SOFT DRINK CANS CLIPPING AS FIBER REINFORCEMENT IN CONCRETE MIX

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ABSTRACT

Reinforced concrete structure still face the same problem of uncontrolled flexural strength that can allow cracks occurred on the structure surface and can reach to the reinforcement bar. This problem can be overcome by adding some additive materials such as fiber. This study was conducted to examine hardened properties of plain concrete and fibers reinforced concrete based on wet properties and mechanical properties. The second objective is to determine the flexural behavior and mid-span deflection of soft drink cans fiber reinforced concrete beam and conventional beam. Two percentages (1% and 3%) of aluminum fiber based on weight of cement were incorporated to the mix design. Aluminum is the most abundant metal in the earth's crust. It is produced from bauxite, a clay-like ore that is rich in aluminum compounds. The performance of cube was analyzed in term of their compressive strength and the values increase with increase the length of curing days, but the fiber amount for the mix in more than 1% makes the bond between cement and aggregates less. The cylinder was testing in term of their indirect tensile strength and the result show increment significantly by about 1% at 28 days. For the rest of mixes, adding fibers has no major effect. Soft drink cans aluminum fiber reinforced concrete can be used to achieve the concrete performance in term of flexural strength. Flexural behavior of soft drink cans aluminum fiber reinforced concrete and plain concrete are much better compared to theoretical in term of ultimate load. All the results for mid-span deflection also achieved the theory calculation based on ACI 318-05. The soft drink cans aluminum fiber controls the cracking behavior of the specimens. Although the soft drink cans aluminum fiber reinforced concrete beam has more cracks compare to plain concrete, but the crack width is smaller.

ABSTRAK

Struktur konkrit bertetulang masih menghadapi masalah yang sama iaitu kekuatan lenturan yang tidak terkawal yang membenarkan retak berlaku pada permukaan struktur sehingga boleh mencapai ke bar tetulang. Masalah ini boleh diatasi dengan menambah beberapa bahan tambah seperti gentian. Kajian ini dijalankan untuk mengkaji sifat-sifat keras daripada konkrit biasa dan konkrit gentian bertetulang berdasarkan sifat-sifat basah dan sifat-sifat mekanikal. Objektif kedua adalah untuk menentukan kelakuan lenturan dan rentang pesongan rasuk konkrit tin minuman ringan aluminium gentian bertetulang dan rasuk konvensional. Dua peratusan (1% dan 3%) daripada serat aluminium berdasarkan berat simen digabungkan dalam campuran. Aluminium adalah logam yang paling banyak terdapat dalam kerak bumi. Ia dihasilkan daripada bauksit, bijih seperti tanah liat yang kaya dengan sebatian aluminium. Prestasi kiub dianalisis dari segi kekuatan mampatan dan keputusan ujikaji menunjukkan peningkatan kekuatan berkadar terus dengan peningkatan tempoh pengawetan, tetapi pertambahan jumlah gentian untuk campuran membuatkan ikatan antara simen dan agregat berkurangan. Silinder pula diuji dari segi kekuatan tegangan tidak langsung dan kenaikan kekuatan tegangan tidak langsung menunjukkan hasil dengan ketara pada sampel 1% untuk hari ke 28. Bagi campuran lain, pertambahan serat tidak mempunyai kesan yang besar kepada kekuatan tegangan tidak langsung konkrit. Konkrit tin minuman ringan aluminium gentian bertetulang boleh digunakan untuk mencapai prestasi konkrit bagi kekuatan lenturan. Kelakuan lenturan rasuk konkrit tin minuman ringan aluminium gentian bertetulang dan rasuk konvensional adalah jauh lebih baik berbanding dengan teori dari segi beban muktamad. Semua keputusan bagi rentang pesongan juga mencapai pengiraan teori berdasarkan ACI 318-05. Tin minuman ringan aluminium gentian juga mengawal tingkah laku keretakan rasuk. Walaupun rasuk konkrit tin minuman ringan aluminium gentian bertetulang mempunyai lebih retak berbanding dengan rasuk konvensional, tetapi lebar retak adalah lebih kecil.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

%	percent
$	currency
N/mm^2	Newton per millimeter square
mm	millimeter
MPa	Mega Pascal
GPa	Giga Pascal
μm	micrometer
g/cm^3	gram per centimeter cube
<	lower than
g/m^3	gram per meter cube
kg/m^3	kilogram per meter cube
kN	kiloNewton
π	phi
m^3	meter cube
kg	kilogram
N	Newton

LIST OF ABBREVIATIONS

ACI	American Concrete Institute
FRC	Fiber Reinforced Concrete
CRI	Container Recycling Institute
ECC	Engineered Cementitious Composite
SFRAC	Steel Fiber Added Reinforced Concrete
UMP	Universiti Malaysia Pahang
OPC	Ordinary Portland Cement
MS	Malaysia Standard
BS	British Standard
ASTM	American Society for Testing and Materials
LVDT	Linear Variable Displacement Transducer

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Presently, new technological innovation appears about every minute of our life. With reasons simply to improve the positive aspects of many things to people. Concrete is the majority of construction material which is widely used in the world today. This material also offers a continuing improvement through research to boost it in many ways. Fiber reinforced concrete research is mostly on the list of advancements in order to improve concrete engineering properties. The development of concrete may help its application for a greater top quality construction.

Fiber reinforced concrete is a favourite construction substance due to the improvement of the mechanical properties and performance compared to conventionally reinforced concrete. The fiber might be classified into metallic, mineral or organic. Metallic type might be included as steel fiber. While mineral fibers consist of many such as asbestos and glass fibers. Organic fibers may be additionally divide into pure or man-made fibers such as cellulose, proteins, coir, silk cotton, nylon, polyethylene and polypropylene.

1.2 BACKGROUND OF STUDY

Fibers have been used as reinforcement since ancient times. Long time ago, horsehair seemed to be used in mortar advertising as straw inside a mud brick. Asbestos also used in concrete recorded as early as the 1950s. The use of composite material is one of the topics that will have attention in this study.

The fibers added in concrete because unreinforced concrete is usually a brittle substance with lower tensile strength and low strain capacity. Thus, at one point fiber may take a main role in order to bridge across the cracks in concrete. It will provide some post cracking 'ductility' to the concrete.

Bank (1993) mentioned that fibers have been used to prevent and control plastic and drying shrinkage in the concrete. Right after some research and enhancement, the concrete properties such as flexural toughness, fatigue toughness, impact resistance and post-crack strength can improve by adding a number of fiber materials in the concrete. Research has shown that the compressive property of cement and tensile property of the fibers, whether synthetic or naturally complement each other once the two are combined as a composite. A composite means a variety of materials created by the synthetic assembly of two or more components, in order to obtain specific characteristics and properties.

1.3 PROBLEM STATEMENT

Lower tensile strength is a greatest weakness pertaining to cement-based composite. In order to help overcome this specific weakness is by simply incorporate high-strength and small size fibers in the composites. In the end, fiber reinforced concrete (FRC) efficiency shows a significant increase tensile strength and overall toughness is actually compared to plain concrete.

Zakaria (1997) reported that various type, proportion, design, measurement or even surface condition on the fibers will probably impact the actual building up device on the FRC. A state-of-art report of fiber reinforced concrete was presented by the American Concrete Institute (ACI) committee in 1973 (ACI Manual, 1977). Incorporation of fibers inside concrete make the actual flexural strength increased when compared with plain concrete as ability the fibers withstands stress after cracking.

Container Recycling Institute estimates that 1,010,000,000,000 (= 1trillion, 10 billion) cans have been wasted since 1972, when the industry started keeping records. According to CRI, a trillion wasted cans weigh in at 17.5 million tons - a quantity of scrap aluminum worth about $21 billion at today's market prices.

FRC is significantly used in civil architectural constructions, including bridges, streets, rooms, offshore platforms, bridge decks, hydraulic structures, international airport and highway paving and overlays. Although they discover previously generally used in this FRC in another country, there is still a lack of application of this product within the Malaysian industry. This may be due to deficiency of information as well as information regarding FRC inside design segment within Malaysia. This kind of new material however not favored in the civil engineering works although have advantages in comparison to conventional cast-in-situ concrete. FRC will probably be approved in construction industry immediately after their feature components completely researched along with effectively understood (Zakaria, 1997).

However, the full potential involving fiber reinforced concrete can be still not fully exploited with practice. It is mainly due to a lack of specific rules of fiber reinforced concrete in building codes. In fact, the latest rules for conventional concrete can hardly possibly be adopted for fiber reinforced concrete that is markedly non linear since fibres start working after cracking of the concrete matrix (Soutsos, 2012).

1.4 OBJECTIVES OF RESEARCH

a) To examine hardened properties of plain concrete and fibers reinforced concrete based on wet properties (workability and density) and mechanical properties (compressive strength and indirect tensile strength).
b) To determine the flexural behavior and mid-span deflection of soft drink cans fiber reinforced concrete beam and conventional beam.

1.5 SCOPE OF STUDY

There is a lot of soft drinks cans easily which can be simply discovered any place. So, I try to using of fiber to soft drinks cans fiber. The soft drink may be more cheaply. Furthermore, it can help reuse the using of soft drink cans.

So the study will look for different fiber length, dimension as well as written content with hardened concrete properties. Constraints on this project are generally:

a) The target characteristic strength of 18N/mm^2.
b) Percentages of fiber in this study are 0% as a control, 1% and 3% by weight of cement content.
c) The length and size of fiber introduce.
d) Sizes of test samples are 150mm x 150mm x 150mm cube for compressive strength test, 1500mm x 200mm x 150mm plain concrete beam for flexural strength test and cylinder test sample with 100mm diameter and 200mm height for tensile strength test.
e) Curing in water until testing.

This research is usually carried out through specifying, proportioning, mixing, setting along with testing of soft drink cans fiber concrete subsequent local along with worldwide requirements.

1.6 SIGNIFICANT OF STUDY

The significance of this study is to improve the strength of the conventional concrete by using soft drinks can fiber. When the strength of the concrete can be controlled, the long life of the building also can be controlled. Therefore, it easily can manage the life of the building for making it safer and in good strength.

This information about the study is beneficial to student who want to do further research on the properties of aluminum fiber in concrete design. Laboratory testing is carried out and determination of aluminum fiber properties which can improve the concrete strength. Compressive strength test and flexure test can produce required results for the concrete strength. The signs of aluminum fiber are controlling the crack and improve the concrete strength.

The flexural performance of the beam will be analyzed in term of load deflection behavior, concrete strain during loading, crack pattern and mode of failure.

1.7 EXPECTED OUTCOME

It is hoped that aluminum fiber reinforced concrete can be used to increase the concrete's performance in flexure. Soft drink cans fiber with 1% and 3% aluminum fibers has almost same behaviour, but both show better performance compared to plain concrete.

1.8 CONCLUSION

The study is to improve the strength of plain concrete by added 1% or 3% of soft drink can. From experimental, we want to see whether the value compressive strength and tensile strength is increase or decrease. Besides that, we want to know the reaction for beam when do the flexural test.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Concrete in general is a building material where its constituents consist of cement, fine aggregates, coarse aggregates, water and admixtures if necessary. Concrete as we can see is the most widely considered construction materials. Among the reason why it is widely use is because the abundantly availability of its raw materials. Apart from that, it is able to cast into any shape is also one of the main reasons why it is the most widely considered building materials.

Concrete is not limited to only one kind of property. It can also be enhanced by adding different materials onto it. Among the materials that can be used to improve the concrete abilities is aluminum fiber. The usage of aluminum fiber will probably produce a revolution in producing high strength and good quality concrete compared to normal concrete.

Applying fibers as reinforcement can be not new. Fibers are actually used as reinforcement since the old periods. As an example, horsehair had been used in the back days as reinforcement in mortar. Early on 1900s, asbestos fibers have been found in concrete and in 1950s obtaining composite materials idea as being reinforcement in concrete had been on the list of topics of issues for researches in the technology area. Within the 60s, using asbestos involves harmful health risk in dealing with it, steel, glass, polymer fibers were considered in concrete. Study directly into new fiber reinforced concrete still keep continues today.

2.2 FIBER REINFORCED CONCRETE

According to ACI 544.1R (Reapproved 2002), fiber reinforced concrete is defined as concrete made with hydraulic cement, containing fine or fine and coarse aggregate, and discontinuous discrete fiber. The fiber can made from natural material (e.g asbestos, sisal, cellulose) or are a manufactured product such as glass, steel, carbon and polymer (Neville *et al.*, 1987).

Fibers would be the main constituents in a fiber-reinforced composite material. They take up the most important volume fraction in a composite laminate and also share the main portion of force performing on a composite structure. Correct selection of the fiber type, fiber size portion, fiber length and also fiber alignment is very important, as it affects the following characteristics of the composite laminate:

i. Density
ii. Tensile strength and modulus
iii. Compressive strength and modulus
iv. Fatigue strength as well as fatigue failure mechanism
v. Electrical and thermal conductive (Mallick, 1988).

Currently, they are several types of fibers which have been used to reinforced concrete matrices. Selecting the kind of fibers is guided through the properties of steel fibers such as diameter, specific gravity, young modulus, tensile strength, and the extent how these type of fibers affect the properties of the cement matrix (Daniel, 1998).

2.3 PROPERTIES OF FIBERS

Fiber reinforcement increases the affect strength and fatigue strength, and also decreases shrinkage. The amount of fibers used is tiny, generally 1 to 5 percent by volume, and to give them efficient as reinforcement the tensile strength, elongation at failure and modulus of elasticity from the fibers should be substantially greater than the related properties of the matrix. Table 2.1 shows standard values. In addition, the fibers must demonstrate minimal creep: other-wise, stress relaxation will happen. Poisson's ratio ought to be similar to that of the matrix to prevent induced lateral stress. Any kind of large lateral stress might affect the interfacial bond which should have shear strength large enough allowing the move of axial stress in the matrix to the fibers (Brooks *et al.*, 1987).

Table 2.1: Typical properties of fibers

Type of fiber	Specific gravity	Tensile strength		Modulus of Elasticity		Elongation at failure (%)	Poisson's ratio
		MPa	psi	GPa	10^6 psi		
Crysotile asbestos	2.55	3.0-4.5	435-650	164	23.8	3	0.30
Alkali-resistant glass	2.71	2.0-2.8	290-410	80	11.6	2.0-3.0	0.22
Fibrillated polypropylene	0.91	0.65	95	8	1.2	8	0.29-0.46
Steel	7.84	1.0-3.2	145-465	200	29.0	3.0-4.0	0.30
Carbon	1.74-1.99	1.4-3.2	200-465	250-450	36.2-65.3	0.4-1.0	0.2-0.4
Kevlar	1.45	3.6	520	65-130	94.3-18.8	2.0-4.0	0.32

Source: Johnston (1980)

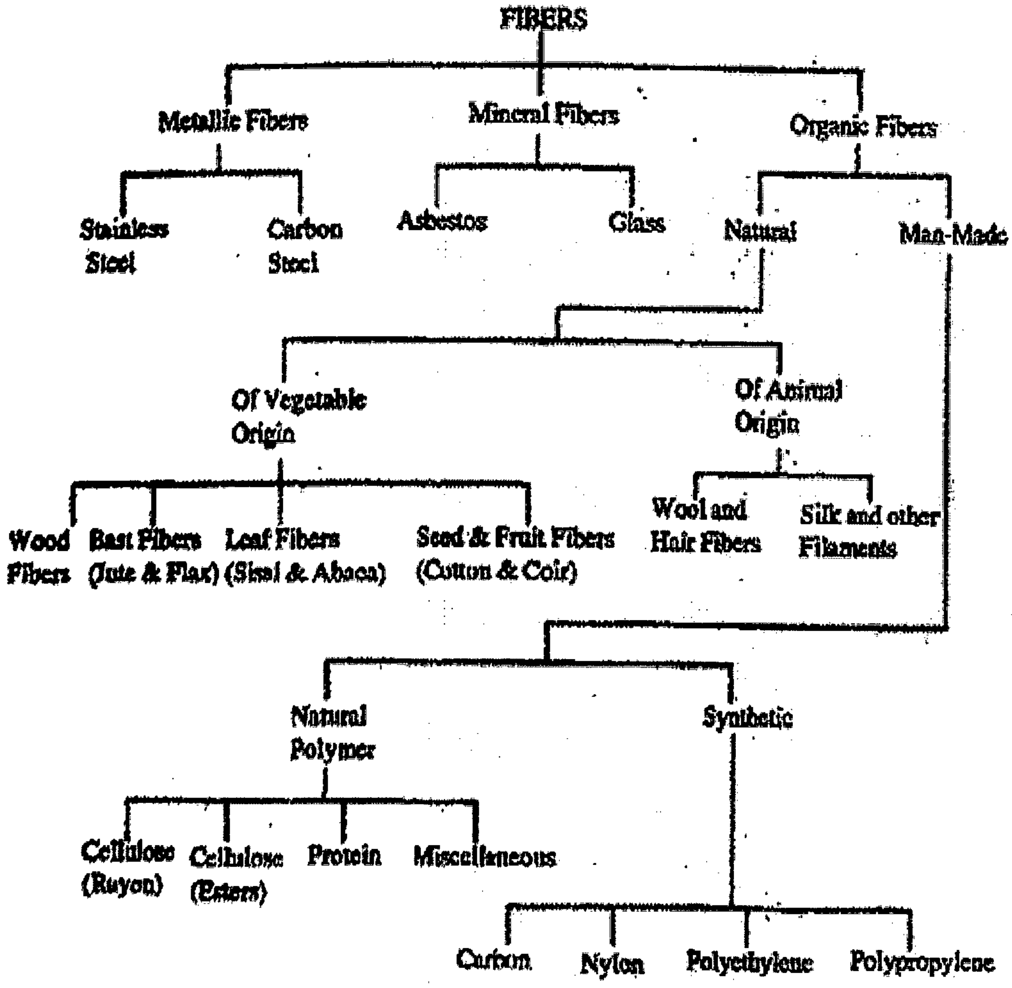

Figure 2.1: Fiber Classification

Source: James Patrick and Maina Mwangi (1985)

2.4 TYPES OF FIBER AS REINFORCED

2.4.1 Glass Fiber

Fibers of various varieties of glass such as, E-glass (electrical glass), S-glass (which has high stiffness), C-glass (which is chemical resistant), E-CR-glass (which is electrical and corrosion resistant) and AR-glass (which is alkali resistant) usually are well-known.

For producing glass fiber, the raw materials tend to be melted in a hopper and the molten glass will be drawn by gravity through a Pt-Rh bushing that contains a large number of openings. The glass fiber size depends on the orifice diameter of the bushing, viscosity of molten glass and the head level of glass in the hopper. Fibers of 10μm diameter might be easily produced by the above technique (Srinivasan, 2009).

Table 2.2: Typical physical and mechanical properties of commercial glass fibers

Parameter	E-glass	S-glass	C-glass	AR-glass
Tensile strength (GPa)	3.45	4.3	3.03	2.5
Tensile modulus (GPa)	72.4	86.9	69.0	70.0
Ultimate strain (%)	4.8	5.0	4.8	3.6
Poisson's ratio	0.2	0.22	-	-
Density (g/cm^3)	2.54	2.49	2.49	2.78
Diameter (μm)	10.0	10.0	4.5	-
Longitudinal CTE ($10^{-6}/^{o}C$)	5.0	2.9	7.2	-
Dielectric constant	6.3	5.1	-	-

Source: Benmokrane *et al.* (1995)

The most common application of Glass Fiber Reinforced Concrete is actually on the location cladding and architectural panels for buildings. However, ones application of Glass Fiber Reinforced Concrete nowadays is quite broad, that will coming from agriculture, building to marine applications.

2.4.2 Aramid Fiber

Kevlar and Nomex are two typical examples for aramid fibers. Kevlar 49 is an excessive modulus of elasticity material designed especially for reinforcing plastics in aerospace and related industries. In belongs to a group of highly crystalline aramid (aromatic polyamide) fibers which have the lowest specific gravity and the highest tensile strength-to-weight ratio among the current reinforcing fibers (Mallick, 1988).

Aramid fiber reinforced concrete is actually applied intended for chemical storage facilities, off-shore structures and in other aggressive environments. It also obtained for railway sleepers, hazard security walls and other dynamically packed structures due for the high fatigue resistance. In addition, the idea additionally being applied to be able to pre-stressing masonry cavity walls (Bottcher, 1991).

2.4.3 Steel Fiber

Concrete reinforced with sliced steel fiber in amounts usually less than 1% has a tensile stress-strain curve of the type as OXB in figure 2.2. The reason for this is that it is physically very hard to include sufficient fibers in the mix to exceed the crucial fiber volume which, for quick random three-dimensionally oriented fibers.

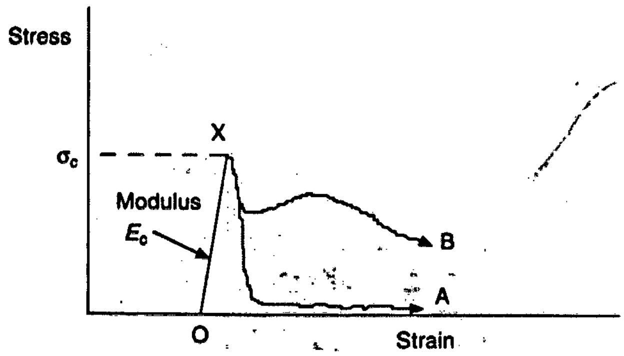

Figure 2.2: Typical stress-strain curves for short random fiber concrete

Source: Newman *et al.* (2003)

Steel fibers present virtually no increase inside the compressive or even uniaxial tensile strength of concrete. The main advantages is uniaxial tension result from the control of crack widths due to shrinkage or thermal results in slabs and tunnel linings and this is really simply not an great easily quantifiable parameter but relates to post cracking fiber pull-out or perhaps fracture forces. A regular stress/deflection curve for beams with a high fiber volume is shown in figure 2.3 and illustrates the actual post-cracking feature in bending which result from the ductile characteristic of the tensile stress block even the fiber volume is less than the critical volume in tension (Newman, 2003).

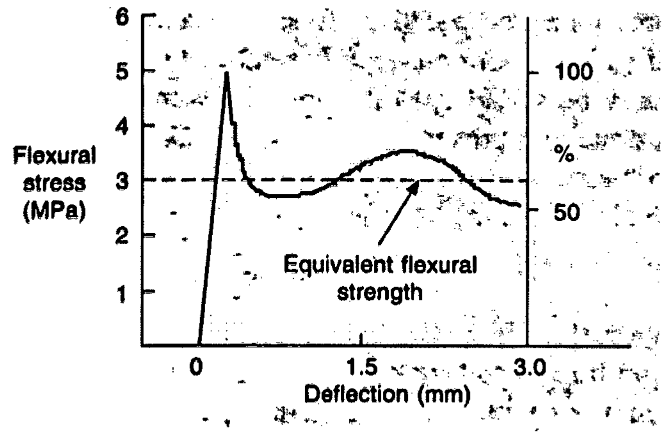

Figure 2.3: Typical stress-deflection curve for steel fiber concrete used to determine equivalent flexural strength in the post-crack state

Source: Newman *et al.* (2003)

2.4.4 Natural Fiber

Aziz *et al.* (1984) claimed that coconut coir, sisal, sugarcane bagasse, bamboo, jute and wood cement composites had recently been researched in over 40 countries all around the globe.

Natural fibers tend to be broadly and cheaply available through Malaysia. Plantation and agricultural field possess contributed to mass production of plant fiber.

Before the natural fibers may be used, specific treatment should be carried out around the fibers itself in order to avoid chemical and biological attack.

Issue experienced with the poor toughness of fibers in some reinforced cement composites had been probably because of alkali attack of fibers by the pore water, replacing section of the cement within silica fume, making use of natural pozzolans in the mix or by sealing the pore process using chemical in the mix or impregnating it along with sulphur. Among the pozzolans which has previously examined is the rice husk ash although it has been suggested that sugarcane bagasse ash is usually obtained just like it has high silica content and thus might display pozzolanic properties.

2.5 RECYCLE MATERIAL FIBER AS REINFORCED

2.5.1 Waste Plastic

Plastic recycling is taking place on a significant scale in India. Around 60% of each industrial and urban plastic waste is recycled. Indian have released plastic wastes include immense economic value, as a result of this, recycling of waste plastics plays a major role in economic. Plastic waste is bulky, heavy and improper for disposal by incineration or compositing which result in polluting environmental surrounding. The benefits of using waste plastics as a modifier tend to be the item easily binds to coarse aggregates at medium temperature. It does not demand any change throughout road laying practice. The actual material can also be available in the form of shredded plastic, which is currently treated as a waste (Kiran *et al.*, 2006).

Recycled plastic could be efficiently used in the repair and overlay of broken cement concrete surfaces in pavements, bridges, floors and dams. Recycled plastic also may be used in a number of recast applications for example utility components (e.g. drains for acid wastes, underground vaults and junction boxes, sewer pipes, and power line transmission poles). In addition, recycled plastic works extremely well in transportation related components (e.g. median barriers, bridge panels and railroad ties). The obtainable kinds of recycle plastics may be used to fabricate marine structure