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Review: Concrete Pavement using Recycled Asphalt Material

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Abstract: *Asphalt concrete is a composite material use for construction of road, parking lots, core of embankment, airport runway etc. After end of their life of working, the production of demolition and construction waste has been increasing at a gradual rate in day to day. Such waste leads to impact on environment due to lack of landfill available and disposal locations. Recycling programs of such waste materials offer a viable solution. The use of these Recycled Asphalt Materials is allowed and encouraged in the construction of new roadways and pavements. Its use reduces environmental impacts and cost of road construction by reusing existing asphalt pavement.*

While construction of pavement habitually fail before their life span, in spite of rigid pavement is more durable with the low maintenance cost about 75% less than asphaltic pavement road. The utilization of recycle asphalt is very economical for the construction of road pavement also the environmental conditions have advocate to recycling and reuse it for the various construction. 1. Coarse Aggregate of fresh aggregate with 5, 10,95, 20 25 15 75 & 100% of the recycled Asphaltic pavement (RAP).

This review paper on outcomes of study which was held on recycled asphalt materials, that have minimal knowledge of incorporating recycled asphalt material into new asphalt and would like to understand more.

Keywords: *Rigid Pavement, Recycled Aggregate Concrete (RAC), Asphalt Composite Material (ACM)*

I. Introduction

Historically, pavements have been divided into two broad categories, rigid and flexible. There is one major difference between concrete and asphalt road surfaces. Concrete pavement is a rigid structure and asphalt is a flexible structure. These classical definitions, in some cases, are an over-simplification. However, the terms rigid and flexible provide a good description of how the pavements react to traffic loads and the environment. The flexible pavement is an asphalt pavement. It generally consists of a surface of asphalt built over a base course and sub base course.

Base and subbase courses are usually gravel or stone. These layers rest upon a compacted subgrade (compacted soil). In contrast, rigid highway pavements are made up of Portland cement concrete and have only a base course between the pavement and sub grade (Jain, et al.,2004).

1.1 Use of Recycled Materials

The first concrete pavement was constructed in Washington which had the thickness of 6 inches and it was in the shape of 6 feet wide square sections. After that in 1950 Continuous Reinforced Concrete Pavement (CRCP) was introduced by Bureau of Public Roads (Pasko 1998). The cost of construction of the rigid pavements is very high as compared to the asphaltic pavements in order to reduce its cost; the Engineers/researchers are experimenting from more than 3 decays. Various techniques have been used in the past like changing the dowel bars, changing position and

Spacing of dowel bars, introducing various mix designs but the best and most effective technique is the introduction of the recycled aggregates at the place of the virgin's in the concrete pavements (Bakash, et al., (2012).

A summary of the experimental and the research work by the various investigators or scientists is described here; At Iowa in 1976 a two lift concrete pavement was constructed (Bergren and Britson 1977). The top lift was constructed by virgin materials and having thickness of 4-in. The bottom lift having thickness of 7-in was made up of the recycled aggregates having 25% of Reclaimed Asphalt Pavement (RAP) which was obtained from the existing pavement (Amirkhanian). It was actually an experimental pavement. The main aim was to determine the behaviour of the RAP in concrete pavements. The experimental studies on this pavement encouraged the utilization of the RAP in the Cemented roads (Fergus 1980).

The Austrian Highway Authority constructed some test sections in 1991 and 1993 with 10% of the RAP. Upto date no any ill effects was found in these sections. Later on Sommer (1994) published a report on the test sections constructed by Austrian Highway Authority. On the basis of this broad experimental research Current Austrian construction specifications allow up to 20% RAP in the bottom lift of two-lift concrete pavements (Brand, et al., 2009).)...

Delwar (1997) investigated a number of mixtures with varying percent replacements of coarse and fine RAP (0, 25, 50, 75, and 100%) and two water-cement (w/c) ratios (0.4 and 0.5) the results that up to 20% of RAP can be used in the concrete pavements and the high contents of RAP (more than 20%) is suitable for only non-pavement applications such as sidewalks, barriers, and gutters (Delwar, and Fahmy. 1997).

In the same year, the Kansas Department of Transportation constructed numerous doweled twolift concrete test sections, one of which contained 15% RAP (Wojakowski 1998). In 2009 these test sections were examined, and it was found that the RAP section had a load transfer efficiency of 85% (Brand, et al., 2009).).

A follow-up study by (Gillen, Brand.) reported that adding coarse RAP to the concrete was acceptable up to a replacement content of 40 to 50%. The strength of RAP concrete could also be improved by reducing the water-cement ratio. At RAP contents greater than 4050% in air-entrained concrete, the concrete was reported to have insufficient strength and frost resistance for adequate pavement performance, even at lower w/c ratios. The laboratory study investigated RAP replacements of 0, 25, 50, 75, and 100%. The compressive, splitting tensile, flexural strengths and modulus of elastic decreased with an increase in coarse RAP. In general, the frost resistance was reduced with an increase in RAP (Brand, et al.,
2009).)...

Hassan (2000) constructed three test sections, first having 100% coarse RAP with fresh natural sand the second test section composed of 100% coarse RAP and fine RAP and the third mix included 30% replacement of cement with fly ash and 100% coarse RAP. The section having both 100% fine and coarse RAP had the lowest compressive and flexural strength and greatest porosity and oxygen permeability. The fly ash mix with 100% coarse RAP had similar compressive and flexural strengths relative to the same mix without fly ash but had lower porosity and oxygen permeability(Hassan, and Brooks. 2000).

Mathias (2004) constructed many test sections composed of the surface and the bottom layer. Five different percentages of RAP were examined: 0, 12.5, 26, 51, and 90%. The temperature sensitivity was also taken into account during the compressive and tensile strength test by keeping the temperature at 40°C. The results of this experimental study showed that the compressive, splitting tensile strengths and elastic modulus all decreased with increasing high percentages of RAP, and that as the amount of RAP in concrete increased, the concrete properties became more sensitive to temperature. Fatigue testing was also conducted on some of the mixes. The stress ratio required to achieve at least one million cycles to fatigue failure was approximately 10% lower with the inclusion of 90% RAP into the concrete(Mathias, 2004).

Huang examined the fine and coarse replacements of RAP with 0, 10, 30, 50 and 100% percentages. In some of the mixtures cement was also replaced with silica fume up to 0, 10, and 20%. It was found that lower the percentages of RAP higher the slump, higher the percentages of RAP lower the slump. The addition of silica fume resulted in a nearly zero slump.
(Huang, 2006).

Hossiney (2008) experimented on 0, 10, 20, and 40% RAP replacements with both coarse and fine. The slump and unit weight both decreased with increasing RAP replacement, but the air content change was variable, with increased air content at higher RAP contents. In general, the addition of RAP resulted in a decrease in the modulus of elasticity, compressive strength, flexural strength, and split tensile strength. The inclusion of RAP resulted in a reduction in free shrinkage (Hossiney, and Tia.2006).).

Al-Oraimi used 0, 25, 50, 75, and 100% of RAP at the place of coarse aggregates with two different water cement ratios (0.45 and 0.5). The compressive, flexural strengths and the modulus of elasticity decreased with increment the percentage of RAP. However the author recommended the usage of 20% of the RAP in the Rigid Pavement construction (Al-Oraimi, Hassan. 2009).

In 2010 Hossiney conducted his second experimental study and examined two RAP sources with varying w/c ratios and cement contents. The result was same as of the previous study and in addition he found that the effect of RAP on the free shrinkage and coefficient of thermal expansion was variable (no clear trend) (Hossiney, 2010)...).

Okafor (2014) performed many experiments for the comparison of the performance of the 100% coarse RAP versus 100% virgin gravel aggregate. The impact crushing test showed the RAP more durable than the fresh aggregates. Okafor concluded that the RAP provides more resistance to impact loading than of virgin aggregate. The author also resulted that increment of the percentages of RAP may reduce the slump. Additionally the author noted that failure in compression often resulted as the failure between the RAPmortar interface with little aggregate crushing while the virgin aggregate often failed by aggregate crushing. The compressive strength of the RAP and virgin concretes did not differ as much once the strength of the mortar approached the strength of the asphalt mortar bond between the RAP and cement matrix, which was noted in a leaner concrete mix at a higher w/c ratio(Okafor).

Bilodeau (2012).introduced RAP in steel fiber reinforced roller compacted concrete (RCC). The hydraulic binder shares 12% of the weight of aggregates. The binder consists of limestone, fly ash, slag and clinker. Three RAP percentages (0, 40, and 80) were used and hydraulic-binder-treated RAP material was also used which contained 5% binder. The bindertreated RAP had the lowest compressive, splitting tensile strengths and elastic modulus (Cuttell, and Snyder.
1997).

Bermel conducted a study with collaboration of Montana State University. He examined behaviour of RAP (both coarse and fine) through some special experiments differ from normal laboratory experiments. The coarse RAP percentage ranges from 25-100%, fine RAP having 0-50%, water cement ratios were 0.35 and 0.45. The target mean strength requirements were 2000 psi compressive after 7 days of effective curing, and after 28 days were 3000 psi. In case of Flexural strength it was 500 psi at 28 days. The compressive and flexural strengths, in general, decreased with increasing RAP content. Through statistical analysis, it was found that the 7 day compressive strength was dependent on the coarse RAP content while the 28 day compressive strength was dependent on both the coarse and fine RAP content. The fine RAP appeared to affect the strength more than the coarse RAP, especially at 28 days.

Literature review indicates that Recycled Portland cement concrete has been profitably used all through the world in the construction of concrete pavements, In case of the unbound layers recycled aggregates gave a very good result. In many of the European countries there is a specification that demolition waste specially the aggregates must be recycled and utilized. The Britain has put an initiative and using 25 percent of recycled aggregates in construction especially in pavements. In the United States, Concrete shares 67 percent of the weight of the demolition waste. But the only 5 percent is recycled back and used again(Medani, Ziedan .). In case of Pakistan the aggregates account half of the weight of construction but a very less amount is recycled and utilized.

II. Materials And Methods

2.1 Collection of Recycled Asphaltic Material

The RAP may be obtained by pavement milling with rotary drum cold milling machine or from a ripping/crushing operation. Cold milling machines are available in various sizes and capacities (horse power). A full line of milling machines is available to suit different production requirements. The milling width can be from one meter to a full lane and the milling depth can be from 20 cm to 38 cm (8 to 15 in). Alternative to cold milling is ripping and crushing operations with earthmoving equipment, scarifiers, grid rollers or rippers. In this research the RAP was obtained from Indus Highway (Near Indus River), Matli and Hala.

2.2 Extraction of RAP (AASHTO T 164 or ASTM D2172)

Basically this test is carried out for quantitative determination of asphalt cement in a bituminous paving mixture and addition in order to determine the behaviour of the Extracted aggregates in Rigid Pavements. The RAP or paving mixture is extracted with trichloroethylene and by using Petrol. The extracted aggregates were washed to remove fines smaller than 75 µm and the remaining aggregates are used for sieve analysis. To achieve the sufficient workability and representative sample Quartering was carried out then the field sample warmed into microwave oven at 110°C for 24 hours. The Extraction Machine Capacity is 1200 gm, asphalt cement content is obtained by subtracting the extracted aggregate mass from the original mass of the test sample.

The Mix Design 1:1.5:3 and Water Cement Ratio (0.45) was used during this research because it was recommended by various researchers as found in the literature review. Five concrete cubes and Cylinders were cast for Virgin material, 5%, 10%, 15%, 20%, 25%, 50%, 75%, 100% RAP Samples and Extracted Aggregates (EA) and these were inspected for Compressive and Tensile strengths after curing period of 7, 14,21 and 28 Days.

III. Results And Discussions 3.2 Compressive Strengths

By using virgin material (0% RAP) the compressive strength was found 3475 Psi with 5% RAP strength decreases 3.53% of the total and came 3352 Psi. In a similar way at 10% RAP strength was 3123 Psi, at 15% RAP strength was 2772 Psi, at 20% RAP strength was
2454 Psi, at 25% RAP strength was 2099 Psi, at 50%

RAP strength was 1904 Psi, at 75% RAP strength was 1799 Psi and by using 100% Recycled Materials strength was 1684 Psi which was approximately 50% of the fresh material's strength. By using Extracted Aggregates Ultimate Strength was 2215 Psi (64% of the Virgin

Aggregate's). The results illustrated that the cube made up of virgin aggregates have higher strength than all those having RAP. This tendency was analysed very closely and it can be explained as the concrete strength depends on the bonding between the cement and aggregates. The less compressive strength of concretes cubes made from RAP aggregate was due to the improper bond between cement and RAP because the surface of aggregates were already coated with the bitumenous layer. This argument was established by an inspection of the failure surface of the broken cubes. The effect of the RAP on the compressive strength can be altered by proper heating and cleaning of the RAP before the manufacturing of concrete.**(Fig.3).**shows percentage of the recycled asphaltic material, maximum peak load at which crack appeared in concrete cubes and the Ultimate Strength after 7 Days of the effective curing period which was obtained by dividing Max: Peak Load with the x-sectional area of Concrete Cube.

RAP(%) VS Ultimate Strength (Psi)
4000
Ultimate Strength (Psi)
3500
3000
2500
2000
1500
1000
500
0
RAP (%)

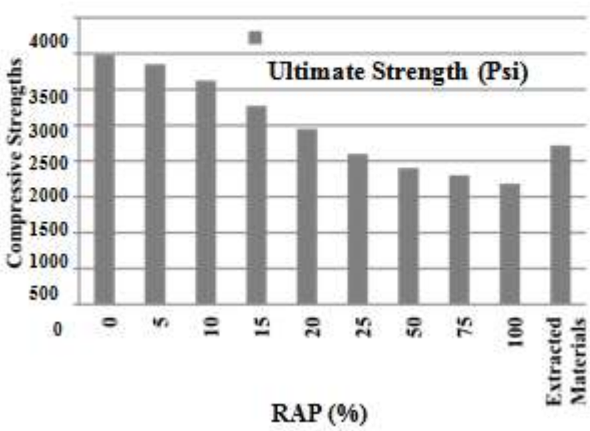
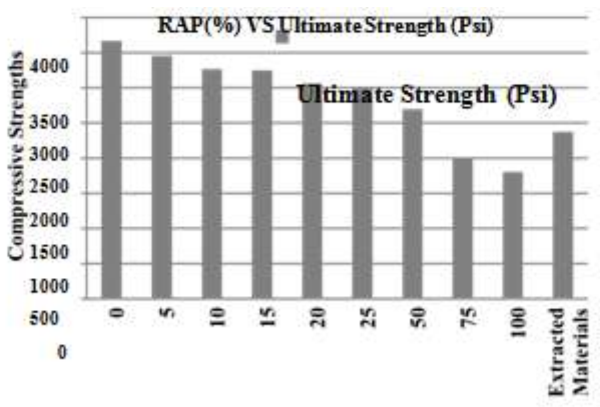


Fig.1. Compressive Strength after 7 Days of Curing

(Fig.2).shows the performance of Recycled material after 14 days of curing period. By using fresh material ultimate strength is 3665 Psi (means 195 Psi increment due to curing of more 7 Days) by using 5% of RAP the Ultimate Strength was 3457 Psi at 7 days of curing it was 3352 psi that illustrates that 105 Psi increment, at 10% of RAP the Ultimate Strength was 3265 Psi (142 Psi increment) , cube having 15% RAP the Ultimate Strength was increased to 142 Psi, at 20% of RAP the Ultimate Strength was 3059 Psi (606 psi increment just curing of 7 more days), by using 25% of RAP a huge increment (911 psi) was observed and the Ultimate Strength was reached to 3010 Psi , cube made up of 50% RAP the Ultimate Strength was 2694 Psi (790 psi increment), at 75% of RAP the Ultimate Strength was jumped to 1986 Psi because of the increment of 187 psi and by using 100% Recycled Materials Ultimate Strength is 1805 Psi (121 Psi increment in Past 7 Days of Curing). The concrete cubes made up of the Extracted aggregates gave compressive strength 2375 Psi (Having 160 psi increments). The trend of the rapid increment in the compressive strengths can be explained as the concrete made up of RAP require more curing than that of conventional concrete.

RAP(%) VS Ultimate Strength (Psi)
4000
Ultimate Strength (Psi)
3500
3000
2500
2000

1500
1000
500
0
RAP (%)



RAP (%)

Fig.2. Compressive Strength after 14 Days of Curing

(Fig.3)shows the performance of Recycled material after 21 days of curing period. By using fresh material ultimate strength is 3816 Psi (means 341 Psi increment due to curing of more 14 Days), at 5% of RAP ultimate strength was found 3627 psi, at 10% of RAP compressive strength increases to 3448 psi, cube having 15% of RAP gave ultimate strength 3340 psi, the 20% RAP's specimen had the strength of 3182 psi, at 25% of the RAP ultimate strength was reached to 3024 psi and the specimen having 75, 100% Recycled Materials gave Ultimate Strength 2183 and 1915 Psi respectively. At the 100% RAP 231 Psi increment was observed in Past 7 Days of Curing. The test of compressive strength after 21 days of curing is also the evidence of the previous argument that the concrete made up of RAP requires more and effective curing period as compared to the normal concrete.

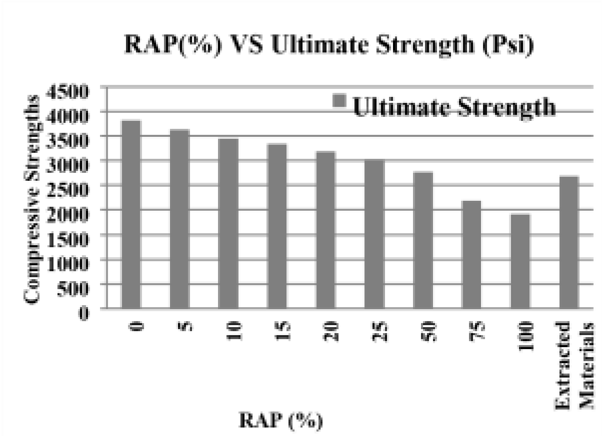


Fig.3. Compressive Strength after 21 Days of Curing

After 14 Days of Curing Period at 0% RAP we have Ultimate Strength 3875 Psi, at 5% RAP Ultimate Strength is 3755 Psi (96% of the fresh material's), at 10% RAP Ultimate Strength is 3683 Psi (95% of the fresh material's), at 15% RAP Ultimate Strength is 3466 Psi (89% of the virgin), at 20% RAP Ultimate Strength is 3310 Psi (85% of the fresh aggregate's), at 25% RAP Ultimate Strength is 3029 Psi (78% of the fresh material's), at 50% RAP Ultimate Strength is 2918 Psi (75% of the fresh), at 75% RAP Ultimate Strength is 2700 Psi (70% of the fresh material), and by using 100% of the Recycled Aggregates the Ultimate Strength is 2480 Psi (64% of the virgin aggregates). In a similar way by using Extracted Aggregates Ultimate Strength is 2868 Psi (74% of the fresh aggregate's) as shown in **(Fig-4).** After the 28 Days of the curing period 100%

Recycled material's sample gain 64% of the fresh material's strength which was only 49% after 7 Days of curing of the fresh aggregate's sample. It means that Recycled Material requires more curing time than of fresh material and after proper curing we can achieve Target Mean Strength.

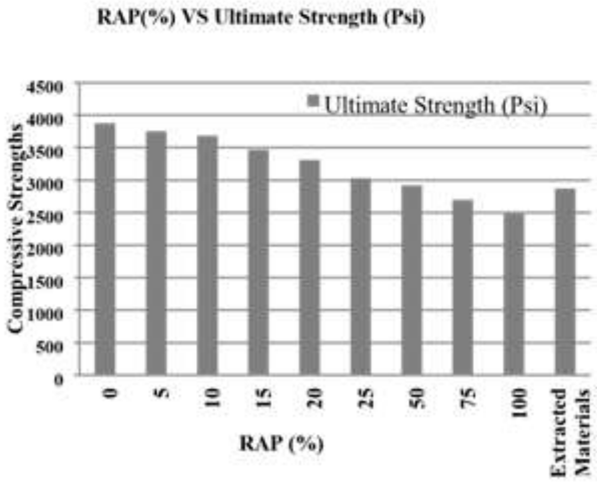


Fig. 4. Compressive Strength after 28 Days of Curing

After seven days of curing at 0 % RAP the Ultimate Strength was 3475 Psi, which was increased 190 psi after seven days of more curing then at 21 days of curing it was found 3816 psi and the effective curing of 28 days the strength was reached to 3875 psi it means 400 psi increment in the ultimate strength in 21 days of more curing. Similarly after seven days of curing at 100 % RAP the Ultimate Strength was 1684 Psi, which was increased 121 psi after seven days of more curing then at 21 days of curing it was found 1915 psi and the effective curing of 28 days the strength was reached to 2480 psi it means 796 psi increment in the ultimate strength in 21 days of more curing. On the basis of this result one can observe that concrete containing RAP requires longer curing period as compared to the conventional concrete, if the proper curing is provided then RAP can achieve more than 50% of the target mean strength. These results/comparisons are shown in Table-1 and in the graphical form at **(Fig-5)**.

Table-1 Comparison of the Compressive Strengths

RAP (%)	Compressive strength (psi)			
	After 7Days	After 14Days	After 21Days	After 28Days
0	3475.1	3665.7	3816.8	3875
5	3352.5	3456.9	3627.6	3755
10	3123.75	3265.3	3448	3683
15	2772.43	3248.8	3340.75	3466
20	2454.5	3059.6	3182.5	3310
25	2099.1	3010.6	3024.6	3029
50	1904.5	2694.6	2770.375	2918
75	1799	1986.1	2183	2700
100	1684.3	1805.5	1915.3	2480
Extracted Materials	2215.4	2375	2685	2868

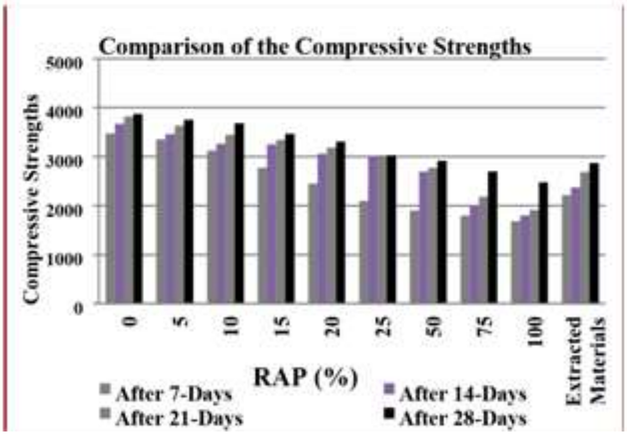


Fig.5. Comparison of the Compressive strengths

3.2 Tensile Strength

(Fig-5). Shows the Splitting Tensile Strength of concrete cylinders after 7 Days of curing. At 0% RAP The Splitting Tensile Strength is 421 Psi which is 1/9.5th of the Ultimate Strength, similarly at 5% RAP it decreases 6.3% and was 395 Psi, at 10%RAP Splitting Tensile Strength is 361 Psi which illustrates 8.6% of decrease, at 15%RAP Splitting Tensile Strength is 343 Psi, by 7.5% of decrement at 20% RAP Splitting Tensile Strength was found 371 Psi, at 25% RAP Splitting Tensile Strength is 263 Psi, at 50% RAP

Splitting Tensile Strength is 163 Psi, at 75% RAP Splitting Tensile Strength is 151 Psi, at 100% RAP Splitting Tensile Strength is 113 Psi (which is 27% of the fresh material's) and by using Extracted Aggregates Splitting Tensile Strength is 181 Psi (42% of the virgin material's). This test also demonstrates that the strength of the concrete either it compressive, tensile or flexural depends on the bond between aggregates and cementing compound. The aggregates having the pores already filled with any impervious mixture gives less strength. In order to achieve the desires target mean strength the bituminous coating should be removed by heating or rinsing.

RAP(%) VS Splitting Tensile Strength(Psi)

450

400 Splitting Tensile Strength(Psi)

350

300

250

200

150

100

50

0

RAP (%)

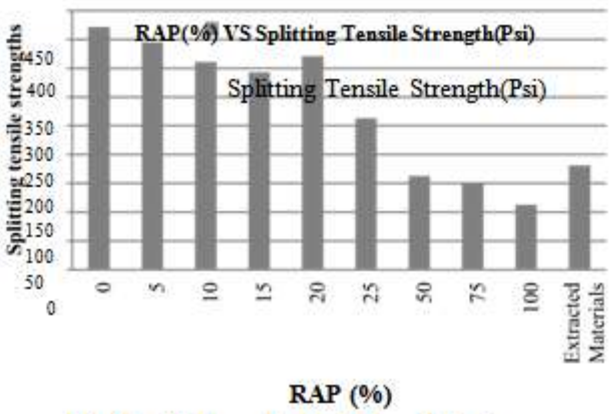


Fig.6.Tensile Strength after 7 Days of Curing

Fig-7 shows that after 14 days of curing at 0% RAP the Splitting Tensile Strength is 444 Psi, at 7 days of curing it was only 421 psi so there is increment of 23 psi which is 5.5% of the total, similarly at 5% RAP it is 411psi, after 7 days it was 395 Psi there is increment of 16 psi which is 4% of the total, at 10%RAP Splitting

Tensile Strength is 385 Psi which is 24 psi increment, at 15%RAP Splitting Tensile Strength is 368 at 7 days it was only 343 Psi, at 20% RAP Splitting Tensile Strength is 396 Psi which was 371 Psi after 7 days, at 25% RAP Splitting Tensile Strength is 294 Psi there is increment of 31 Psi, at 50% RAP Splitting Tensile Strength is 190 Psi which was after 7 days 163 Psi means increment of 27 Psi, at 75% RAP Splitting Tensile Strength is 170.6 Psi after 7 days it was 151 Psi, at 100% RAP Splitting Tensile Strength is 136

Psi(which is 30.6% of the fresh material's) previously it was 113 Psi (27% of the fresh) and by using Extracted Aggregates Splitting Tensile Strength is 220.5 Psi (42% of the virgin material's) which is increased 39.5 Psi after 7 days of further curing. The results show that the concrete made up of RAP requires more curing period than the virgin aggregates concrete. By expanding the effective concrete period we can approach towards the designed strength.

500 **RAP(%) VS Splitting Tensile Strength (Psi)**
Splitting Tensile Strength(Psi)
400
300
200
100
0
RAP (%)

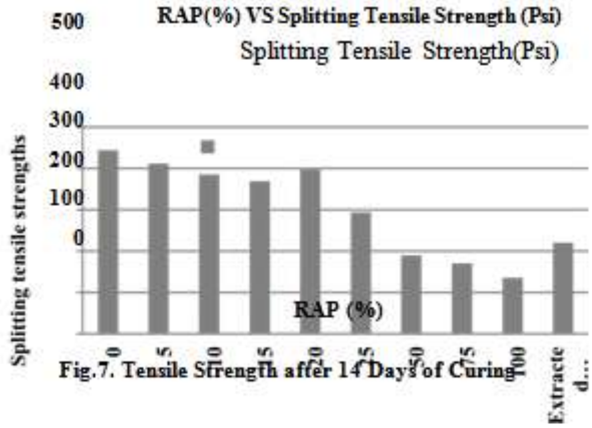


Fig.7. Tensile Strength after 14 Days of Curing

After 21 days of curing at 0% RAP the Splitting Tensile Strength is 489 Psi as shown in Fig-8, at 7 days of curing it was only 421 psi so there is increment of 68 psi which is 14% of the total, similarly at 5% RAP it is 455psi, after 7 days it was 395 Psi there is increment of 60 psi which is 12.3% of the total, at 10%RAP Splitting Tensile Strength is 411 Psi which is 50 psi increment, at

15%RAP Splitting Tensile Strength is 389 at 7 days it was only 343 Psi, at 20% RAP Splitting Tensile Strength is 429.7 Psi which was 371 Psi after 7 days, at 25% RAP Splitting Tensile Strength is 337.7 Psi there is increment of 74.7 Psi, at 50% RAP Splitting Tensile Strength is 190 Psi which was after 7 days 163 Psi means increment of 27 Psi, at 75% RAP Splitting Tensile Strength is 188 Psi after 7 days it was 151 Psi, at 100% RAP Splitting
Tensile Strength is 149

Psi(which is 30.6% of the fresh material's) previously it was 113 Psi (27% of the fresh) and by using Extracted Aggregates Splitting Tensile Strength is 276 Psi (56% of the virgin material's) which is increased 94.7 Psi after 14 days of further curing.

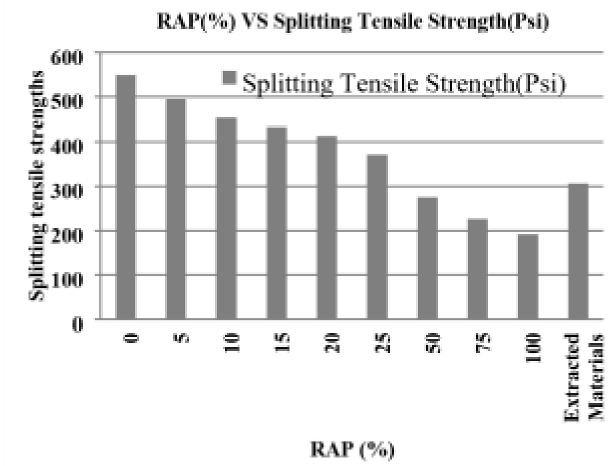


Fig.8. Tensile Strength after 21 Days of Curing

At 28 days of the effective curing period at 0% RAP the Splitting Tensile Strength was 548.8 Psi, at 7 days of curing it was only 421 psi so there is increment of 127.8 psi which is 23.3% of the total, similarly at 5% RAP it is 495.25psi, after 7 days it was 395 Psi there is increment of 100.25 psi which is 18.3% of the total, at 10%RAP Splitting Tensile Strength is 453.3 Psi which is 92 psi increment, at 15%RAP Splitting Tensile Strength is 432.7 at 7 days it was only 343 Psi, at 20% RAP Splitting Tensile Strength is 413 Psi which was 371 Psi after 7 days, at 25% RAP Splitting Tensile Strength is 371 Psi there is increment of 76 Psi, at 50% RAP Splitting Tensile Strength is 275.6 Psi which was after 7 days 163 Psi means increment of 112.6Psi, at 75% RAP Splitting Tensile Strength is 226 Psi after 7 days it was 151 Psi, at 100% RAP Splitting Tensile Strength is 192 Psi(which is 35% of the fresh material's) previously it was 113 Psi (27% of the fresh) and by using Extracted Aggregates Splitting Tensile Strength is 306 Psi(56% of the virgin material's) which is increased 124.7 Psi after 21days of further curing.
These results are also shown below in the graphical form in**(Fig-9)**.

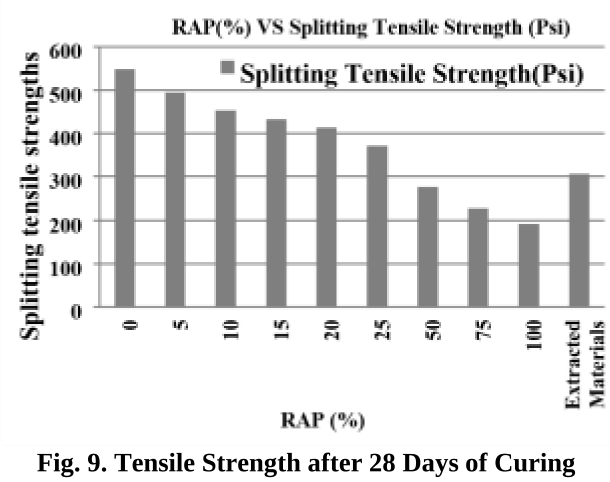


Fig. 9. Tensile Strength after 28 Days of Curing

The comparison of the tensile strengths is shown in (**Table-2)** and in graphical form in **(Fig-10).** After seven days of curing at 0 % RAP the Splitting Tensile Strength was 421 Psi, which was increased 23 psi after seven days of more curing then at 21 days of curing it was found 489 psi and the effective curing of 28 days the strength was reached to 548 psi it means 127 psi increment in the Splitting Tensile Strength in 21 days of more curing. Similarly after seven days of curing at 100 % RAP the Splitting Tensile Strength was 113Psi, which was increased 136 psi after seven days of more curing then at 21 days of curing it was found 276 psi and the effective curing of 28 days the strength was reached to 192 psi it means 79 psi increment in the SPT in 21 days of more curing. On the basis of this result one can observe that concrete containing RAP requires longer curing period as compared to the conventional concrete, if the proper curing is provided then RAP can achieve more than 50% of the target mean strength.

Table 2. Comparison of the Splitting Tensile Strengths

RAP (%)	Splitting Tensile Strength(Psi)			
	After 7Days	After 14Days	After 21Days	After 28Days
0	421.66	444.2	489	548.8
5	395	411.72	455.7	495.25
10	361	385.5	411	453.3
15	343	368.72	389	432.7
20	371	396.85	429.7	413
25	263	294	337.7	371
50	163	190.3	231.6	275.6
75	151.85	170.6	188	226
100	113	136	149	192
Extracted Materials	181.3	110.3	276	306

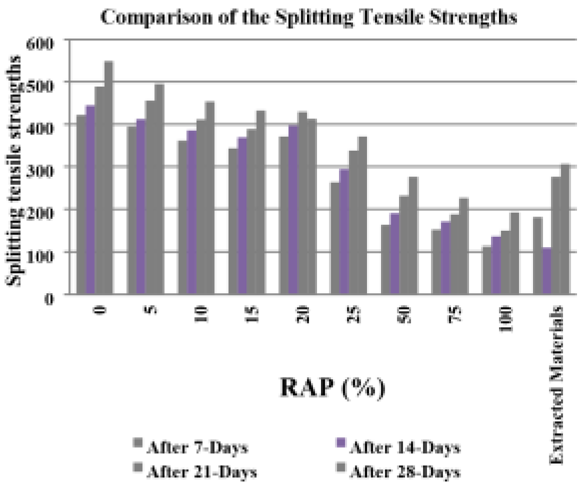


Fig.10. Comparison of the splitting tensile strengths

IV. Conclusions

On the basis of the experimental study it was found that strength of concrete depends on the bond between cement and aggregates. RAP concrete have the compressive and tensile strengths less than that of virgin concrete. The strength of the recycled material's concrete can be increased by lowering the water cement ratio and by increasing the curing period. The results of this experimental study indicate that use of RAP as the replacement of the fresh aggregates in the Pavement Concrete appears to be not only feasible in terms of cost and strengths but also offers the possibility of improving the performance of the concrete pavement because of higher toughness and the RAP can be used directly in the construction of middle and low strength concrete pavements.

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