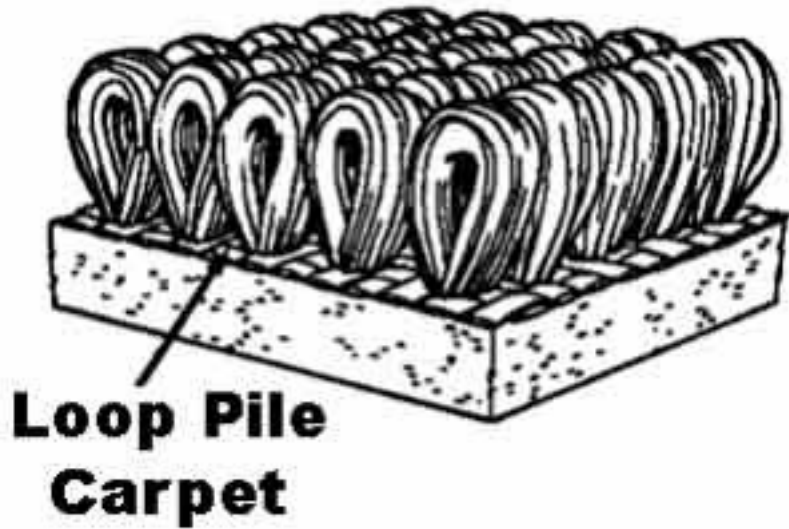
### Comparison of Density between Control and the Optimised Sample

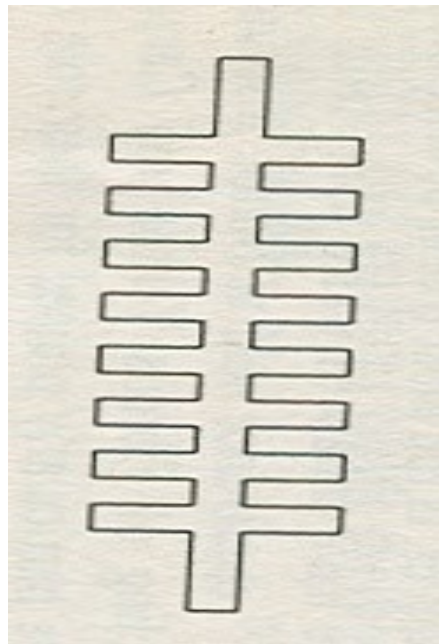
Reference

Reinforcement of plasterboards using cross-linked PVA in polypropylene short waste fibre matrix, M.Miraftab, A T M Faiz Ahmed and G. Whittleston, 5th International Fibre Recycling Symposium, June 8-10, 2015, Union Square, San Francisco, USA.



## Containment of concrete blocks using carpet wastes

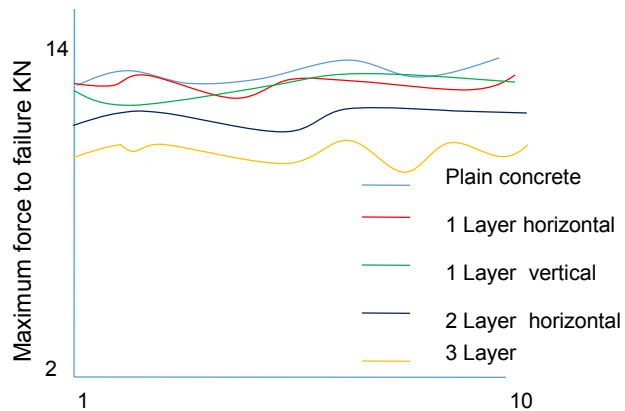




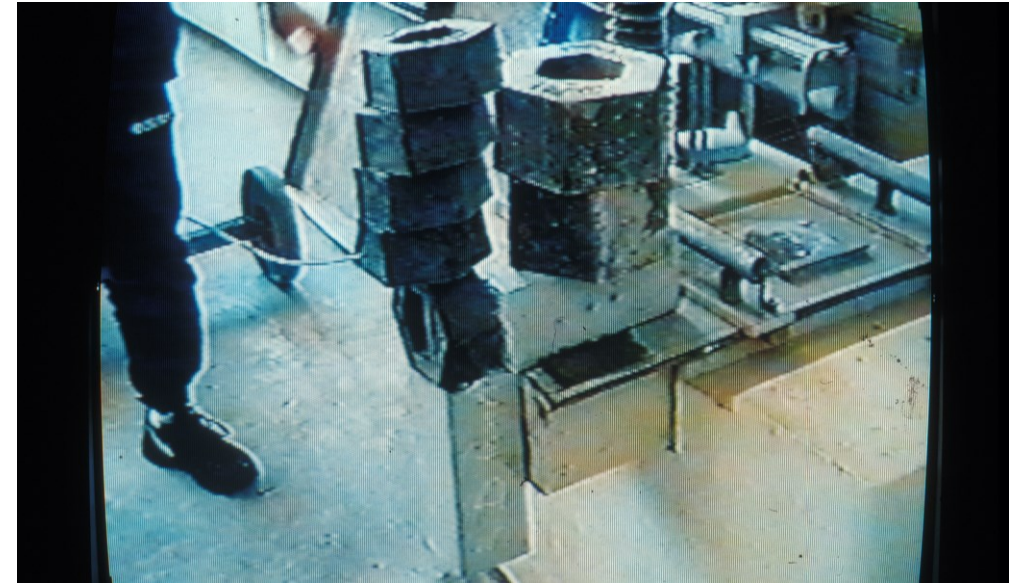
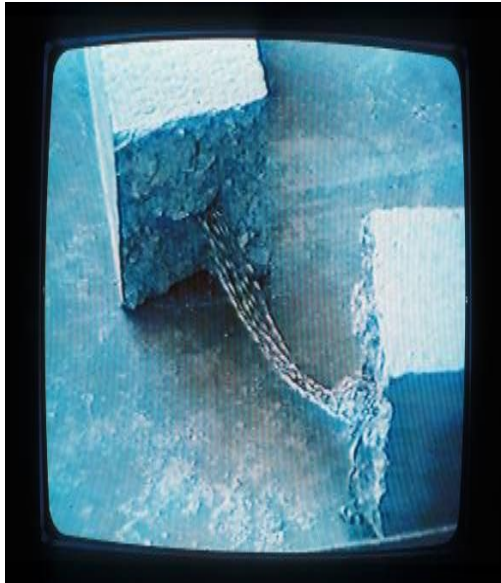
Concrete **confinement**  
Of broken structure  
after  
receiving  
successive  
blows



Four-point  
Flexural test



Sample	Average maximum Breaking Load KN	Average Maximum Stress MPa
Plain	12.76	5.10
1 layer horizontal	12.40	4.96
1 layer vertical	12.78	5.11
2 Layer horizontal	11.95	4.78
3D insert	10.50	4.20

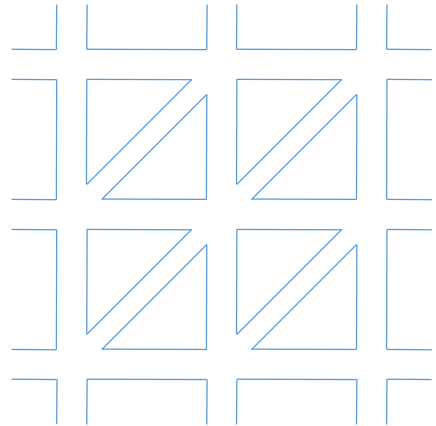
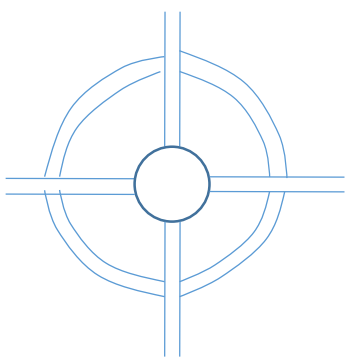


Unravelling of tufted loops when subjected to three-point test and subsequent separation/extension



## Possible application areas

- Earthquake resistant, low cost dwellings
- Resistance against gas leaks and/or bomb blasts
- Containment of pavement slabs



### References

1. Novel application of pre-and-post consumer carpet waste in concrete, M.Mirafab, The Fourth Annual Conference on Recycling of Fibrous Textile and carpet Waste, Georgia, USA, May 1999.
2. New application for selected range of carpet wastes, M.Mirafab, R'99 conference, Geneva, Switzerland, February 1999.



**Thanks and acknowledgments:**

- Alison Taylor.....PhD Student
- Ian Rushforth.....Postdoctorate
- Ann Lickford.....M.Sc. Student
- Mehdi Mirzababaie .....PhD Student
- Saeed Hamzeh.....PhD Student
- Mustapha Olaoluwa Babatunde .....M.sc. Student
- A T M Faiz Ahmed .....M.Sc. Student





Thank you for your attention !

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