

JOURNAL OF GREEN SCIENCE AND TECHNOLOGY

THE EFFECT OF ADDING WIRE MESH ON THE COMPRESSIVE STRENGTH OF CONCRETE USING PEAT WATER AND SEA WATER

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ABSTRACT

Concrete is a widely used construction material due to its strength and durability, but its quality is greatly influenced by its constituent materials and the environment. In West Kalimantan, people use scrap wire from building demolition as an additive in concrete, while clean water is limited, so peat water or seawater is often used as a mixer. This study aims to determine the effect of wire mesh usage and mixing water type on concrete compressive strength at 7, 14, and 28 days. Test specimens in the form of cubes were made with variations: normal concrete (clean water), concrete with peat water, concrete with seawater, and concrete with 1% wire mesh added to each type of water, and compressive strength testing was conducted using a compression testing machine. The results showed that peat-water concrete achieved the highest strength (119.50, 207.37, and 247.73 kg/cm² at 7, 14, and 28 days), seawater concrete produced the lowest (92.87, 182.27, and 225.90 kg/cm²), and the addition of 1% wire mesh increased early-age strength up to 186.57 kg/cm² at 7 days but its effect diminished at later ages. Thus, the type of mixing water plays a dominant role in concrete quality, while steel tie wire is more effective in increasing strength during the early stages of hardening.

Keyword: *compressive strength, concrete, peat water, seawater, wire mesh*

1. INTRODUCTION

Concrete is the most widely used construction material worldwide because it has the advantages of high compressive strength, good durability, and ease of workmanship. Almost all types of infrastructure, from buildings and bridges to highways, use concrete as the main material [1]. As development increases, the demand for concrete continues to grow, driving the need for innovation in both material selection and mixing technology [2].

On the other hand, the availability of conventional raw materials for concrete production, such as aggregates and clean water, is becoming increasingly limited. This calls for alternative materials that are not only capable of maintaining concrete quality but also environmentally friendly through the utilization of potentially polluting waste [3]. One type of construction waste that can be utilized is wire mesh from building demolition. Its use is not widespread, but in some areas, particularly West Kalimantan, wire mesh is still used, for example to tie or tidy up brick arrangements in simple constructions. This fact shows that wire mesh is already known to the community, although its application has not been scientifically researched in concrete mixtures.

Concrete is a composite material consisting of cement, sand, gravel, and water [4]. One of the main mechanical properties of concrete is compressive strength, which is an indicator of its quality and suitability for use in construction. Factors that affect compressive strength include the water-cement ratio [5], quality of constituent materials [6], type of mixing water [7], as well as the presence of additives or substitutes [8]. As development needs increase, research on concrete continues to evolve,

particularly in relation to the use of alternative materials to maintain resource availability while supporting sustainable development.

The use of waste as an additive in concrete has been widely practiced, for example, using glass waste [9], fly ash [10], as well as metal scraps [11]. Metal waste such as wire or steel scraps is known to improve the mechanical properties of concrete by increasing internal bonding and stress distribution [12]. One material with potential for use is steel tie wire from construction waste. Although its use in concrete mixtures has not been widely researched, steel tie wire is believed to contribute to the mechanical properties of concrete, particularly in terms of crack resistance and load-bearing capacity. Research on steel fiber reinforced concrete (SFRC) has shown that the inclusion of steel fibers significantly improves concrete's post-cracking behavior, toughness, and load-carrying capacity by enhancing internal bridging and energy absorption mechanisms [13]. Several studies also report that even low fiber dosages (0.5–1.5%) can increase compressive strength and reduce crack propagation, indicating that waste steel wire or mesh fragments may provide similar reinforcement effects when properly distributed in the concrete matrix.

In addition to additives, the quality of concrete is also influenced by the type of mixing water. In swampy and coastal areas, clean water is often difficult to obtain, so people use peat water or seawater. Peat water has a low pH (3–5) and a high organic content, which can interfere with the cement hydration process, so concrete made with peat water generally has a lower compressive strength than normal concrete [14]. Meanwhile, seawater contains salt and chloride ions that can reduce concrete quality and cause corrosion in reinforced concrete. However, several studies show that seawater can still be used for non-reinforced concrete, although its compressive strength remains lower than that of concrete made with fresh water.

Previous studies support the importance of this study. The use of steel wire pieces in concrete has been proven to provide resistance to cracking, although its effect on compressive strength varies. Studies on concrete with peat water show a decrease in compressive strength of up to 20-30% compared to concrete with clean water, while research on concrete with seawater shows that although the initial compressive strength is lower, it continues to develop up to 28 days. Thus, it can be concluded that the addition of steel tie wire as construction waste has the potential to improve concrete performance, but its effect on compressive strength still needs to be further investigated, especially in conditions where peat water and seawater are commonly found in West Kalimantan.

West Kalimantan also has unique environmental conditions dominated by peatlands. This has led the community to build more stilt houses with wooden pillars to reduce the load on the buildings. In addition, the limited availability of clean water in peatland and coastal areas has caused the community to frequently use peat water or seawater in their daily activities, including construction work [15]. Peat water has a high acidity level that can interfere with the cement hydration process [16]. Meanwhile, seawater contains salt and chloride, which can potentially reduce the quality and durability of concrete [17].

Despite these conditions, research combining waste wire mesh with unconventional mixing water (peat water and seawater) is extremely limited, especially in the context of regions where clean water scarcity is a real challenge. Most existing studies focus on steel fiber reinforced concrete using industrial-grade fibers with controlled dimensions and purity. There is almost no research examining low-cost recycled steel wire from field demolition, which has variable shapes and diameters, nor its behavior when mixed with chemically aggressive water sources. This creates a clear research gap that needs to be addressed.

In this study, a 1% wire mesh content is selected because preliminary literature and pilot trials indicate that low-volume steel inclusions (0.5–1.5% by weight of cement) can improve early-age strength and crack resistance without significantly reducing workability or causing segregation. Higher percentages tend to form clumps, reduce compaction quality, and negatively affect compressive strength. Therefore,

1% is considered an optimal and practical proportion for community-level construction practices in West Kalimantan.

Based on this, the purpose of this study is to analyze the compressive strength of concrete with the addition of steel wire using peat water and seawater as mixing agents. Through this study, it is hoped that the extent to which steel wire affects the increase or decrease in concrete compressive strength can be determined, while also providing an overview of the differences in concrete performance between the two types of mixing water.

2. RESEARCH METHOD

This study was conducted experimentally in a laboratory with the aim of assessing the effect of adding steel tie wire on the compressive strength of concrete with different types of mixing water. The materials used included Portland cement type I, sand, gravel, steel tie wire from building demolition waste, and three types of mixing water: normal water, peat water, and seawater. The steel tie wire used in this study was obtained from dismantled building components and consisted of braided low-carbon steel wires. The material was manually cut into short pieces measuring approximately 3–5 cm before being incorporated into the concrete mix. Although photographs are not included, its appearance resembles commonly used construction wire mesh with interconnected steel strands. The steel tie wire used in this study can be seen in Figure 1. Normal water used in this study was clear and neutral in pH, while peat water—collected from a peatland area—had a visually dark brown color, low pH, and high organic content, which may inhibit cement hydration. Seawater was taken from a coastal area and showed visible salt residues after settling, indicating high chloride and sulfate content that can potentially affect concrete strength and durability.



Figure 1. The steel Tie Wire

The test specimens consisted of five groups, namely N (0% steel wire with normal water), A (0% steel wire with peat water), B (0% steel wire with seawater), C (1% steel wire with peat water), and D (1% steel wire with seawater). All mixtures used the same proportion of materials, with the only differences being the type of mixing water and the addition of steel wire. To ensure data reliability, each variation was produced in three test specimens for each testing age (7, 14, and 28 days), resulting in a total of 45 specimens (5 mixture variations \times 3 ages \times 3 specimens per age).

The test specimens were made in the form of cubes measuring $15 \times 15 \times 15$ cm. The curing process was carried out by immersing the specimens in clean water until they reached the test age. Compressive strength testing was performed at 7, 14, and 28 days using a compression testing machine. The compressive strength value was obtained from the maximum applied load divided by the bearing area of the cube. The results were then analyzed by comparing the variations in each mixture to observe the influence of wire mesh addition and mixing water type on the development of concrete compressive strength over time.

3. RESULTS AND DISCUSSION

3.1. 7-Day Concrete Compressive Strength

Compressive strength testing of concrete at 7 days of age in Table 1 and Figure 2 shows significant variation in values between samples. Normal concrete (N) has an average compressive strength of 100.46 kg/cm², which can be used as a baseline reference. In samples mixed with peat water without wire mesh (A), the compressive strength increased to 119.50 kg/cm². This indicates that the use of peat water still allows the hydration process to proceed quite well at an early age, even slightly higher than normal concrete.

Table 1. 7-Day Concrete Compressive Strength Data Results

Sample	Sample Mass (kg)	Compressive Strength of Concrete (kg/cm ²)	Average Concrete Compressive Strength (kg/cm ²)
N1	7,37	101,52	100,46
N2	7,54	108,31	
N3	7,31	91,55	
A1	7,36	118,40	119,50
A2	7,42	121,10	
A3	7,39	119,00	
B1	7,34	95,10	92,87
B2	7,33	92,30	
B3	7,38	91,20	
C1	7,43	189,89	186,57
C2	7,37	185,81	
C3	7,35	184,00	
D1	7,40	154,99	155,90
D2	7,37	151,37	
D4	7,44	161,34	

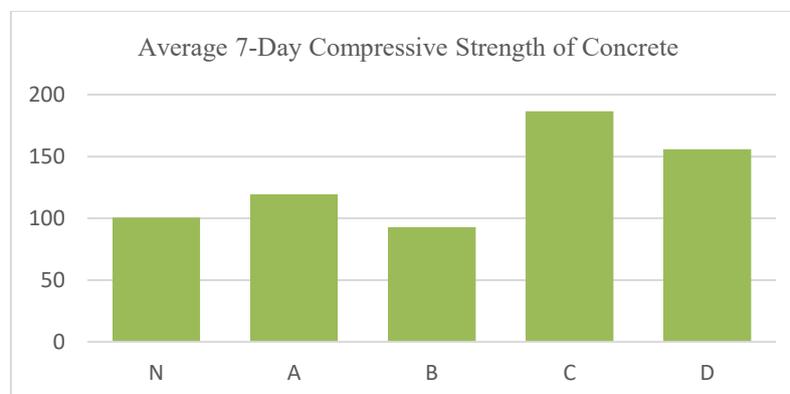


Figure 2. Graph of 7-Day Concrete Compressive Strength Values

In contrast, samples using seawater without steel wire (B) had lower compressive strength, averaging 92.87 kg/cm². This decrease is thought to be due to the salt content in seawater, which interferes with the cement hydration process in the early stages, resulting in suboptimal cement paste formation.

Meanwhile, the effect of using steel tie wire was quite significant in samples C and D. Concrete with steel tie wire and peat water (C) obtained the highest compressive strength, namely 186.57 kg/cm², far above the other variations. This shows that the addition of steel tie wire can improve the mechanical properties of concrete, especially when combined with peat water. Meanwhile, the sample with steel tie wire and seawater (D) had an average compressive strength of 155.90 kg/cm², which was lower than C, but still much higher than normal concrete and variations without steel tie wire.

In general, at 7 days of age, seawater was found to reduce the compressive strength of concrete, while peat water tended to increase it. In addition, the addition of wire mesh significantly increased compressive strength, especially when peat water was used as a mixer.

3.2. 14-Day Concrete Compressive Strength

The results of concrete compressive strength testing at 14 days of age in Table 2 and Figure 3 show an increase in values for all sample variations compared to 7 days of age. Normal concrete (N) achieved an average compressive strength of 195.03 kg/cm², almost double the value at 7 days of age. This is in line with the theory that in the first two weeks, the cement hydration process is still quite intensive, resulting in a significant increase in concrete strength.

In samples with peat water without wire mesh (A), the compressive strength showed higher results than normal concrete, with an average of 207.37 kg/cm². This condition indicates that even though peat water contains organic matter, the hydration process still occurs properly, even slightly more optimally than using normal water.

Table 2. 14-Day Concrete Compressive Strength Data Results

Sample	Sample Mass (kg)	Compressive Strength of Concrete (kg/cm ²)	Average Concrete Compressive Strength (kg/cm ²)
N1	7,39	193,52	195,03
N2	7,52	194,42	
N3	7,30	197,14	
A1	7,40	206,50	207,37
A2	7,42	207,90	
A3	7,37	207,70	
B1	7,33	181,40	182,27
B2	7,29	183,20	
B3	7,39	182,20	
C1	7,43	216,18	217,38
C2	7,37	217,08	
C3	7,35	218,90	
D1	7,40	165,42	164,96
D2	7,37	162,25	
D3	7,44	167,23	
D4	7,44	167,23	

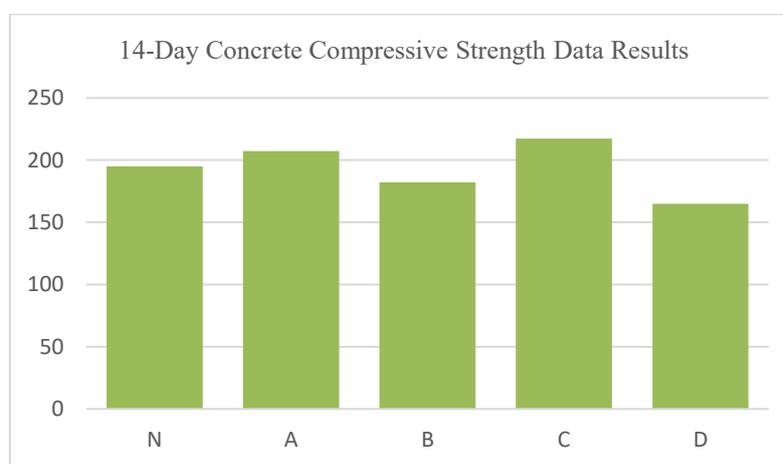


Figure 3. Graph of 14-Day Concrete Compressive Strength Values

Samples with seawater without steel reinforcement (B) showed an increase compared to 7 days, but remained below normal concrete, with an average of 182.27 kg/cm². This reinforces previous findings that the salt content in seawater has a negative effect on the development of concrete strength.

The use of wire mesh again showed a significant positive impact. In sample C (peat water with wire mesh), the compressive strength reached an average of 217.38 kg/cm², making it the highest value at 14 days. In contrast, sample D (seawater with wire mesh) actually showed a decrease when compared to samples without wire mesh, with an average compressive strength of 164.96 kg/cm². This is likely due to the combined negative effects of chloride ions from seawater, which weaken the bond between the cement paste and the wire mesh.

In general, the results at 14 days confirmed the pattern seen at 7 days. Concrete with seawater continued to show the lowest performance, while peat water gave higher results than normal concrete. In addition, wire mesh was shown to increase compressive strength, especially in concrete with peat water, but was not effective when used with seawater.

3.3. 28-Day Concrete Compressive Strength

At 28 days of age, all concrete samples experienced an increase in compressive strength compared to the previous age. Normal concrete (N) reached an average compressive strength of 237.18 kg/cm², which is in line with the standard that concrete at 28 days of age is close to its maximum design strength.

Table 3. 28-Day Concrete Compressive Strength Data Results

Sample	Sample Mass (kg)	Compressive Strength of Concrete (kg/cm ²)	Average Concrete Compressive Strength (kg/cm ²)
N1	7,45	239,29	237,18
N2	7,36	235,21	
N3	7,40	237,02	
A1	7,38	247,10	247,73
A2	7,41	248,30	
A3	7,37	247,80	
B1	7,35	225,40	225,90
B2	7,36	226,30	
B3	7,39	226,00	
C1	7,45	226,15	226,30
C2	7,42	220,71	
C3	7,5	232,04	
D1	7,39	170,40	172,22
D2	7,42	172,22	
D3	7,45	174,03	
D4	7,45	174,03	

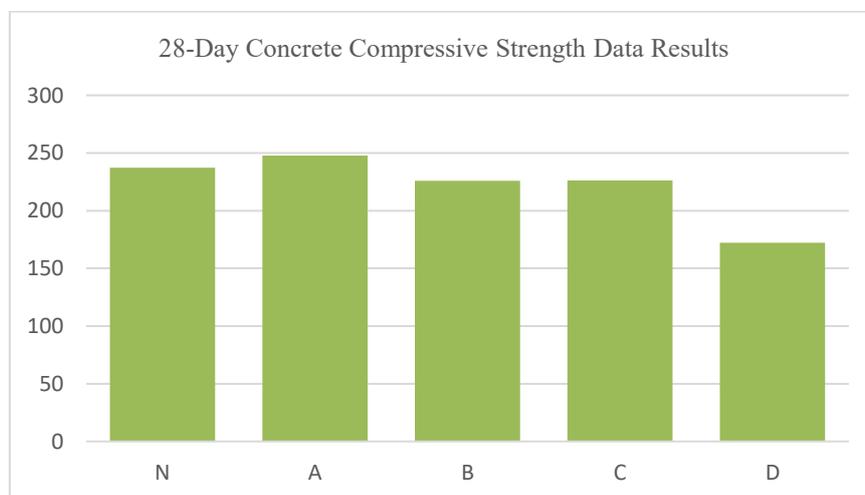


Figure 4. Graph of 28-Day Concrete Compressive Strength Values

The sample with peat water without wire mesh (A) in Table 3 and Figure 4 showed the highest result, namely 247.73 kg/cm², exceeding normal concrete. This reinforces the previous finding that peat water is still capable of supporting the hydration process well and can even produce concrete with higher strength, possibly due to the presence of certain minerals that contribute to hardening.

Meanwhile, samples with seawater without steel reinforcement (B) remained below normal concrete, with an average compressive strength of 225.90 kg/cm². Although this was a significant increase compared to the 14-day age, this value shows that the use of seawater tends to reduce concrete performance, due to the effect of chloride ions which can interfere with the cement bonding process.

Interestingly, the results for samples with steel reinforcement differed from those of the previous age. In concrete with steel reinforcement and peat water (C), the compressive strength was recorded at 226.30

kg/cm², which was lower than that of peat concrete without steel reinforcement. This indicates that at 28 days of age, the contribution of steel wire is no longer dominant, and even tends to reduce strength when compared to concrete without steel wire. A similar condition was also seen in concrete with steel wire and seawater (D), which averaged only 172.22 kg/cm², the lowest among all variations.

From these results, it can be concluded that at 28 days of age, the use of peat water gave the best results, while seawater gave the lowest results. The effect of wire mesh, which initially (at 7 and 14 days) was able to increase compressive strength, at 28 days of age was inconsistent and tended to decrease strength, especially when used in combination with seawater.

3.4. The Effect of Wire Mesh Use and Mixing Water Type on Concrete Compressive Strength

Based on the summary of the research results in Table 4, it can be seen that concrete with peat water produces higher compressive strength than normal concrete and concrete with seawater, both at 7, 14, and 28 days of age. Concrete with seawater consistently produced the lowest results, while the addition of steel reinforcement increased compressive strength at 7 days of age, but its positive effect decreased at 14 and 28 days of age.

Table 4. Compressive Strength of Concrete

Sample	7 Days (kg/cm ²)	14 Days (kg/cm ²)	28 Days (kg/cm ²)
N (normal + normal water)	100,46	195,03	237,18
A (0% wire rope + peat water)	119,50	207,37	247,73
B (0% wire rope + sea water)	92,87	182,27	225,90
C (1% wire rope + peat water)	186,57	217,38	226,30
D (1% wire rope + sea water)	155,90	164,96	172,22

These results are in line with the research by Purwantoro et al., which reported that concrete exposed to seawater experienced a decrease in compressive strength compared to normal concrete, from 29.96 MPa to 28.06 MPa [19]. This condition is also reflected in this study, where concrete samples with seawater showed the lowest values at all testing ages. This proves that the salt and chloride ion content in seawater has a negative effect on the cement hydration process.

Conversely, the use of peat water provides quite good results. Although Ardiansyah's (2023) research found that concrete with peat water has lower compressive strength than concrete with clean water (35.670 MPa vs. 26.632 MPa at 28 days), the quality of the concrete still meets the standards [20]. In this study, concrete mixed with peat water (samples A and C) showed higher results than normal concrete. This difference may be influenced by the chemical characteristics of the peat water at the research site, which allowed the cement hydration process to proceed quite well. This confirms the importance of local testing because the properties of peat water can vary greatly between regions.

The use of steel tie wire as an additional material also has a distinctive effect. At 7 days of age, concrete with steel tie wire (C and D) showed a significant increase in compressive strength compared to concrete without steel tie wire. However, at 14 and 28 days of age, this increase was inconsistent, and in some cases, the value was even lower than that of concrete without steel tie wire. This phenomenon is in line with the research by Hidayat et al (2024) who studied steel scrap as a concrete admixture. He reported that the use of recycled steel can increase compressive strength at 28 days, but the results are highly dependent on the amount and distribution of metal material in the mixture [20]. Thus, the steel mesh in this study may be effective in improving the internal bond of concrete at the beginning of hardening, but its contribution decreases over time, especially if there is corrosive interaction with ions in the mixing water.

By comparing the three studies, it can be concluded that the results of this study are consistent with previous theories and studies: seawater has the potential to reduce concrete quality, peat water can still be used with varying results depending on local conditions, and the use of metal waste such as wire mesh does affect the increase in compressive strength, but its effectiveness is greatly influenced by the age of the concrete and its environmental conditions.

4. CONCLUSION

The use of different types of mixing water has a significant influence on the compressive strength of concrete. The highest 28-day compressive strength was obtained in concrete mixed with peat water without wire addition (247.73 kg/cm²), while the lowest was observed in concrete mixed with seawater with 1% wire addition (172.22 kg/cm²). The addition of steel wire increases compressive strength at an early age (7 days)—with the highest early strength reaching 186.57 kg/cm²—but its effect decreases at 14 and 28 days, indicating that mixing water type plays a more dominant role in long-term concrete performance.

ACKNOWLEDGEMENT

The author would like to thank Politeknik Negeri Ketapang through the Center for Research Development and Community Service for funding support in the Applied Research scheme in 2025 based on Decree Number 494/PL39/AM.06.01/2025.

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