METHODOLOGY FOR PRACTICAL WORKS

1. Samples collected: Natural and Recycled aggregate materials

- *i.* Sources for sample collection: *IL* &*FS C*&*D waste recycling plant, Burari site.*
- ii. Types of samples:
 - a) Natural coarse and fine aggregates
 - b) Recycled Coarse and fine aggregates

2. Experimental programs:

- i. Characterization of the materials
 - a) Natural aggregate materials
 - 1. Coarse aggregate
 - 2. Fine aggregate
 - b) Recycled aggregate materials
 - 1. Coarse aggregate
 - 2. Fine aggregate
- ii. Admixture
- **3.** Grade of concrete: Three concrete grades have been selected for conducting current investigations: M30

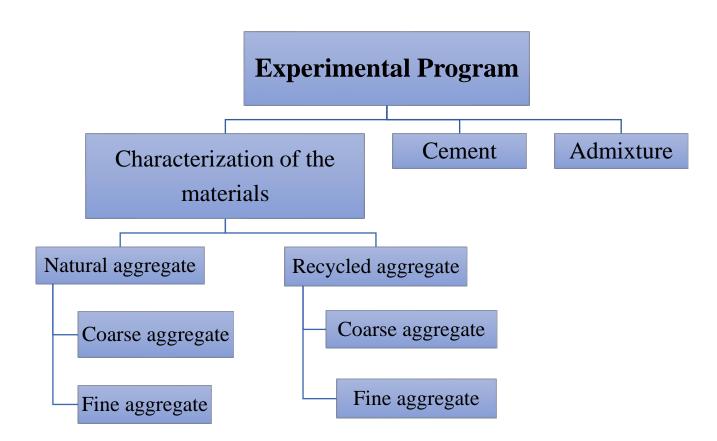


Figure 1: Experimental program for laboratory investigations

Various substitution rates have been used for each type of mix design that includes M30 for this specific research work. Fundamental properties of concrete materials which incorporates recycled aggregates from C&D waste were observed thouroughly and analysis have been done. The following replacement types were done for evaluation purpose and compared with the allowable limits for practical applications (utilization) of recycled aggregate materials.

- 1) Coarse aggregate replaements (Ranges from 0% to 100%)
- 2) Fine aggregate repalcements (Ranges from 0% to 100%)
- 3) Both coarse and fine aggregate replacements (Ranges from 0% to 100%)

Ten types of mix design were produced to each categories of replacements listed above, that ranges from 10% to 100% and it was applied for each grades of concrete. The total of 91 different mix designs were done to determine basic properties of concrete materials such as slump test, compressive strength test, compaction factor test, permeability test, tensile strength test, and flexural strength test.

4. Mix Design for M30 grade of concrete:

The following tables were use to record laboratory reports during the investigations that have been done to evaluate the performance of concrete materials that uses recycled aggregate materials from C&D debris as a replacement for natural aggregate materials.

	Coarse			Compress	ive strength	
Mix n <u>o</u>	aggregate	Fine agg	regate	in	MPa	ks
	Natural	Replacement	Natural			Remarks
	aggregate	with recycled	aggregate	7 days	28 days	Re
		aggregate				
M30 _(P)	100%	0%	100%			
M30(1)	>>	10%	90%			
M30(2)	>>	20%	80%			
M30(3)	>>	30%	70%			
M30 ₍₄₎	>>	40%	60%			
M30(5)	>>	50%	50%			
M30(6)	>>	60%	40%			
M30(7)	>>	70%	30%			
M30(8)	>>	80%	20%			
M30 ₍₉₎	>>	90%	10%			
M30(10)	>>	100%	0%			

Table 1: Compressive strength of Mix design for M30 Concrete (Fine aggregate replacements)

				Compress	ive strength	
Mix n <u>o</u>	Coarse	aggregate	Fine aggregate	in I	MPa	k
	Natural	Replacement	Natural			Remark
	aggregate	with recycled	aggregate	7 days	28 days	Re
		aggregate				
M30 _(P)	100%	0%	100%			
M30(1)	90%	10%	>>			
M30 ₍₂₎	80%	20%	>>			
M30 ₍₃₎	70%	30%	>>			
M30(4)	60%	40%	>>			
M30(5)	50%	50%	>>			
M30(6)	40%	60%	>>			
M30 ₍₇₎	30%	70%	>>			
M30 ₍₈₎	20%	80%	>>			
M30 ₍₉₎	10%	90%	>>			
M30(10)	0%	100%	>>			

Table 2: Compressive strength of Mix design for M30 Concrete (Coarse aggregate replacements)

Table 3: Compressive strength of Mix design for M30 Concrete (Coarse and fine aggregate
replacements)

					Comp	ressive	
Mix n <u>o</u>	Coarse aggregate		Fine	Fine aggregate		strength in MPa	
	Natural	Replacement	Natural	Replacement	7 days	28 days	Remarks
	aggregate	with recycled	aggregate	with recycled			Reı
		aggregate		aggregate			
M30 _(P)	100%	0%	100%	0%			
M30(1)	90%	10%	90%	10%			
M30(2)	80%	20%	80%	20%			
M30(3)	70%	30%	70%	30%			
M30(4)	60%	40%	60%	40%			
M30(5)	50%	50%	50%	50%			
M30 ₍₆₎	40%	60%	40%	60%			
M30(7)	30%	70%	30%	70%			
M30 ₍₈₎	20%	80%	20%	80%			
M30 ₍₉₎	10%	90%	10%	90%			
M30(10)	0%	100%	0%	100%			

	Coarse				
Mix n <u>o</u>	aggregate	Fine aggre	egate		arks
	Natural	Replacement with	Natural	Workability	Remarks
	aggregate	recycled aggregate	aggregate	(Slump test)	R
M30(P)	100%	0%	100%		
M30(1)	>>	10%	90%		
M30(2)	>>	20%	80%		
M30(3)	>>	30%	70%		
M30 ₍₄₎	>>	40%	60%		
M30(5)	>>	50%	50%		
M30(6)	>>	60%	40%		
M30(7)	>>	70%	30%		
M30 ₍₈₎	>>	80%	20%		
M30(9)	>>	90%	10%		
M30(10)	>>	100%	0%		

Table 4: Workability (Slump test) of Mix design for M30 Concrete (Fine aggregate replacements)

Mix n <u>o</u>	Coarse	aggregate	Fine aggregate		ks
	Natural	Replacement	Natural	Workability	Remarks
	aggregate	with recycled	aggregate	(Slump test)	Reı
		aggregate			
M30 _(P)	100%	0%	100%		
M30(1)	90%	10%	>>		
M30(2)	80%	20%	>>		
M30(3)	70%	30%	>>		
M30(4)	60%	40%	>>		
M30(5)	50%	50%	>>		
M30 ₍₆₎	40%	60%	>>		
M30(7)	30%	70%	>>		
M30 ₍₈₎	20%	80%	>>		
M30 ₍₉₎	10%	90%	>>		
M30(10)	0%	100%	>>		

Table 5: Workability (Slump test) of Mix design for M30 Concrete (Coarse aggregate replacements)

Mix n <u>o</u>	Coarse aggregate		Fine aggregate		Workability	Remarks
	Natural	Replacement	Natural	Replacement	(Slump test)	ma
	aggregate	with recycled	aggregate	with recycled		Re
		aggregate		aggregate		
M30 _(P)	100%	0%	100%	0%		
M30(1)	90%	10%	90%	10%		
M30(2)	80%	20%	80%	20%		
M30(3)	70%	30%	70%	30%		
M30(4)	60%	40%	60%	40%		
M30(5)	50%	50%	50%	50%		
M30 ₍₆₎	40%	60%	40%	60%		
M30(7)	30%	70%	30%	70%		
M30 ₍₈₎	20%	80%	20%	80%		
M30 ₍₉₎	10%	90%	10%	90%		
M30(10)	0%	100%	0%	100%		

Table 6: Workability (Slump test) of Mix design for M30 Concrete (Coarse and fine aggregate replacements)

Mix n <u>o</u>	Coarse aggregate	Fine aggre		SX	
	Natural aggregate	Replacement with recycled aggregate	Natural aggregate	Compaction factor test	Remarks
M30 _(P)	100%	0%	100%		
M30(1)	>>	10%	90%		
M30 ₍₂₎	>>	20%	80%		
M30 ₍₃₎	>>	30%	70%		
M30 ₍₄₎	>>	40%	60%		
M30(5)	>>	50%	50%		
M30 ₍₆₎	>>	60%	40%		
M30(7)	>>	70%	30%		
M30 ₍₈₎	>>	80%	20%		
M30(9)	>>	90%	10%		
M30(10)	>>	100%	0%		

Table 7: Compaction factor test of Mix design for M30 Concrete (Fine aggregate replacements)

Mix n <u>o</u>	Coars	e aggregate	Fine aggregate		Remark
	Natural	Replacement with	Natural	Compaction	Rem
	aggregate	recycled aggregate	aggregate	factor test	
M30 _(P)	100%	0%	100%		
M30(1)	90%	10%	>>		
M30 ₍₂₎	80%	20%	>>		
M30 ₍₃₎	70%	30%	>>		
M30(4)	60%	40%	>>		
M30(5)	50%	50%	>>		
M30(6)	40%	60%	>>		
M30 ₍₇₎	30%	70%	>>		
M30 ₍₈₎	20%	80%	>>		
M30 ₍₉₎	10%	90%	>>		
M30(10)	0%	100%	>>		

 Table 8: Compaction factor test of Mix design for M30 Concrete (Coarse aggregate

 replacements)

Note: (P), Parent mix-100% natural aggregate materials

 Table 9: Compaction factor test of Mix design for M30 Concrete (Coarse and fine aggregate replacements)

Mix n <u>o</u>	Coarse	aggregate	Fine	aggregate		·k
	Natural	Replacement	Natural	Replacement	Compaction	Remark
	aggregate	with recycled	aggregate	with recycled	factor test	Re
		aggregate		aggregate		
M30 _(P)	100%	0%	100%	0%		
M30(1)	90%	10%	90%	10%		
M30 ₍₂₎	80%	20%	80%	20%		
M30 ₍₃₎	70%	30%	70%	30%		
M30(4)	60%	40%	60%	40%		
M30(5)	50%	50%	50%	50%		
M30 ₍₆₎	40%	60%	40%	60%		
M30(7)	30%	70%	30%	70%		
M30 ₍₈₎	20%	80%	20%	80%		
M30 ₍₉₎	10%	90%	10%	90%		
M30(10)	0%	100%	0%	100%		

Mix n <u>o</u>	Coarse aggregate	Fine aggre	egate	Permeability	rks
	Natural	Replacement with	Natural	test	Remarks
	aggregate	recycled aggregate	aggregate		R
M30 _(P)	100%	0%	100%		
M30(1)	>>	10%	90%		
M30(2)	>>	20%	80%		
M30 ₍₃₎	>>	30%	70%		
M30 ₍₄₎	>>	40%	60%		
M30(5)	>>	50%	50%		
M30 ₍₆₎	>>	60%	40%		
M30 ₍₇₎	>>	70%	30%		
M30 ₍₈₎	>>	80%	20%		
M30 ₍₉₎	>>	90%	10%		
M30(10)	>>	100%	0%		

Table 10: Permeability test of Mix design for M30 Concrete (Fine aggregate replacements)

				Permeability	
Mix n <u>o</u>	Coars	se aggregate	Fine aggregate	test	ark
	Natural	Replacement with	Natural		Remark
	aggregate	recycled aggregate	aggregate		Γ
M30 _(P)	100%	0%	100%		
M30(1)	90%	10%	>>		
M30 ₍₂₎	80%	20%	>>		
M30 ₍₃₎	70%	30%	>>		
M30 ₍₄₎	60%	40%	>>		
M30(5)	50%	50%	>>		
M30 ₍₆₎	40%	60%	>>		
M30(7)	30%	70%	>>		
M30 ₍₈₎	20%	80%	>>		
M30(9)	10%	90%	>>		
M30(10)	0%	100%	>>		

Table 11: Permeability test of Mix design for M30 Concrete (Coarse aggregate replacements)

Note: (P), Parent mix-100% natural aggregate materials

Mix n <u>o</u>	Coarse aggregate		Fine aggregate		Permeability	k
	Natural	Replacement	Natural	Replacement	test	Remark
	aggregate	with recycled aggregate	aggregate	with recycled aggregate		Reı
M30 _(P)	100%	0%	100%	0%		
M30(1)	90%	10%	90%	10%		
M30 ₍₂₎	80%	20%	80%	20%		
M30(3)	70%	30%	70%	30%		
M30 ₍₄₎	60%	40%	60%	40%		
M30(5)	50%	50%	50%	50%		
M30 ₍₆₎	40%	60%	40%	60%		
M30(7)	30%	70%	30%	70%		
M30 ₍₈₎	20%	80%	20%	80%		
M30 ₍₉₎	10%	90%	10%	90%		
M30(10)	0%	100%	0%	100%		

Table 12: Permeability test of Mix design for M30 Concrete (Coarse and fine aggregate replacements)