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Development of an Automated System for Material Management at the RMC plant using Computer Vision

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Abstract*— Ready Mix Concrete (RMC) plants are critical components of modern construction, yet their operational efficiency is often compromised by reliance on traditional, manual material management practices. These outdated methods introduce significant challenges, including inventory inaccuracies, the risk of stockouts or overstocking, procurement delays, and increased operating costs. To address these systemic inefficiencies, this research explores the implementation of Computer Vision (CV) an advanced application of Artificial Intelligence for automated and intelligent material monitoring within RMC facilities. The proposed CV system is designed to provide real-time, accurate data on key operational aspects, such as raw material levels in storage bins, vehicle movement tracking, and the precise flow of materials throughout the plant. By automating these monitoring functions, the system eliminates the need for constant human checks, thereby minimizing errors and enhancing process control. The adoption of computer vision offers a scalable, robust, and reliable solution to ensure immediate inventory precision and a consistent material supply, ultimately leading to significant improvements in the overall accuracy, efficiency, and cost-effectiveness of RMC production.

Key words: Ready Mix Concrete (RMC), Computer Vision (CV)

1 INTRODUCTION

Ready Mix Concrete (RMC) plants are essential for modern construction, providing large quantities of consistent, high-quality concrete. The efficient operation of these plants largely depends on how well they manage materials like cement, sand, aggregates, water, and chemical admixtures. Many RMC plants still use mostly manual methods for material management, relying on people to watch and keep records. This often causes problems like not knowing exactly how much material is on hand, running out of materials or having too much, delays in getting materials, and higher costs. To deal with these problems, it's important to use automation and smart monitoring systems. Using computer vision is a modern way to improve how accurate, efficient, and reliable material management is.

Computer vision, which is part of artificial intelligence, allows machines to understand and analyze visual data from images or videos. In RMC plants, computer vision can monitor how much material is in storage bins, spot when vehicles move, track how materials flow, and guarantee a steady supply without needing people to constantly check. RMC plants are a key part of today's construction world, providing concrete that is carefully controlled in composition and consistent in quality. How well these plants work relies heavily on managing raw materials correctly, including cement, fine and coarse aggregates, water, and chemical additions. Traditionally, most RMC plants depend on manual checks and record-keeping for managing materials and keeping track of inventory. These traditional ways can easily lead to mistakes made by people, which can cause problems like not estimating materials correctly, unexpected shortages, building up too much stock, and delays in production. The construction business increasingly needs automation and digital changes. An automated system can guarantee accuracy, openness, and real-time monitoring of materials. Using computer vision tech seems promising. Computer vision is part of artificial intelligence that allows computers to analyze visual information from cameras and sensors.

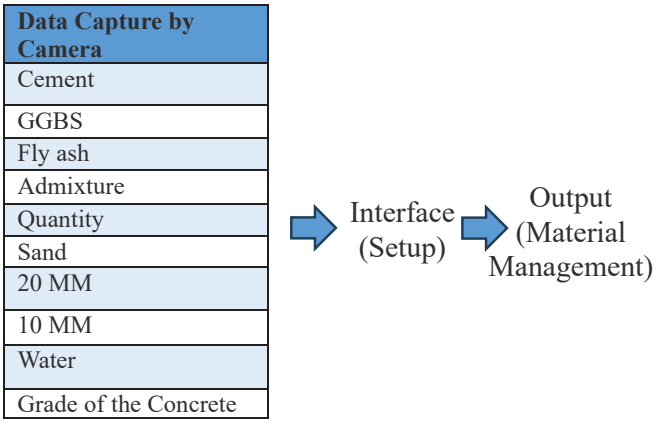

Fig.1.1 Process followed by using Computer Vision

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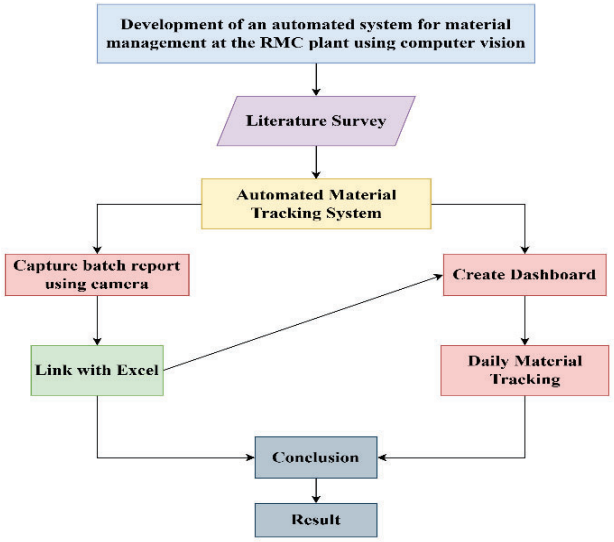
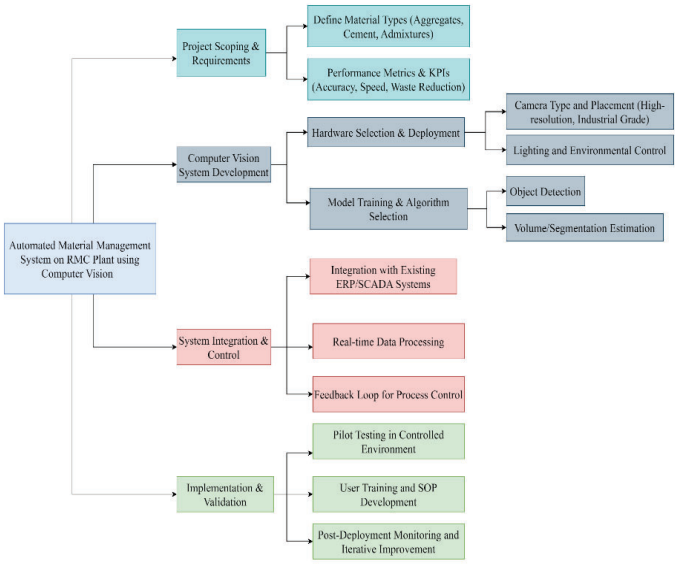
2 OBJECTIVE OF STUDY

a. To understand the current process of material handling and its challenges in RMC plants.
b. To identify information needed to manage materials more accurately and in real time.
c. To design an automated system using computer vision to track and manage materials like cement, aggregates, water, and admixtures.
d. To validate the system for improvement in efficiency, reduces waste, at RMC plant operations.

3 METHODOLGY



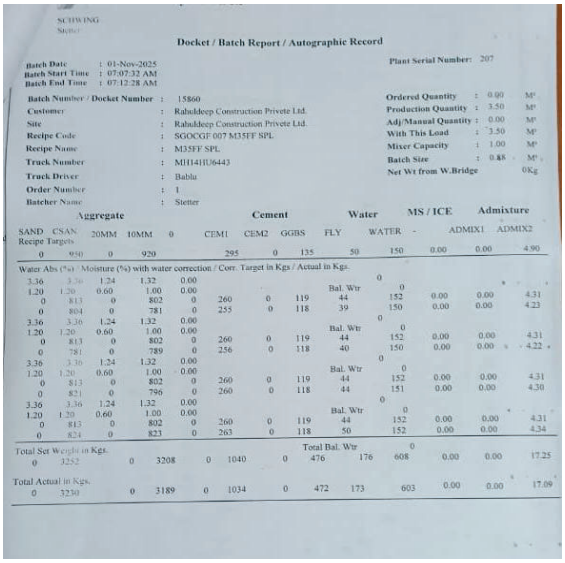
3.1 Detailed of Methodology:



4 PROCESS FOLLOWED IN RMC PLANT

In RMC Plant the Cement, GGBS, Fly ash, Sand, Aggregate (20MM, 10MM), Water, Admixture and Grade of Concrete this value mention in batch report. And RMC plant followed up the daily material used.

manually work using this value create an excel sheet for daily update of how much material used. They tracking material manually like Storage and Order for material. In manually daily consumption can take to much time and sometimes mistakes will happen due to quantity of production in high.



Docket / Batch Report / Autographic Record

Plant Serial Number: 207

Batch Date : 01-Nov-2025
Batch Start Time : 07:07:32 AM
Batch End Time : 07:12:28 AM

Batch Number / Docket Number : 15860
Customer : Rahuldeep Construction Private Ltd.
Site : Rahuldeep Construction Private Ltd.
Recipe Code : SGOCGF 007 M35FF SPL
Recipe Name : M35FF SPL
Truck Number : MH14JU6443
Truck Driver : Bablu
Order Number : 1
Batcher Name : Stetter

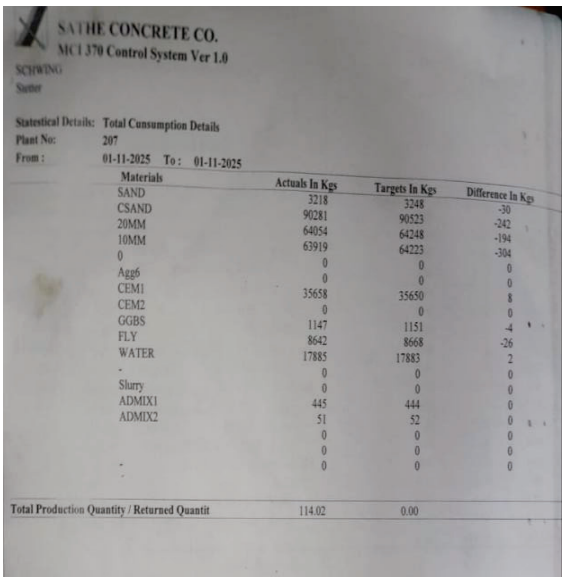
Ordered Quantity : 0.00 M³
Production Quantity : 3.50 M³
Adj/Manual Quantity : 0.00 M³
With This Load : 3.50 M³
Mixer Capacity : 1.00 M³
Batch Size : 0.85 M³
Net Wt from W.Bridge : 0Kg

	Aggregate				Cement			Water	MS / ICE	Admixture	
	SAND	CSAN	20MM	10MM	0	CEM1	CEM2	GGBS	FLY	WATER	-	ADMIX1	ADMIX2
Recipe Targets	0	930	0	920		295	0	135	50	150	0.00	0.00	4.90

Water Abs (%) / Moisture (%) with water correction / Corr. Target in Kgs / Actual in Kgs.

3.36	3.36	1.24	1.32	0.00							0		
1.20	1.20	0.60	1.00	0.00					Bal. Wtr		0		
0	813	0	802	0	260	0	119	44		152	0.00	0.00	4.31
0	804	0	781	0	255	0	118	39		150	0.00	0.00	4.23
3.36	3.36	1.24	1.32	0.00							0		
1.20	1.20	0.60	1.00	0.00					Bal. Wtr		0		
0	813	0	802	0	260	0	119	44		152	0.00	0.00	4.31
0	781	0	789	0	256	0	118	40		150	0.00	0.00	4.22
3.36	3.36	1.24	1.32	0.00							0		
1.20	1.20	0.60	1.00	0.00					Bal. Wtr		0		
0	813	0	802	0	260	0	119	44		152	0.00	0.00	4.31
0	821	0	796	0	260	0	118	44		151	0.00	0.00	4.30
3.36	3.36	1.24	1.32	0.00							0		
1.20	1.20	0.60	1.00	0.00					Bal. Wtr		0		
0	813	0	802	0	260	0	119	44		152	0.00	0.00	4.31
0	824	0	823	0	263	0	118	50		152	0.00	0.00	4.34
Total Set Weight in Kgs.									Total Bal. Wtr		0		
0	3252	0	3208	0	1040	0	476	176	608		0.00	0.00	17.25
Total Actual in Kgs.													
0	3230	0	3189	0	1034	0	472	173	603		0.00	0.00	17.09

Image.4.1 Batch Report



SATHE CONCRETE CO.
MC1 370 Control System Ver 1.0
SCHWING
Stetter

Statistical Details: Total Consumption Details
Plant No: 207
From : 01-11-2025 To : 01-11-2025

Materials	Actuals In Kgs	Targets In Kgs	Difference In Kgs
SAND	3218	3248	-30
CSAND	90281	90523	-242
20MM	64054	64248	-194
10MM	63919	64223	-304
0	0	0	0
Agg6	0	0	0
CEM1	35658	35650	8
CEM2	0	0	0
GGBS	1147	1151	-4
FLY	8642	8668	-26
WATER	17885	17883	2
-	0	0	0
Slurry	0	0	0
ADMIX1	445	444	0
ADMIX2	51	52	0
	0	0	0
	0	0	0
-	0	0	0
Total Production Quantity / Returned Quantit	114.02	0.00	

Image 4.2 Quantity of Material in Batch report

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DATE		01.11.2026	CONSUMPTION CROSS CHECK SHEET														
DOCKET NO	GRADE	CEMENT	GGBS	PFA	QTY.	CEMENT TOTAL IN KG AS PER TARGET	CEMENT TOTAL IN ACTUAL	TOTAL GGBS IN KG	GGBS TOTAL IN ACTUAL	PFA TOTAL IN KGS	PFA TOTAL IN ACTUAL	TARGET ADMIXTURE QTY MID PCE	ADMIXTURE TOTAL IN KG MID PCE	ADMIXTURE TOTAL IN ACTUAL IN KG MID PCE	TARGET ADMIXTURE QTY HIGH PCE	ADMIXTURE TOTAL IN KG HIGH PCE	ADMIXTURE TOTAL IN ACTUAL IN KG HIGH PCE
15860	M35FF	295	135	50	3.5	1040	1034	476	472	176	175	0	0	0	4.9	17.25	17.9
15861	M25	265	0	70	9	2385	2387	0	0	630	630	3.7	33.3	33.3	0	0	0
15862	M25	265	0	70	9	2385	2382	0	0	630	630	3.7	33.3	33.3	0	0	0
15863	M25	265	0	70	4.7	1245	1245	0	0	329	330	3.7	17.39	17.39	0	0	0
15864	M40	365	0	80	7.7	2800	2808	0	0	614	616	4.9	37.63	37.68	0	0	0
15865	M40	365	0	80	9.5	3470	3466	0	0	760	760	4.9	46.55	46.55	0	0	0
15866	M40	365	0	80	7.7	2800	2810	0	0	614	616	4.9	37.63	37.73	0	0	0
15867	M7.5	120	0	95	7.7	920	951	0	0	730	728	2.2	16.9	16.94	0	0	0
15868	M40	365	0	80	9.5	3470	3466	0	0	760	760	4.9	46.55	46.51	0	0	0
15869	M35FF	295	135	50	4	1180	1177	540	540	200	200	0	0	0	4.9	19.6	19.55
15870	M40	365	0	80	7.7	2800	2812	0	0	614	616	4.9	37.63	37.69	0	0	0
15871	M40	365	0	80	9.5	3470	3470	0	0	760	753	4.9	46.55	46.51	0	0	0
15872	M25	265	0	70	9	2385	2382	0	0	630	630	3.7	33.3	33.3	0	0	0
15873	M35FF	295	0	50	1	295	291	135	135	50	43	0	0	0	4.9	4.9	4.85
15874	M35SCC	370	0	100	2	740	757	0	0	200	196	0	0	0	5	10	9.95
15875	M40	365	0	80	9.5	3470	3470	0	0	760	757	4.9	46.55	46.51	0	0	0
15876	M25	265	0	70	3	795	790	0	0	210	204	3.7	11.1	11.1	0	0	0
			114	35650	35658	1151	1147	8667	8642	55.0	444.38	444.51	19.7	51.75	52		
TOTAL CONSUMPTION DATA FROM PLANT																	
			CEMENT TOTAL IN ACTUAL			GGBS TOTAL IN ACTUAL		PFA TOTAL IN ACTUAL		ADMIXTURE TOTAL IN ACTUAL							
					35658		1147		8642		497						
			DIFFERENCE IN KG		-8		4		25		-0.63						
			TOLERANCE PERCENTAGE				0.00										
REMARK																	

Image 4.3 Consumption report of Cement, GGBS, Fly ash and Admixture

DATE 01.11.2025.			CONSUMPTION CROSS CHECK SHEET										
DOCKET NO	GRADE	SAND	20MM	10MM	WATER	QTY.	SAND TOTAL IN KG AS PER TARGET	SAND TOTAL IN ACTUAL	TOTAL 20MM IN KG	20MM TOTAL IN ACTUAL	10MM TOTAL IN KGS	10MM TOTAL IN ACTUAL	WATER TOTAL IN KGS	WATER TOTAL IN ACTUAL
15860	M35FF	813	0	802	152	3.5	3252	3230	0	0	3208	3189	608	603
15861	M25	815	642	556	153	9	7335	7303	5778	5764	5004	4995	1417	1416
15862	M25	815	642	554	155	9	7335	7319	5778	5760	4986	4975	1395	1403
15863	M25	766	604	521	145	4.7	3830	3805	3020	3005	2605	2589	710	714
15864	M40	756	589	494	149	7.7	6048	6018	4712	4696	3952	3937	1172	1171
15865	M40	746	582	487	147	9.5	7460	7456	5820	5801	4870	4857	1440	1439
15866	M40	756	589	494	149	7.7	6048	6048	4712	4698	3952	3941	1174	1173
15867	M7.5	973	569	484	176	7.7	7784	7744	4552	4546	3872	3857	1426	1417
15868	M40	746	582	487	147	9.5	7460	7438	5820	5806	4870	4850	1470	1469
15869	M35FF	933	0	926	161	4	3732	3703	0	0	3704	3673	644	647
15870	M40	756	589	494	149	7.7	6048	6027	4712	4697	3952	3935	1172	1171
15871	M40	746	582	487	142	9.5	7460	7439	5820	5809	4870	4850	1440	1439
15872	M25	815	642	554	155	9	7335	7301	5778	5761	4986	4965	1395	1403
15873	M35FF	933	0	926	161	1	933	904	0	0	926	896	161	161
15874	M35SCC	903	0	967	162	2	1806	1887	0	0	1934	1921	324	323
15875	M40	746	582	487	147	9.5	7460	7440	5820	5803	4870	4850	1470	1469
15876	M25	815	642	554	155	3	2445	2437	1926	1908	1662	1639	465	467
TOTAL CONSUMPTION DATA FROM PLANT						114.0	93771	93499	64248	64054	64223	63919	17883	17885
							20MM TOTAL IN ACTUAL		10MM TOTAL IN ACTUAL				WATER TOTAL IN ACTUAL	
							93499		64054		63919		17885	
		DIFFERENCE IN KG					272		194		304		-2.00	
		TOLERANCE PERCENTAGE												
		TOLERANCE PERCENTAGE				0.00		0.00		0.00			0.00	
REMARK														
RE INCHARGE			QC MANAGER											

Image 4.4 Consumption report of Sand, 20MM, 10MM and Water

5 PROPOSED SETUP FOR COMPUTER VISION

Ready Mix Concrete (RMC) plants are important in current construction because they supply a lot of consistent, good concrete. How well these plants run depends a lot on how well materials like cement, sand, aggregates, water, and chemical admixtures are managed. Many RMC plants still use hand monitoring and record keeping. This can cause wrong inventory data, not enough or too much material, late procurement, and higher costs. To fix these problems, it is key to add automation and smart monitoring. Computer vision is a current and helpful way to make material management in RMC plants more correct, efficient, and reliable.

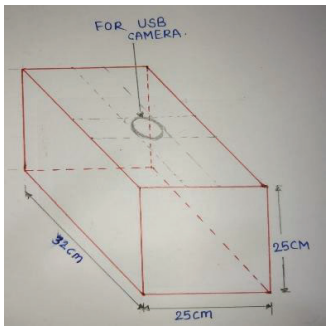

Image 5.1 Design of the Box with dimension

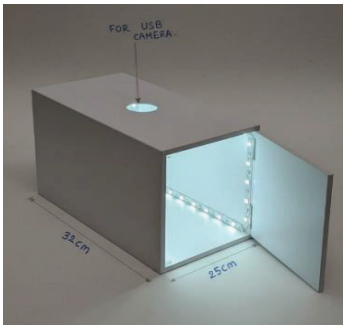

Image 5.2 Expected Model of the Box

6 EXPERIMENTAL WORK

Computer vision, which is part of artificial intelligence, allows machines to understand and analyze visual data from images or videos. How well these plants work relies heavily on managing raw materials correctly, including cement, fine and coarse aggregates, water, and chemical additions. Traditionally, most RMC plants depend on manual checks and record-keeping for managing materials and keeping track of inventory. These traditional ways can easily lead to mistakes made by people, which can cause problems like not estimating materials correctly, unexpected shortages, building up too much stock, and delays in production. The construction business increasingly needs automation and digital changes.

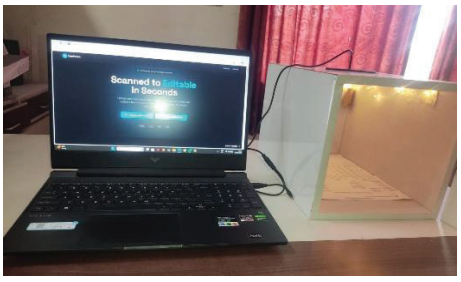

Image 6.1 Actual model for Computer vision

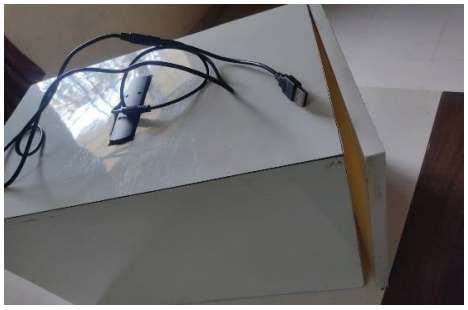

Image 6.2 Actual Model of the Box

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An automated system can guarantee accuracy, openness, and real-time monitoring of materials. Using computer vision tech seems promising. Computer vision is part of artificial intelligence that allows computers to analyze visual information from cameras and sensors. By adding this tech to an RMC plant, material levels can be automatically tracked, vehicle or equipment movements can be followed, and stockpile levels can be checked using images or videos. Creating an automated material management system using computer vision tries to reduce the need for people to be involved and make RMC plants work better. By using image processing methods, getting real-time data, and creating analytical models, the system can continuously track material levels, produce precise inventory reports, and send alerts for getting new material. This keeps production running smoothly, cuts down on waste, and controls resources.

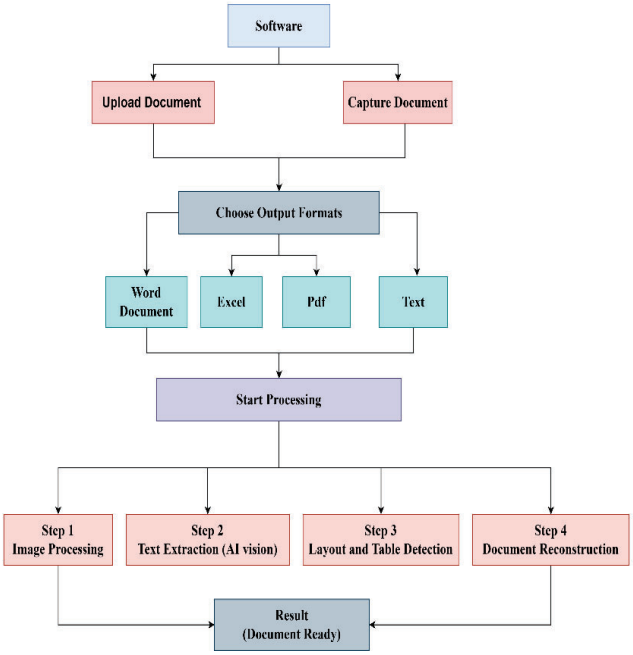

Image 6.3 Software Processing

6.2 Input:

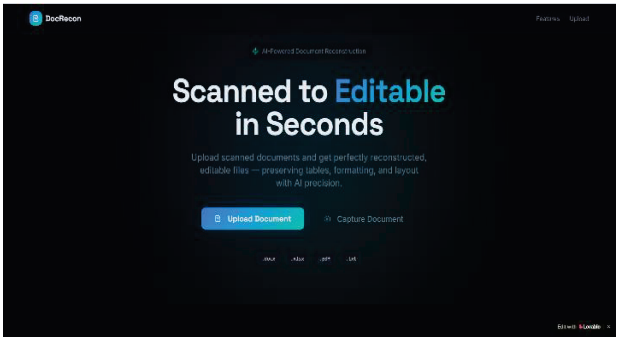

Image 6.2.1 Input Window

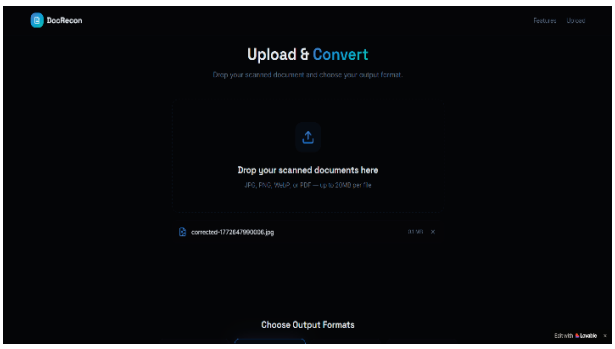

Image 6.2.2 Document Uploading

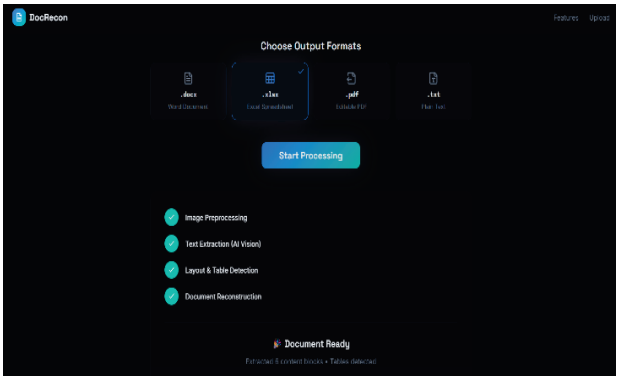

Image 6.2.3 Document Processing

6.3 Output:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
9	Recipe Name : M-35SCC														
10	Truck Number : MH14JL6375														
11	Truck Driver : Chandan														
12	Order Number														
13	Batcher Name : Stetter														
14	Label	SAND	CSAN	20MM	10MM	0	CEM1	CEM2	GGBS	FLY	WATER	-	ADMIX1	ADMIX2	
15		Aggregate					Cement				Water	MS/ICE	Admixture		
16	Recipe Ta	0	920	0	960		370	0	0	100	152		0	4.9	
17	Water Ab	3.36	3.36	1.24	1.32	0						2			
18	Moisture	1.2	1.2	0.8	0.8	0					Bal. Wtr	0			
19	Target in	0	901	0	955		370	0	0	100	178		0	4.9	
20	Actual in	0	871	0	945		367	0	0	100	178		0	4.85	
21	Water Ab	3.36	3.36	1.24	1.32	0						2			
22	Moisture	1.2	1.2	0.8	0.8	0					Bal. Wtr	0			
23	Target in	0	901	0	955		370	0	0	100	178		0	4.9	
24	Actual in	0	892	0	943		366	0	0	102	178		0	4.91	
25	Water Ab	3.36	3.36	1.24	1.32	0						2			
26	Moisture	1.2	1.2	0.8	0.8	0					Bal. Wtr	0			
27	Target in	0	901	0	955		370	0	0	100	178		0	4.9	
28	Actual in	0	897	0	945		371	0	0	99	178		0	4.86	
29	Water Ab	3.36	3.36	1.24	1.32	0						2			
30	Moisture	1.2	1.2	0.8	0.8	0					Bal. Wtr	0			
31	Target in	0	901	0	955		370	0	0	100	178		0	4.9	
32	Actual in	0	887	0	950		372	0	0	99	180		0	4.88	
33	Water Ab	3.36	3.36	1.24	1.32	0						2			
34	Moisture	1.2	1.2	0.8	0.8	0					Bal. Wtr	0			
35	Target in	0	901	0	955		370	0	0	100	178		0	4.9	
36	Actual in	0	915	0	955		372	0	0	96	179		0	4.9	
37	Water Ab	3.36	3.36	1.24	1.32	0						2			
38	Moisture	1.2	1.2	0.8	0.8	0					Bal. Wtr	0			
39	Target in	0	901	0	955		370	0	0	100	178		0	4.9	
40	Actual in	0	909	0	985		369	0	0	104	180		0	4.94	
41	Label	SAND	CSAN	20MM	10MM	0	CEM1	CEM2	GGBS	FLY	WATER	-	ADMIX1	ADMIX2	
42	Total Set	0	5406	0	5730	0	2220	0	0	600	1068		0	29.4	
43	Total Actu	0	5371	0	5723	0	2217	0	0	600	1073		0	29.34	
44															

Image 6.3.1 Upload Document Result

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	A	B	C	D	E	F	G	H	I	J	K	L
1	Type	SAND	CSAN	20MM	10MM	CEMI	CEM2	GGBS	FLY	WATER	ADMIX1	ADMIX2
2	Recipe Targets	0	782	605	506	365	0	0	80	177	4.5	0
3	Recipe Targets	0	807	585	533	235	0	0	60	165	3.2	0
4	Recipe Targets	0	770	594	500	295	0	0	80	164	4.1	0
5	Recipe Targets	0	811	635	545	265	0	0	70	175	3.9	0
6	Recipe Targets	0	569	568	481	120	0	0	95	196	2.2	0
7	Recipe Targets	0	809	585	533	235	0	0	60	163	3.2	0
8	Recipe Targets	0	894	0	876	295	0	135	50	169	0	4.9
9	Recipe Targets	0	901	0	952	370	0	0	100	179	0	5
10	Recipe Targets	0	784	606	506	365	0	0	80	169	4.5	0
11	Recipe Targets	0	809	585	533	235	0	0	60	163	3.2	0
12	Recipe Targets	0	894	0	876	295	0	135	50	169	0	4.9
13	Recipe Targets	0	809	585	533	235	0	0	60	163	3.2	0

Image 6.3.2 Capture Document Result

6.4 Material Variations:

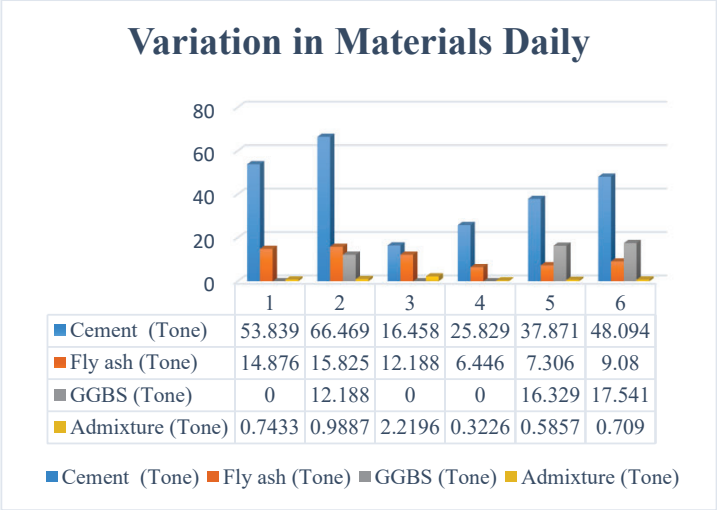

Image 6.4.1 Daily Material Variation in Cement, Fly Ash, GGBS and Admixture

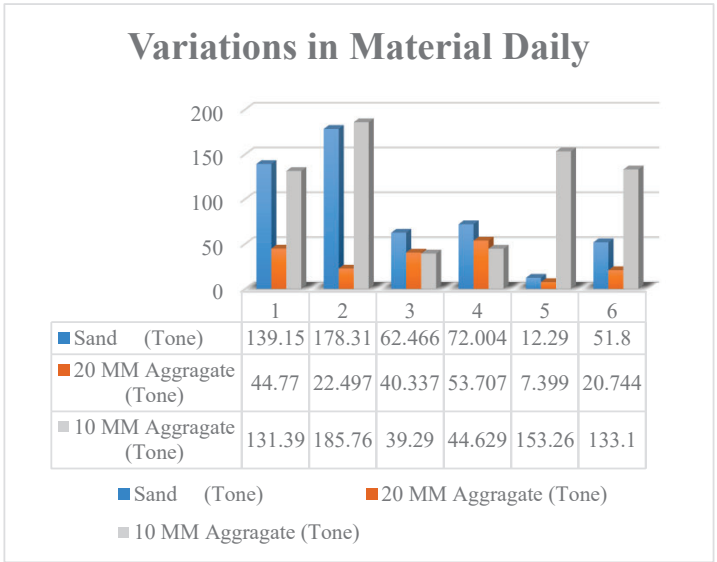

Image 6.4.2 Daily Material Variation in Sand, 10MM and 20MM

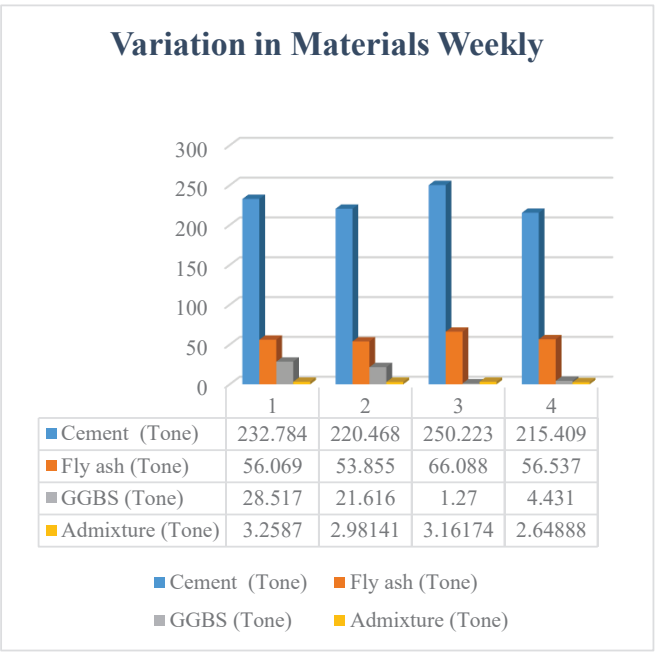

Image 6.4.3 Weekly Material Variation in Cement, Fly Ash, GGBS and Admixture

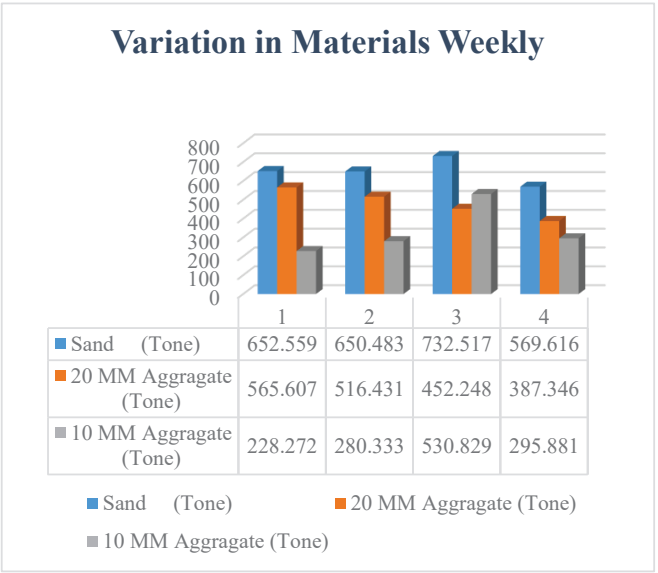

Image 6.4.4 Weekly Material Variation in Sand, 10 MM and 20 MM

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6 CONCLUSION

1. Consumption of materials is high in RMC plants, where cement is consumed up to 66 tons per day, while aggregate can be up to 185 tons per day.
2. Material management through human intervention causes time wastage and makes humans prone to errors and incorrect material management.
3. A proposed computer vision system allows for data acquisition and tracking of materials automatically.
4. Automating activities results in increased efficiency by 8-10% as well as minimizing wastage of materials by 1-2%.
5. The system minimizes human involvement by almost 80-90%, thus ensuring accuracy.
6. It helps to plan material inventories and prevents shortage and excess of materials.
7. Facilitates decision-making based on daily consumption of materials.

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