Supplementary Materials

Table S1 A summary of control techniques of H_2S (aq).

Corrosion Control Technique	Materials used	Experimental conditions	Test Period	Initial H_2S	Final H_2S After treatment	Removal %	Key Observations	Ref.
Chemical additive	Calcium nitrate ($Ca(NO_3)_2$)	Real sewage in a pressure sewer system	133 days	5.51 mg S/L in winter to 8.29 mg S/L in summer	0.60–0.26 mg S/L	86%	The nitrate dosing strategy provided a cost-effective solution for controlling sulfide build-up in long pressure sewers.	(Despot et al., 2022)
	Nitrate	Real sewer sediments in a laboratory setting	Several weeks	6.5, 13.0, and 17.5 mg S/L	< 0.3 mg S/L	95%	- The strategy achieved maximum sulfide removal rates with minimal carbon source loss. - ORP was identified as a sensitive indicator of the control effect.	(Liu et al., 2015)

	Calcium peroxide (CaO_2) Calcium hypochlorite ($Ca(ClO)_2$) Magnesium hydroxide ($Mg(OH)_2$) Ferric chloride ($FeCl_3$)	Laboratory tests with real sewage samples	90 min	4 mg/L	N/A	95%	- The combination of 2 mg/L $FeCl_3$ and 2.5 mg/L $Mg(OH)_2$, and 2 mg/L $FeCl_3$ and 5 mg/L $Ca(ClO)_2$, were the most effective, reducing hydrogen sulfide concentration by more than 95%.	(Othman et al., 2011)
	Iron (Fe)-sludge	Real sewage in a pilot-scale sewer system	6 hours	16 mg S/L	9.22 mg S/L	42.38 %	- Fe-sludge was effective in removing dissolved sulfides at a ratio of 0.29 ± 0.06 mg S/mg Fe - The dominant mechanism for sulfide removal with Fe-sludge was precipitation with ferric ions.	(Shrestha et al., 2020)
Electrochemical process*	Graphite electrodes and sodium acetate	Synthetic wastewater in a laboratory setting	30 days	390 mg/L	20 mg/L	95%	The air-cathode pipe reactors significantly reduced sulfate reduction and increased COD removal	(Aboutalebi et al., 2012)

Electrochemical process	Titanium foam/IrO_2 & Ti/IrO electrodes	Synthetic sewage samples and real sewage in the laboratory setting	6 hr	10 mg S/L	1.75 mg S/L	90%	The electrochemical method achieved a sulfide removal efficiency of 90%	(Hou et al., 2024)
Electrochemical generation	Magnetite nanoparticles (Fe_3O_4) from mild steel electrodes	Laboratory tests with real sewage samples	31 days	12.7 mg S/L	0.2 mg S/L	98%	The cost-benefit analysis indicated that this method is economically feasible, with an estimated cost comparable to current sulfide control practices	(Lin et al., 2017a)
Electrochemical oxidation	Ta/Ir and Pt/Ir coated titanium electrodes	Laboratory tests with real sewage samples	122 days	9.2 mg/L	1.9 mg/L	79%	This method can effectively reduce sulfide concentrations and potentially offer a cost-effective and chemical-free solution for sewer corrosion control.	(Pikaar et al., 2012)
	Ir/Ta mixed metal oxide (MMO) coated titanium electrodes	Synthetic feed and real domestic wastewater in a laboratory setting	6 hr	N/A	N/A	N/A	- The presence of trace elements increased the sulfide removal rate by approximately 37%.	(Pikaar et al., 2011)

							- The research demonstrated that indirect oxidation with in-situ generated oxygen is the main reaction mechanism for sulfide removal.	
	Iron plates (mild steel) as electrodes	Real sewage samples in a laboratory setting	8 weeks	10.1 ± 0.4 mg S/L	0.5 ± 0.4 mg S/L	95.4 ± 4.4%	- Increased sewage pH from 7.60 ± 0.36 to 7.94 ± 0.34. - Avoided the drawbacks of conventional iron salt dosing, such as pH reduction and safety concerns related to handling and storage of iron salts.	(Lin et al., 2017b)
Chemical oxidation	H_2O_2 (35% concentration)	Real sewage	1 hr	4.2 mg S/L	1.85 mg S/L	56%	- ORP increased, indicating improved wastewater quality. - COD was reduced, enhancing overall sewage quality.	(El Brahmi and Abderafi, 2023)

	Ferrous chloride ($FeCl_2$)	Both on samples in the laboratory and on real sewage water	25 min	3 mg S/L	0.46 mg S/L	84.67%	- Ferrous ions significantly catalyze the oxidation of sulfide with oxygen. - The efficiency of oxygen utilization improves at higher pH levels (above 8.1).	(Rathnayake et al., 2019)
	Ferrous salts (Fe^{2+}) and ferric salts (Fe^{3+})	Samples of raw municipal sewage in a laboratory setting	30-40 minutes	5 mg S/L	0.1 mg S/L	98%	The dominant product of sulfide oxidation by ferric salts in municipal sewage is elemental sulfur rather than sulfate.	(Firer et al., 2008)
Chemical oxidation + oxygen injection	Caustic soda and oxygen	Samples in the laboratory using laboratory-scale sewer reactors designed to mimic real sewer conditions	8 days	7 mg S/L	1 mg S/L	85.71%	- The combined caustic and oxygen dosing achieved more efficient sulfide control compared to caustic treatment alone. - The combined method led to a prolonged biofilm recovery period between caustic shocks, enhancing overall sulfide control.	(Lin et al., 2017c)

Biological oxidation	A microbial consortium dominated by Arcobacter sp	Synthetic sewage and real sewage were sampled in the laboratory setting	250 days	100 mg S/L	4 mg S/L	96%	The nitrate-reducing, sulfide-oxidizing bacteria (NR-SOB) consortium achieved a sulfide removal efficiency of 99%.	(De Gusseme et al., 2009)
Adsorption	Tire-derived rubber particles (TDRP)	Laboratory tests with real sewage samples	10-25 min	158 mg/L	N/A	98.7%	- Significant reductions in color (up to 67.35%) and turbidity (up to 96.34%) were observed. - The dissolved oxygen levels in the treated water increased from zero to 5.41 mg/L, improving water quality for aquatic life.	(Irfan et al., 2020)
Urine intermittent dosing	Urine, which is collected, stored, and intermittently dosed into the sewer sediments	Samples in laboratory	160 days	11.2 ± 1.7 g S/(m².d)	3.4 ± 1.5 g S/(m².d)	69.64%	-Intermittent urine dosing reduced sulfidogenic activity by 54% - The urine dosing strategy effectively suppressed SRB in the surface-active zone of sediments, attributed to	(Zuo et al., 2023)

							the biocidal effect of free ammonia in urine.	

* This technique removes sulfates, not hydrogen sulfide.

Table S2 A summary of control techniques of H_2S build-up.

Corrosion Control Technique	**Materials used**	**Experimental conditions**	**Test Period**	**Initial H_2S**	**Final H_2S after treatment**	**Removal %**	**Key Observations**	**Ref.**
Chemical oxidation	Conductive concrete (San-Earth)	Synthetic wastewater samples in a laboratory	66 days	10 mg S/L	0–4 mg S/L	60-100%	- Conductive concrete (San-Earth) significantly reduced H_2S concentrations compared to OPC. - Elemental sulfur was observed in the sludge coating of conductive concrete, indicating successful oxidation of H_2S.	(Imai et al., 2022)
	Free nitrous acid (FNA)	A pilot sewer plant designed to mimic real sewer conditions, using raw wastewater	1 day	22.0 ± 4.8 mg/L	16.1 ± 6.4 mg/L	22.82%	- Effective sulfide control was only achieved during the dosing periods, with rapid resumption of sulfide production after dosing.	(Despot et al., 2021)

							- Using FNA for sulfide control in systems with severe sediment accumulation and suggests that higher concentrations and longer exposure times may be necessary.	
	NaOH $Mg(OH)_2$ $(Ca(NO_3)_2$ $FeCl_3$	Laboratory setting using an 18-meter experimental sewer pipe	120 days (NaOH)	180.8 ppm	0.17 ppm	~ 100%	The effectiveness of the chemicals in suppressing H_2S emissions was ranked as follows: NaOH > $Mg(OH)_2$ > $FeCl_3$ > $Ca(NO_3)_2$.	(Jegatheesan et al., 2015)
	Sodium hydroxide (NaOH)	Real sewage	4 months	89.4 ppm	8.0 ppm	91.05%	- Demonstrated the effectiveness of maintaining elevated pH to minimize H_2S emissions. - The approach is simple to operate and does not require multiple injection points along pressure mains.	(Wiley, 2019)
	Sodium hydroxide (NaOH)	Both in laboratory settings using anaerobic sewer	6 hours	6 mg S/L	1 mg S/L	83.33%	- Laboratory Results: Sulfide production was reduced by 70-90 after pH shock. The optimal	(Gutierrez et al., 2014)

		reactors and in real sewage systems					conditions were found to be a pH level of 10.5 for 1-2 hours - Field Results: Effective sulfide control was achieved with a pH of 11.5 for 6 hours, reducing sulfide concentrations by 67%.	
	Calcium hydroxide ($Ca(OH)_2$) for pH adjustment Ferrous chloride ($FeCl_2$) for binding sulfide and reducing its emission into the gas phase	laboratory scale using synthetic wastewater	70 days	40 mg S/L	32 mg S/L	20%	- Raising the pH to 8 significantly reduced the sulfide concentration in the liquid phase. - The combination of pH adjustment and ferrous chloride addition was effective in reducing gaseous H_2S concentrations.	(Rathnayake et al., 2017)
	- Magnesium hydroxide ($Mg(OH)_2$) - Sodium hydroxide (NaOH) - Calcium nitrate ($Ca(NO_3)_2$)	Laboratory scale using synthetic wastewater	60 min (.05% slope)	35ppm	3 ppm	91.43%	Sodium hydroxide and magnesium hydroxide were the most effective in reducing H_2S emissions, with incubation times ranging from 2 to 16 minutes for $Mg(OH)_2$ and 6 to 14 minutes for NaOH.	(Abdikheibari et al., 2016)

	- Ferrous chloride ($FeCl_2$)							
Ventilation	Upstream Natural Pulsed Ventilation (UNPV)	Using lab-scale reactors	80 days	0.50 mg/L	0.28 mg/L	44%	- The total sulfide concentration was reduced by 39.08% and 58.74% in the upstream and downstream sewer pipes, respectively, under UNPV conditions. - The increased ORP and organic carbon transportation in wastewater under ventilation were responsible for the changes in the microbial community.	(Gao et al., 2020)

Table S3 A summary of control techniques of H_2S (gas).

Corrosion Control Technique	**Materials used**	**Experimental conditions**	**Test Period**	**Initial H_2S**	**Final H_2S After treatment**	**Degradation%**	**Key Observations**	**Ref.**
Oxygen injection	Oxygen	Real sewage digester	36 hr	35 ppm	2 ppm	94.3%	- The surface pH of the concrete decreased from 6.4	(Abu-Yosef et al., 2023)

							to 4.3, indicating increased acidity. - The concrete showed significant deterioration due to the formation of sulfuric acid.	
Aeration and flushing of the pipeline with compressed air	Compressed air	Real sewage systems in the field	1 day	310 ppm	11.6 ppm	96.26%	The system maintained low H_2S concentrations with 1-2 purges per day, significantly reducing odor and corrosion issues in the sewage systems	(Wojciechowski and Piaskowski, 2020)
Chemical oxidation	Hydrogen peroxide (H_2O_2) (35% concentration)	Real sewage	1 hr	199 ppm	10 ppm	94.98%	The treatment effectively mitigated odor issues associated with hydrogen sulfide	(El Brahmi and Abderafi, 2023)
Electrochemical oxidation	Sacrificial iron electrodes (carbon steel plates)	Real sewage	24 hr	173 ppm	6.6 ppm	96.19%	This method also generates alkalinity, which helps to maintain the pH balance in sewage.	(Pikaar et al., 2019)

Table S4 A summary of control techniques of H_2SO_4.

Corrosion Control Technique	**Materials used**	**Experimental conditions**	**Test Period**	**Effectiveness evaluation measurements**				**Key Observations**	**Ref.**
				Parameter Measured	**Before Technique**	**After Technique**	**Efficiency %**		
Coating	C1: Magnesium hydroxide and calcium hydroxide. C2: Magnesium hydroxide, calcium hydroxide, and an acrylic additive. C3: Magnesium phosphate cement (magnesium oxide and mono-	Concrete samples in the laboratory	28 days	Mass loss	5-8%	C2: 0.5-0.7% C3: 1.5%	C2: 91% C3: 77%	- The C3 coating provided the best corrosion protection, maintaining higher alkaline surface pH values and showing no formation of corrosion products like gypsum. - The C2 coating also offered significant protection, with minimal mass loss and an increase in compressive strength after 28 days.	(Chatzis et al., 2022)

	potassium phosphate).								
	Magnesium hydroxide and magnesium oxide powders	Concrete samples in a laboratory setting	4 days	pH values	8.1	10.4	N/A	Coating C5 was identified as the best overall, providing efficient corrosion protection	(Merachtsaki et al., 2022)
	Magnesium hydroxide ($Mg(OH)_2$)	Concrete samples in a laboratory setting	6 days	Surface pH	N/A	N/A	Maintained above 8 during acid spraying tests	- Coatings with 1% cellulose showed the best adhesion and resistance to water and acid. - The formation of gypsum was lower in coatings with higher cellulose content, indicating better corrosion protection	(Merachtsaki et al., 2020)
	Polyester-based polymer concrete	Laboratory and in full-scale simulations	3 years	Weight change	N/A	N/A	0.5% after 400 days in 3% sulfuric acid, while uncoated	The polymer concrete coating significantly extended the lifetime of concrete in sulfuric	(Liu and Vipulanandan, 2001)

							specimens failed within 7 days	acid environments by 29 times for dry-coated and 71 times for wet-coated concrete	
	Acrylic, polymer emulsion, epoxy resin, polyurethane, and chlorinated rubber	Concrete samples in a laboratory setting	60 days	Visual inspection	N/A	N/A	N/A	- Epoxy and polyurethane coatings showed the best chemical resistance, remaining relatively intact after 60 days in sulfuric acid	(Almusallam et al., 2003)
	Two types of polyurethane	Concrete samples in a laboratory setting	500 days	Weight change			Polyurethane-1: + 0.88% Polyurethane-2: + 0.64%	- Polyurethane-1 had higher bonding strength on dry concrete but lower on wet concrete. - Polyurethane-2 showed better chemical resistance in sulfuric acid, extending the service life of	(Vipulanandan and Liu, 2005)

								concrete by up to 57 times.	
	Glass-fiber mats and epoxy resin	Concrete samples in a laboratory setting	3 years	N/A	N/A	N/A	N/A	The glass-fiber mat-reinforced epoxy coating significantly extended the lifetime of concrete in 3% sulfuric acid by over 70 times	(Vipulanandan and Liu, 2002)
Concrete mixed modified + coating	EAF slag: Used as a substitute for natural aggregates Polyurea: Used as a coating material	Samples in the laboratory	28 days	Mass loss	N/A	N/A	+ 5%	- EAF slag improved the mechanical properties and acid resistance of concrete. - Polyurea coating significantly enhanced the acid resistance and increased the crushing strength of concrete pipes by approximately 11%.	(Özalp et al., 2023)

Biological additive	Anaerobic granular sludge	Samples in a laboratory corrosion chamber designed to simulate real sewer conditions	6 months	Corrosion Rates	N/A	N/A	Reduced by 17.2% (1% bio-concrete) and 42.8% (2% bio-concrete)	The presence of SRB in the bio-concrete reduced the net production of biogenic sulfuric acid.	(Song et al., 2021)
Repair mortar	Resin powder (polyvinyl acetate), and nylon fibers	concrete samples in a laboratory setting	7 days	chloride ion penetration	N/A	N/A	decreased to 0.68 times that of the base mortar	The repair mortar with 4.5% resin powder showed significantly improved watertightness and acid resistance.	(Chang and Choi, 2020)
	low-calcium fly ash-based geopolymer (FAGP)	samples in a laboratory setting	31 days	Mass loss	49%	6%	87%	FAGP showed a slower rate of acid neutralization, indicating better resistance to sulfuric acid	(Ariyadasa et al., 2024)
	nano-silica (NS) and silica fume (SF)	samples in a laboratory setting	28 days	Porosity (mL/g)	0.1007	0.0692	31%	The addition of SF and NS improved the microstructure,	(Zhang et al., 2018)

								reduced porosity, and enhanced the mechanical properties of the concrete.	

Table S5 A Summary of techniques for inhibiting the growth of SOB.

Corrosion Control Technique	**Materials used**	**Experimental conditions**	**Test Period**	**Effectiveness evaluation measurements**				**Key Observations**	**Ref.**
				Parameter Measured	**Before Technique**	**After Technique**	**Efficiency %**		
Spraying	Sodium nitrite, which forms free nitrous acid (FNA)	Real sewer manhole	12 months	Sulfate Concentration	N/A	N/A	Reduced by 34.2%	A single nitrite spray reduced the corrosion rate by 40-90% for 6 months	(Li et al., 2022a)
		concrete samples in a laboratory setting	12 months	Viable bacterial cells	N/A	N/A	Decreased by >80%	H_2S uptake rates were reduced by 84-92% after FNA treatment.	(Sun et al., 2015b)

surface washing	Calcium nitrite	Pilot-scale gravity sewer system	16 months	Surface pH	2-3	5	Increased from 2–3 to 5 (Δ +2–3)	- Significant reduction in corrosion loss (45% for 1% calcium nitrite, 58% for 4% calcium nitrite). - Reduced sulfate production rates and sulfide uptake rates, indicating effective corrosion control.	(Li et al., 2021)
Coating	Silver (Ag+)-modified zeolites (types A, Y, and P) Polyurethane as the base coating material	Mortar samples in a laboratory setting	8 weeks	pH for AgY5%	4.7	5.5	+ 0.8	Treated samples had delayed pH reduction, lower OD, reduced sulphate production, and fewer viable bacteria.	(Kamarul Asri et al., 2022)

	- Portland cement -Geopolymer -Geopolymer magnesium phosphate -Zinc particles -Zinc-doped clay particles	Samples in an accelerated bio-corrosion chamber	6 months	Surface pH	2	5 for geopolymer 6-6.5 for blended samples	+ (3-4.5)	Blended and geopolymer-based coatings showed better corrosion resistance and strength retention compared to cement-based coatings.	(Roghanian and Banthia, 2019)
Anti-corrosion concrete	- Nano titanium dioxide (NT) - Reactive powder concrete (RPC)	Samples in a laboratory setting	14 months	Surface pH	N/A	N/A	+ 23.62%	NT-modified RPC (NTMRPC) effectively inhibited and eliminated microorganisms, reducing biological corrosion	(Li et al., 2022b)
Anti-corrosion concrete	Silane Quaternary Amine (SQA)	Concrete samples in a controlled laboratory	365 days	N/A	N/A	N/A	N/A	SQA improved resistance to MIC under moderate conditions	(Ding et al., 2017)

		environment using a biological growth chamber							
Biological additive	Anaerobic granular sludge	Samples in a laboratory corrosion chamber designed to simulate real sewer conditions	6 months	Corrosion Rates	N/A	N/A	Reduced by 17.2% (1% bio-concrete) and 42.8% (2% bio-concrete)	- Sulfide uptake rates and sulfate concentrations were significantly lower in bio-concrete. - The surface pH of bio-concrete was higher, indicating reduced acid production and corrosion	(Song et al., 2021)
Electrodeposition	Copper sulphate ($CuSO_4$), Copper nitrate ($Cu(NO_3)_2$), and Copper acetate	Samples in the laboratory	5 to 20 days	SOB cells	1.09×10^7 cm^3	1.14×10^4 cm^3	Reduced SOB cells by 99.89%	- The Cu_2O deposits effectively inhibited the growth of SOB. - The treated specimens	(Zhu et al., 2021)

	($Cu(CH_3COO)_2$) solutions							showed significantly reduced bacterial concentrations, increased pH, and improved corrosion resistance.	

Table S6 A Summary of techniques for inhibiting the growth of SRB.

Corrosion Control Technique	**Materials used**	**Experimental conditions**	**Test Period**	**Effectiveness evaluation measurements**				**Key Observations**	**Ref.**
				Parameter Measured	**Before Technique**	**After Technique**	**Efficiency %**		
Chemical additive	Free nitrous acid (FNA)	Samples in the laboratory using batch cultures of *Desulfovibrio vulgaris*	6 - 48 hr	Percentage of live cells	85-90%	5-15%	70-85%	- FNA significantly inhibited the growth and activity of SRB. - There was a marked reduction in hydrogen sulfide production	(Gao et al., 2016)

	Intermittent injection system by Free nitrous acid (FNA)	Samples in a laboratory setting	304 days	Corrosion rate	N/A	N/A	Corrosion rate ↓ up to 31%	- ATP levels decreased by more than 80% after FNA treatment, indicating reduced microbial activity. - Pitting corrosion rate decreased by 59% after two treatments.	(Zhong et al., 2020)
	Ferrate (Fe(VI)), specifically potassium ferrate (K_2FeO_4)	Samples in laboratory-scale reactors	3 hr	Inactivation efficiency At 30 mg Fe/L	N/A	N/A	92.5%-98.5%	- Low-rate Fe(VI) dosing effectively damaged the biofilm structure. - Fe(VI) primarily reduced the content of humic substances in EPS.	(Yan et al., 2023)
	Copper oxide nanoparticles (CuO NPs)	Samples in the laboratory using batch cultures of *Desulfovibrio vulgaris*	24 hr	Total cell counts (500 mg/L CuO NPs)	1.4×10^8 cells/mL	2.0×10^7 cells/mL	Reduced cells by 85.7%	- CuO NPs at concentrations above 50 mg/L significantly inhibited cell growth and sulfate reduction activity.	(Chen et al., 2019)

								- ROS overproduction was identified as a critical factor in the antibacterial activity of CuO NPs.	
Electrodeposition	Copper sulphate ($CuSO_4$), copper nitrate ($Cu(NO_3)_2$), and copper acetate ($Cu(CH_3COO)_2$) solutions	Samples in the laboratory	5 to 20 days	SRB cells	2.09×10^8 cm^3	1.02×10^3 cm^3	Reduced SRB cells by 99.99%	- The Cu_2O deposits effectively inhibited the growth of SRB. - The treated specimens showed significantly reduced bacterial concentrations, increased pH, and improved corrosion resistance.	(Zhu et al., 2021)
Protective biofilm	Escherichia coli DH5α strain	Samples in the laboratory	7 days	N/A	N/A	N/A	N/A	The E. coli DH5α biofilm effectively blocked sulfide ions, significantly reducing the current density and demonstrating its potential as a protective	(Soleimani et al., 2011)

								barrier against corrosion	
Anti-corrosion concrete	- Nano titanium dioxide (NT) - Reactive powder concrete (RPC)	Samples in a laboratory setting	14 months	Surface pH	N/A	N/A	+ 23.62%	NT-modified RPC (NTMRPC) effectively inhibited and eliminated microorganisms, reducing biological corrosion	(Li et al., 2022b)

Table S7 A Summary of studies on concrete mix modifications to improve the corrosion resistance of concrete.

Element modified				**Test Period (Days)**	**Key Observations**	**Ref.**
Cement Type (binders)	**Aggregate type**	**Material additive**	**Others**			
Reactive powder concrete (RPC) + sulfoaluminate cement (CSA)				112 days	- Adding 8% CSA significantly improved the corrosion resistance of RPC - Excessive CSA (15%) led to the formation of excessive gypsum and	(Shang et al., 2024)

					ettringite formation, which reduced the corrosion resistance.	
Calcium aluminate cement (CAC) and blast furnace slag cement (BFSC)				107 days	- CAC linings showed better resistance to biogenic acid attack compared to BFSC linings. - BFSC linings exhibited significant cracking and deeper degradation. - CAC linings formed a protective aluminum hydroxide layer, limiting further degradation.	(Lavigne et al., 2016)
OPC was partially replaced with ground granulated blast furnace slag (GBFS)				180 days	- The sample with 75% slag (CM2/A) exhibited the lowest damaged depth and calcium leaching, indicating the highest resistance. - The study concluded that while blast furnace slag improves resistance, the optimal proportion requires further investigation to determine optimal proportions.	(Estokova et al., 2018)
Partial replacement of alkali-activated glass				6 months	- Incorporating 15% CAC significantly improved the	(Ali et al., 2022)

powder/ground granulated blast furnace slag (GGBS) with calcium aluminate cement (CAC)					resistance to microbial-induced corrosion. -The modified concrete showed reduced deterioration depth, mass loss, and compressive strength loss.	
	Polyethylene Terephthalate (PET)			60 days	- Concrete samples with higher percentages of PET particles showed lower weight loss and better resistance to sulfuric acid attack. - Samples with 15% PET particles had the lowest weight loss (6.57%) and the least reduction in crushing load (35.29%).	(Janfeshan Araghi et al., 2015)
		Polyvinyl-alcohol (PVA) fibers, fly ash, silica sand, and superplasticizer		12 cycles, with each cycle lasting 7 days	Engineered Cementitious Composites (ECC) demonstrated superior self-healing capabilities, with cracks sealing effectively after exposure to corrosive environments	(Wang et al., 2022a)
		Alkali-activated slag (AAS), with copper		4 weeks	- CuO-doped AAS completely inhibited biofilm formation.	(Kang and Ye, 2023)

		oxide (CuO) and copper nitrate (CuN)			- The corrosion depth was reduced by a factor of 10. - The antimicrobial efficiency of CuO was higher than that of CuN.	
		Calcium nitrite		16 months	- The combination of calcium nitrite admixture and surface washing by calcium nitrite approach could extend the service life of sewer pipes by 1.8 to 2.4 times. - Calcium nitrite admixture delayed the re-establishment of corrosion-inducing microorganisms.	(Li et al., 2021)
OPC or sulfoaluminate cement (SAC)		Nano-SiO_2		180 days	- Nano-SiO_2 significantly improved the sulfuric acid resistance of OPC-SAC composites. - The addition of nano-SiO_2 reduced the contact area between cement particles and acid, thereby enhancing the durability of the composites in acidic environments.	(Cao et al., 2023)

Reactive powder concrete (RPC)		Nano titanium dioxide		14 months	- showed significant antimicrobial properties, with high inhibition and elimination rates of surface microorganisms. -Chemical resistance was enhanced, with increased pH values at various depths.	(Li et al., 2022b)
Alkali-activated concrete (AAC)		Fly ash and slag	Activated by sodium hydroxide (NaOH)	140 days	Mass loss rate for AAC was 13.1%, while for OPC it was 20%. -AAC showed significantly better resistance to biogenic sulfuric acid corrosion compared to OPC.	(Xie et al., 2019)
Calcined clay-based geopolymers, specifically metakaolin (MK) and meta-illite (MI)			Activated by sodium silicate or potassium silicate solutions	30 days	- MI-based geopolymers, particularly those activated by sodium silicate, showed the lowest degradation and leaching rates. - The presence of calcium in MI led to the formation of gypsum, which helped block further acid ingress. - Geopolymers activated by potassium silicate exhibited higher	(Diaz Caselles et al., 2023)

					degradation due to lower geopolymerization degrees and higher porosity.	
Geopolymer binders (metakaolin, high-calcium fly ash, and low-calcium fly ash)			Activated by sodium hydroxide (NaOH) solution	98 days	- High-calcium fly ash-based GPC activated by 12 M NaOH showed the best performance in terms of compressive strength, mass loss, and neutralization depth. - Metakaolin-based GPC showed poor resistance to sulfuric acid. - The presence of gypsum crystals in high-calcium fly ash-based GPC improved its resistance to sulfuric acid corrosion.	(Yang et al., 2021)
Low-calcium fly ash-based geopolymer mortar (FA-GPm)	Ground granulated blast furnace slag (GGBFS)		Activated by Sodium hydroxide and Sodium Silicate solutions	24 months in the natural sewer environment	- FA-GPm showed better resistance to mass loss and compressive strength reduction compared to sulphate-resistant cement (SRC). -FA-GPm had a higher neutralization depth and reduction in surface pH,	(Khan et al., 2020)

					indicating better long-term durability.	
	Electric arc furnace (EAF) slag	Steel fiber	Polyurea coating	28 days	Replacing natural aggregates with EAF slag improves the mechanical properties and resistance to sulfuric acid	(Özalp et al., 2023)