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

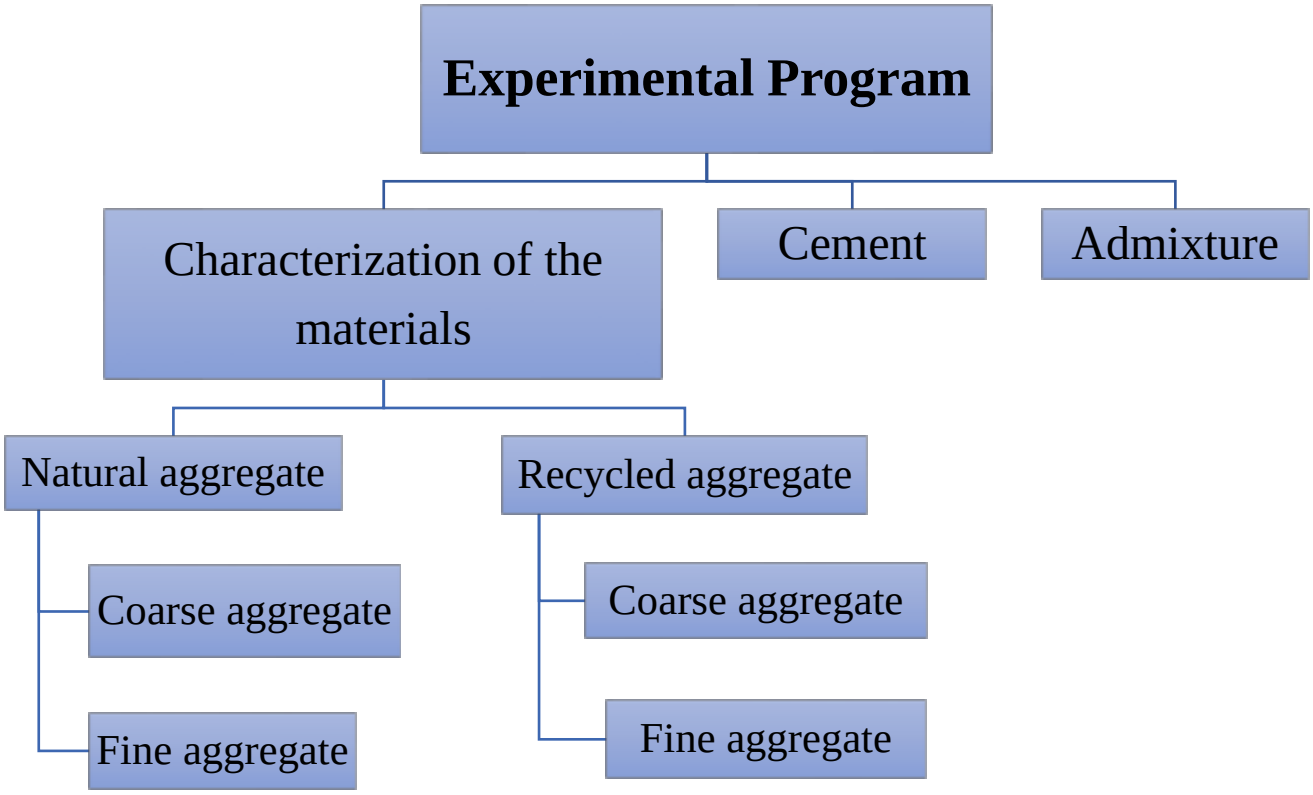

Figure 1: Experimental program for laboratory investigations

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.

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

Mix no	**Coarse aggregate**	**Fine aggregate**		**Compressive strength in MPa**		**Remarks**
	Natural aggregate	Replacement with recycled aggregate	Natural aggregate	7 days	28 days	
$M30_{(P)}$	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%			

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

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

Mix no	**Coarse aggregate**		**Fine aggregate**	**Compressive strength in MPa**		**Remark**
	Natural aggregate	Replacement with recycled aggregate	Natural aggregate	7 days	28 days	
$M30_{(P)}$	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%	>>			

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

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

Mix no	**Coarse aggregate**		**Fine aggregate**		**Compressive strength in MPa**		**Remarks**
	Natural aggregate	Replacement with recycled aggregate	Natural aggregate	Replacement with recycled aggregate	7 days	28 days	
$M30_{(P)}$	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 4: Workability (Slump test) of Mix design for M30 Concrete (Fine aggregate replacements)

Mix no	**Coarse aggregate**	**Fine aggregate**		**Workability (Slump test)**	**Remarks**
	Natural aggregate	Replacement with recycled aggregate	Natural 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%		

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

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

Mix no	**Coarse aggregate**		**Fine aggregate**	**Workability (Slump test)**	**Remarks**
	Natural aggregate	Replacement with recycled aggregate	Natural 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%	>>		

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

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

Mix no	**Coarse aggregate**		**Fine aggregate**		**Workability (Slump test)**	**Remarks**
	Natural aggregate	Replacement with recycled aggregate	Natural aggregate	Replacement with recycled 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%		

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

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

Mix no	**Coarse aggregate**	**Fine aggregate**		**Compaction factor test**	**Remarks**
	Natural aggregate	Replacement with recycled aggregate	Natural 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%		

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

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

Mix no	**Coarse aggregate**		**Fine aggregate**	**Compaction factor test**	**Remark**
	Natural aggregate	Replacement with recycled aggregate	Natural 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%	>>		

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 no	**Coarse aggregate**		**Fine aggregate**		**Compaction factor test**	**Remark**
	Natural aggregate	Replacement with recycled aggregate	Natural aggregate	Replacement with recycled 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 10: Permeability test of Mix design for M30 Concrete (Fine aggregate replacements)

Mix no	**Coarse aggregate**	**Fine aggregate**		**Permeability test**		**Remarks**
	Natural aggregate	Replacement with recycled aggregate	Natural 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%			

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

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

Mix no	**Coarse aggregate**		**Fine aggregate**	**Permeability test**		**Remark**
	Natural aggregate	Replacement with recycled aggregate	Natural 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%	>>			

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

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

Mix no	**Coarse aggregate**		**Fine aggregate**		**Permeability test**		**Remark**
	Natural aggregate	Replacement with recycled aggregate	Natural aggregate	Replacement with recycled 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%			