



A field study compares the use of glass with traditional materials in the context of Dubai.

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ABSTRACT

Dubai's climate at 25.16°N and 55.18°E is hot and humid. The city is famous for its modern glass buildings. This paper argues that advanced glass does not worsen the urban heat island effect in Dubai. The methodology involves a high-rise building with a glass façade. Thermal cameras and heat loggers were used to collect data. The data were organized using a mathematical equation and analyzed with a Python program. Results are available at (<https://github.com>).



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1.The Narrative

The narrative discusses how glass towers may worsen the Urban Heat Island effect by transmitting heat waves. It questions whether glass has a similar impact as stone or concrete. The key idea is that traditional materials are not superior to glass; it is their thermal mass that is active.

2.The Aims and Objectives

The research aims to expose the relationship between glass and the Urban Heat Island (UHI), specifically to uncover the realities in the field. The objective is to elucidate whether advanced low-E glass is indeed environmentally friendly or not.

3.Introduction

Urban heat islands (UHI) are influenced by building materials and urban design, with fenestration contributing to thermal gain. Glazing systems offer mitigation strategies and economic benefits. (Levinson et

al. 2021). Cities worldwide face UHI effects due to design, less greenery, and more gray surfaces. (Mills, 2019) . Cooling elements like water bodies and trees are essential for mitigating these effects (Stewart, 2014).

Advanced materials, including glass facades, play a role in mitigating UHI, particularly in hot regions (Napoleon 2020) . These facades can reduce solar heat gain, enhancing energy efficiency and urban ecology (Manni et al., 2022) .Dubai's climate benefits from sea breezes and winds, but urban design also influences its thermal environment. Urban planning helps confine heat and regulate airflow in Dubai. Dubai is designed to utilize the Al Shamal wind (Santamouris, 2020).

Dubai is slightly cooler than the surrounding arid desert by less than 2°C in summer. Successful urban planning in Dubai helped to regulate the sea breeze (Abunnasr et al. 2018).The city of Dubai is known for its oasis surrounded by tall buildings, greenery, and water bodies, with cooler temperatures than the desert.



Figure 1: The narrative of the paper, accompanying image sourced from the internet.

While stationary windows in Dubai's high-rises save 50% energy (White et al., 2023), glass facades pose energy challenges due to reflection and radiation. Coatings like Low-E are used to maintain reflectivity and reduce solar heat absorption. Urban planning policy in Dubai promotes green roofs, shaded walkways, and artificial lakes to combat Urban Heat Islands (UHI) (Ming et al., 2021). Architectural trends in Dubai focus on heat retention (Napoleon et al., 2020). Dubai's UHI is due to reflection and refraction from urban structures, not just glass (Kio & Ali, 2021). Glare from glass surfaces can create hot spots and hinder air circulation. Managing UHI involves advanced materials, urban planning, and

mitigation strategies to address heat, airflow, and building design within the city (Tablada & Kosori, 2022).

3.The Methodology &Tools

The research employs a quantitative, top-down approach using heat loggers, thermal cameras, and laser meters to collect temperature and humidity data across various orientations and times for a real, existing case study within an urban zone in Dubai. The data were processed using mathematical methods to obtain the results.

3.1 The tools were employed :-

The tools include a thermal camera, laser meter, and heat loggers. Fig. 2



Figure 2. shows the tools: thermal cameras, heat loggers, and laser meters.

The equations are the Stefan-Boltzmann, the Heat Transfer Law, and the heat index. Table 1.

Existing buildings in urban areas serve as case studies for UHI monitoring. Fig. 3A,

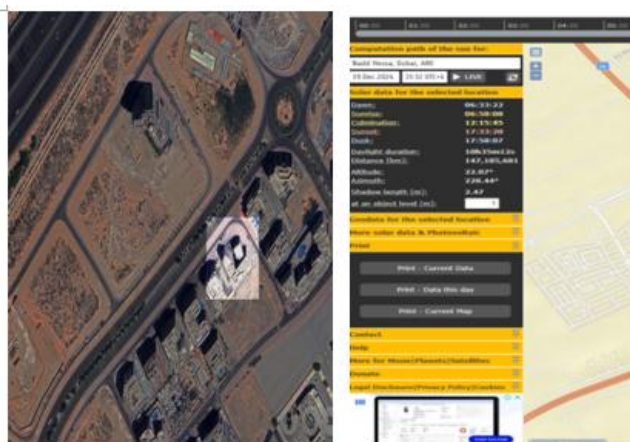
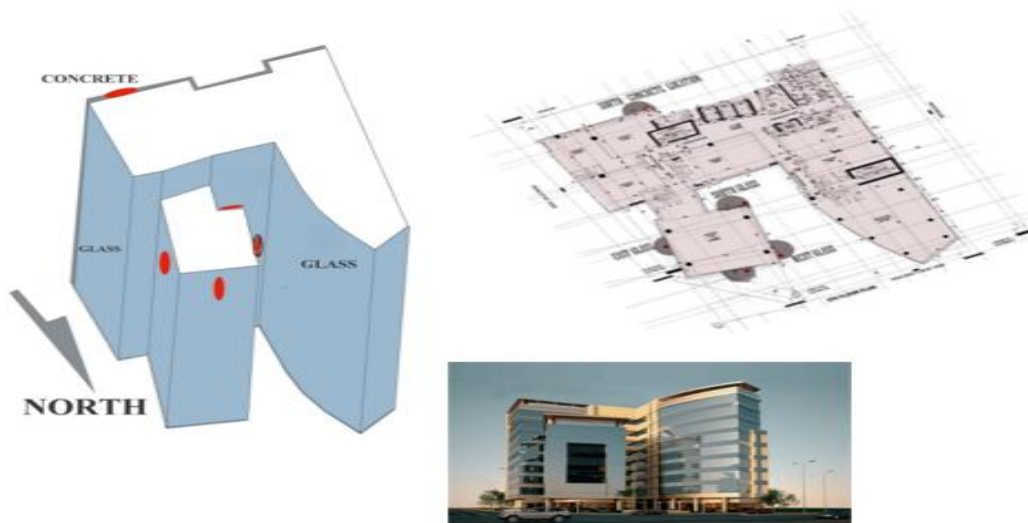
Table 1 methodology equations

1. **Stefan-Boltzmann law (EQ1)** $E = \epsilon * \sigma * T^4$,; E : Radiant energy emitted, σ : Stefan-Boltzmann constant ($5.670374419 \times 10^{-8}$) , T : Surface temperature in Kelvin ($K = C^0 + 273.15$) or just the C^0 as an estimate.
2. **heat transfer (EQ2)** $= Q = U * A * \Delta T$, where: Q : Heat transfer rate (W) ,U : Thermal transmittance or U-value, A : Area of the surface (m^2). ΔT : Temperature difference between the two sides of the surface.

The heat index (HI-EQ3, HI-EQ2, HI-EQ1)

3. The mean value is $(T + RH) / 2$. **HI -EQ1** .
4. $HI = T + (0.33 * RH) - 0.7$. **HI- EQ2** .
5. $HI = C_1 + C_2 * T + C_3 * RH + C_4 * T * RH + C_6 * RH^2 + C_7 * T_2 * RH + C_8 * T * RH^2 + C_9 * T^2 * RH^2$, presents **HI-EQ3** .

The location for this study is in an urban area in Dubai, the Silicon Oasis. Fig.3B



A thermal camera, as an imaging device, detects infrared radiation from the building's facade, using temperature variations to assign colors. The data creates a thermographic image showing heat distribution, which is useful for analyzing thermal leakage in the glass facade and ensuring accurate temperature assessments. Figure 4 shows a thermographic image captured by a simple mobile application as an example. It depicts red as the hottest area and blue as the coldest area.

3.2. The methods

3.2.1 Infrared Thermography Camera (TC).

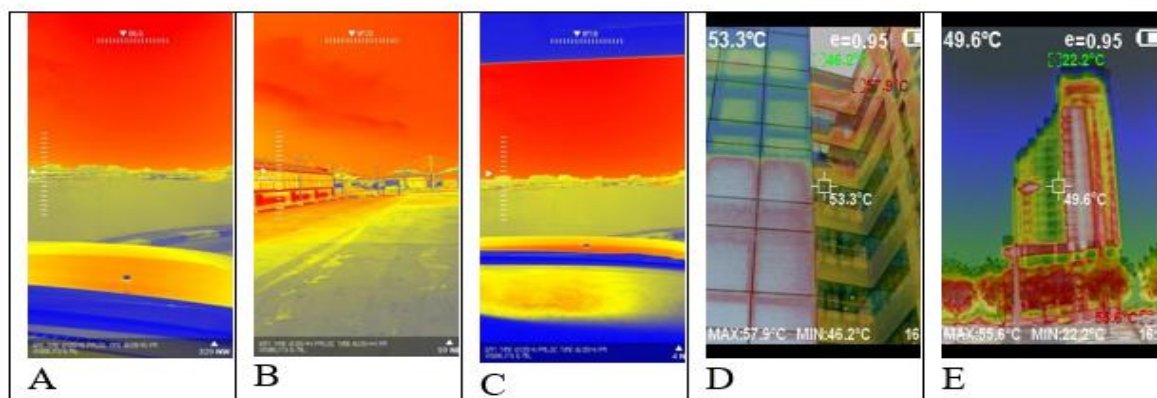


Figure 4 A, B, C, D, and E were excluded due to insufficient clarity.

Figure 4. A, B, C, D, and E were excluded due to insufficient clarity.

The thermal cameras in Fig. 2A were handheld and portable due to restrictions on fixed installations and

drone camera usage. Stabilizing the camera at a designated point for accurate recording was not feasible.

The images underwent processing with specialized software for data extraction. The cameras documented heat reflections and glare, showing interactions of

materials with sunlight. The methodologies used in this paper were aligned with those of preceding researchers, such as (Aksamija, 2013). Thermal imaging was conducted over months, with heat loggers operational all summer, from April to September 2024. The times were set at 10 AM and 4 PM, following previous researchers' concepts in the (U.S. DOE , 2021).

The camera (TC) was labor-intensive and costly, but it yielded results. Figures 5A,B,C show that the surface thermal status was clear, as described in the documents, with data represented as colors and numerical heat in degrees Celsius.

It is evident from Fig. 5A that frigid air escapes through aluminum gaps in the window, as shown by the blue line

enveloping the occupied office space. The yellow ceiling section is insulated but lacks air conditioning, while the glass is in the red area due to heatwave effects.

In Fig. 5 B, the western side at 10 o'clock shows a blue hue with yellowish areas; it is reflecting and refracting heat from nearby regions, with colors representing different heat levels & hues for the thermal flow gradient.

In Figure 5 C, the frame absorbs more heat than the glass, despite the aluminum frame being concealed, as the glass is the initial layer. The image shows that higher levels are cooler due to the sun's elevation and low pollution. The blue color of the office ceiling indicates that it has not been heated enough yet as the workday begins.

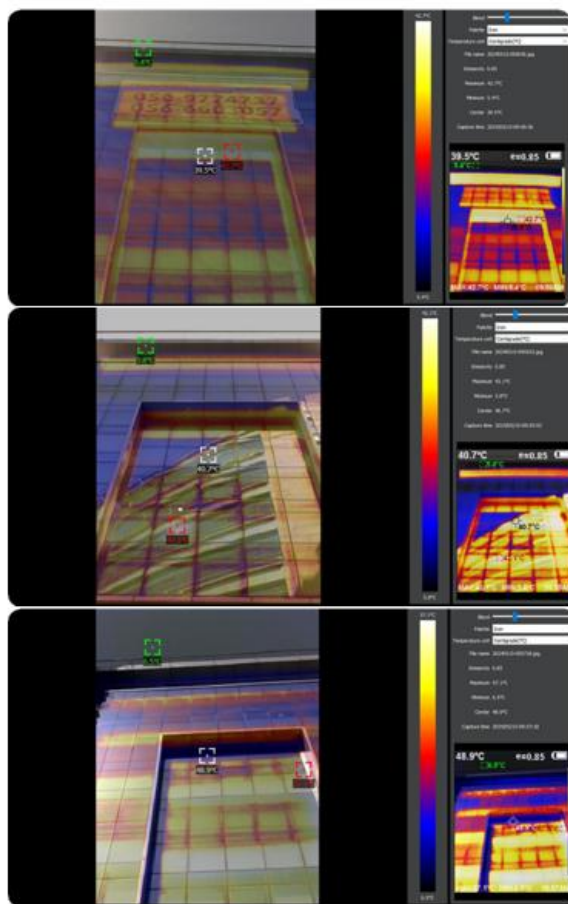


Fig. 5 A, the north direction shows cool air running out of the glass edges.

Fig. 5 B West direction shows infiltration at the glass edges.

Fig. 5 C The east direction.

Figure 5 A, B, C show a sample of images captured and processed by the camera over a span at 10 AM for different orientations on 15th May 2024 at the same time.

It is a straightforward concept: the camera program allows users to select any point within the image and promptly provides the corresponding temperature. The thermal camera is well known for site commissioning in Dubai as building codes. Engineers, as local codes require, are to prepare & submit a comprehensive report on glazing systems and the airtightness of windows and

doors; it is essential to substantiate the evidence for qualified machinery heat discharge at various locations, whether on the roof or at any other elevation. The data was collected during the entire summer period of 2024.

3.2.2. The laser meter (LM)

A temperature laser gun Fig. 2C (LM) measures the surface temperature of objects. The laser meter is used in healthcare and HVAC. The laser meter is helpful for short distances. The laser meter is used as a manual tool

to double-check the material surface with camera readings. Tables 2& 3.

Table 2. shows the tools' data @ 4PM

LASER DATA AT 4PM(LM),					THERMAL CAMERA 4PM (TC)					HEAT LOGGER (HL)					
G=GLASS,CON =CONCRETE															
S.G,LM 4PM	S.G,LM 4PM	S.CON, LM 4P M	W.G,L M 4PM	N.G,L M 4PM	E.G,LM 4PM	S.G,TC 4PM	S.CON, TC 4P M	W.G,T C 4PM	N.G,TC 4PM	E.G,TC 4PM	S.G,HL 4PM	S.CON, HL 4P M	W.G,H L 4PM	N.G,HL 4PM	E.G,HL 4PM
49.1	49.1		52.2	51.8	55.1	45.54	52.6	51.3	55.7	52.4	45	50.2	44	42.1	40.3
45.8	51.2		52.2	51.8	58.1	48.5	45.6	41	48.76	42	41.5	45.2	44	47.2	46.7
42.4	48.9		44.4	50.9	49.1	42	48.1	48	46.7	41.6	43	42.2	43.2	40.4	50.1
41.6	47		45.8	51.7	48.9	42.04	51.2	45.2	51.7	48	45.3	40.7	42.7	48.4	40
40.5	46.5		52.8	48.4	52.8	43.1	52.5	47	50	51.2	43.1	42	40.1	40.4	42.2
44.5	41		52.6	53.8	48.4	44.14	52	53.2	56.1	51.7	45.2	43.3	55.5	52.4	42.8
44.2	45.7		54.4	54.7	49	45.74	52.1	57.1	55.4	50	51.6	43.2	47.8	51.2	43
45	43.9		48.8	55.8	50.2	46.7	55.9	58.1	54.7	50.4	52.7	44.4	45.6	54.8	43.3
48.1	42.5		50.3	54	44.5	45.5	53.9	51.3	56.8	50.2	51.1	42	45.7	53.5	41.6

LASER DATA AT 10AM(LM),					THERMAL CAMERA 10AM (TC)					HEAT LOGGER (HL)				
G=GLASS,CON =CONCRETE														
S-G- LM	S- CON- LM	W-LM-	N-LM-	E-LM	S-G-TC	S-CON- TC	W-G- TC-	N-G- TC	E-G-TC	S-HL- CON	S-G-HL	W-D - HL-	N-D - HL	E-D- HL-
56.8	55.7	46.3	48.3	56.6	42.9	56.4	49.2	51	60.8	50.8	51.6	52.7	46.3	45.6
56.8	55.7	46.3	48.3	56.6	42.9	56.4	49.2	51	60.8	50.8	51.6	52.7	46.3	45.6
45.1	46.1	44	49.7	45.2	38.6	51.9	43.40	44.4	56.6	50	45.4	44.6	40.4	40.6
46.1	46.1	45.2	51.9	46.3	36.9	48.7	41.1	44.9	48.6	49.1	41.6	45.3	42.3	40.3
41.1	51.1	43.3	45.4	52.3	38.2	52.5	42.3	49.6	57	51.4	43.4	41.7	42.5	45.4
40.6	50	43.9	44.7	52.1	38.8	49.4	43.7	47.5	54.8	47.1	43.6	41	41.4	44.7
41.4	56.8	44.3	45.5	55.4	41	59.9	45.4	46.5	61.6	48.7	44	42.3	42.2	46.5
43.3	54.5	46.3	44.2	54.6	41.3	59.7	45.9	46.9	56.8	49.6	43.3	42.3	42.3	46.9
41.5	53.8	43.2	45.7	55.9	41	58.3	45.6	46.7	63.8	49.3	41.2	41.8	41.6	46

Table 3. shows the tools' data @ 10 AM.

3.2.3. Heat Logger (HL)

The Testo 174H recorder measures temperature and humidity, ideal for long-term monitoring. Despite its high cost, it is popular among researchers. Loggers record indoor and outdoor temperature data. They are used on construction sites to activate an alarm at 50°C because of a summer law that prohibits working in health-endangering conditions.

The device collected data hourly for six months to compile a case study. The (HL) were fixed to the glass façade cladding by their PVC base and on concrete surfaces. The loggers were monitored to prevent damage. Figure 3A shows the logger fixed 18m from ground level.

They were positioned on each side of the facade, following previous research.

3.2.4.The Case Study - existing real building specifications

To examine the thermal effects of glass on the exterior, a case study building featuring glass facades in all its primary orientations was chosen in the Silicon Oasis area of Dubai, located at coordinates (@25.1220906,55.3712034) on Google Maps, adjacent to the existing airport. The building served as the focal point for the analysis in Figure 3B.

3.2.5.Time Duration

The research spanned six months from April to September 2024. Summer has high temperatures of up to 50°C and humidity of 90%. Temperature data were collected using HL, TC, and LM at 10 AM and 4 PM. Data are from Tables 2 and 3.

4. The Results

4.1. Applying EQ₁

Data collection from a few days of laser meter (LM) and thermal camera (TC) and heat logger (HL) for the timings of 10AM & 4PM are shown in Table 2 and Table 3.

Applying the law for surface temperature EQ₁, the temperature is converted to Kelvin and then multiplied

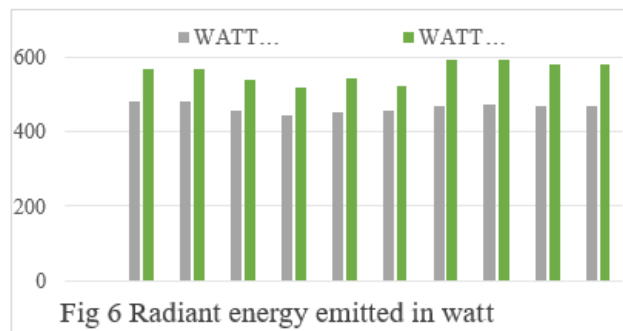
by a constant to get the radiant energy emitted by glass and concrete.

Materials equilibrate temperature with their surroundings or adjacent objects. Therefore, the research compared concrete and glass by assessing temperatures.

While sorting data using the Stefan-Boltzmann Law, the results showed a clear difference between the glass and concrete when compared at the same orientation.

The results in watts were detailed in Tables 4 & Fig. 6 for the application of the first law of the Stefan-Boltzmann Law at 10 AM.

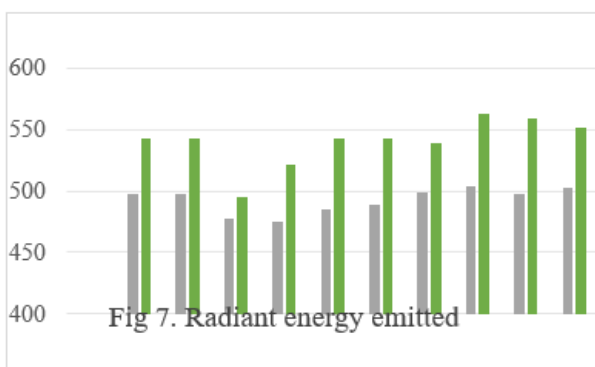
Table 4 TC Results as EQ ₁			
T _{ext} -TC glass south 10AM -°C	Watt	T _{ext} -TC concrete 10AM -°C	Watt
42.90	480.90	56.40	568.48
42.90	480.90	56.40	568.48
38.60	455.26	51.90	538.06
36.90	445.41	48.70	517.18
38.20	452.92	52.50	542.04
38.80	456.43	49.40	521.70
41.00	469.44	59.90	593.02
41.30	471.23	59.70	591.60
41.00	469.44	58.30	581.70
40.80	468.24	58.00	579.60



The research used a few readings for the southern direction to support the theory that glass and concrete surfaces are accountable for heat radiation and refraction.

This process is then replicated for the 4PM time frame for both glass and concrete, as detailed in Table 5, & Fig. 7.

Table 5 TC Results as EQ ₁			
T _{ext} -TC glass south 4PM -°C	Watt	T _{ext} -TC concrete	Watt
45.50	496.9	52.60	542.7
45.50	496.9	52.60	542.7
42.40	477.9	45.10	494.4
42.00	475.4	49.40	521.7
43.50	484.6	52.50	542.0
44.10	488.2	52.50	542.0
45.70	498.2	52.10	539.4
46.60	503.8	55.50	562.3
45.50	496.9	55.00	558.9
46.40	502.6	53.90	551.4



Both timing results and heat reflection show that glass competes with concrete, but with lower performance in southern orientations. Figure Glass with Low-E coating outperforms solid opaque surfaces.

An additional Table 6 and Fig. 8, was constructed for a different orientation, which distinctly illustrates that the

thermal load in watts is approximately the product of 10^8 multiplied by the temperature. All surfaces typically exhibit straight and smooth characteristics, being reflective without clearly delineating their thermal mass capacity.

Table 6. TC data resulting in watts for the EQ1 at 4PM for west, north, and east.

Glass West.	watt	Glass North.	watt	Glass East.	watt
51.30	534.1	55.70	563.7	52.00	538.7
51.30	534.1	55.70	563.7	52.00	538.7
45.00	493.8	46.70	504.4	44.30	489.5
45.20	495.1	51.70	536.7	48.50	515.9
47.30	508.2	53.30	547.4	51.20	533.4
53.20	546.7	56.00	565.7	51.70	536.7
57.10	573.3	55.40	561.6	50.00	525.6
58.10	580.3	54.70	556.8	53.60	549.4
52.30	540.7	58.90	585.9	50.20	526.9
59.50	590.2	58.40	582.4	52.50	542.0

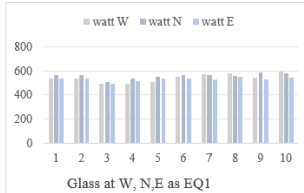


Fig-8 TC results in watts according to EQ1 at 4PM display variations in radiant energy emitted by glass in different orientations.

The reflection of light by materials into a microclimate is so intensive that none of the advantages of concrete are deemed valid; glass registers better or equal results to concrete. The tables illustrate that the glass data collected from all orientations emit an equivalent amount of radiant heat as traditional materials.

However, the table takes into account both the temporal and thermal measurements from TC only because the data from LM and HL, which represent distinct instruments with varying capabilities and degrees of precision. The correlation between surface temperature and air temperature is notably significant. Their classification within the same domain provides ample justification for their comparative analysis. The results were only for a thermal camera and can be duplicated for any other tools.

The data recorded by LM markedly surpasses that of TC, which is considerably lower than that of HL, suggesting

that positioning the camera in a strategic location would yield superior results. The disparities between the readings associated with each instrument are substantial, indicating that the precision of the portable instruments is inherently constrained.

4.2. Applying EQ-2

Research utilized the identical data from Tables 2 & 3 to analyze the heat transfer (EQ₂) by the temperature, with "Text" representing external temperature and "Tint" set at 20°C as the internal temperature reference. In compliance with Dubai HVAC system design, maintaining a comfortable limit of 20°C in August. The temperature difference (delta T) is calculated, then multiplied by the U-value for glass and concrete to show the heat capacity of the material that is released back to the urban surroundings when it reaches the thermal saturation point or equilibrium.

The U-value for low-E glass is recorded at 2.1 W/m²·K according to the DM Code 2021, whereas the U-value for the wall stands at 0.3 W/m²·K. To facilitate the comparison of various orientations, a constant area has been considered. The results presented in Table 7 indicate that the thermal load required to counteract the heat transfer from the exterior to the interior is more favorable with a lower U-value.

Table 7. EQ₂ results for glass as concrete heat mass is higher.

GLASS ΔT.S	glass South watt	CONCRETE ΔT.S	con. South watt	GLASS ΔT.W	glass west watt	GLASS ΔT.N	glass north watt	GLASS ΔT.E	glass east watt
23	481	37	109	29	613	31	651	41	857
23	481	37	109	29	613	31	651	41	857
19	391	32	96	23	491	24	512	37	769
17	355	29	86	21	443	25	523	38	601
18	382	33	98	22	468	30	622	37	777
19	395	30	88	24	498	28	578	35	731
21	441	40	120	25	533	27	557	42	874
21	447	40	119	26	544	27	565	37	773
21	441	39	115	26	538	27	561	48	1008
21	437	38	114	24	498	28	590	45	951

It is possible to compete with concrete by adding an extra layer of glass for better results. Existing double-layered glass exhibits a thermal load four times greater than solid

materials. Orientation exacerbates the predicament, even when aligned north.

However, glass's superiority as a coated material was challenged by heat transfer laws. The benefits are

overshadowed by significant indoor heat transfer. The narrative centers on surface coating and mass capacity.

The heat transfer equation, EQ₂, shows that the U-value surpasses other factors. An equivalent amount of heat is released internally and externally when the capacity is exceeded.

Therefore, traditional materials worsen the urban heat island effect when saturated, while glass overheats all day, reducing indoor comfort even at night. Energy for materials and glass depends on thickness for better insulation.

4.3. Results of Heat Logger (HL) and HI-EQ

The research uses a heat index formula like a weather station. Table 1 presents equations from previous studies. These equations are used by climatologists, meteorologists, and academic institutions (EPA) and (NOAA) as well as health care authorities. Data collected from five heat loggers, affixed to various orientations and surfaces, was input to three heat index equations. The data, consisting of temperature and relative humidity readings for five directions, were processed.

The research used results to create graphs for the initial week of August. Three fundamental formulas were crucial in validating results and reconciling conflicting variables.

The results were calculated using the temperature and humidity with the Boltzmann constant ($5.670374419 \times 10^{-8}$).

Figures 9 A, B, C illustrate the outcomes observed over one day, three days, and seven days, respectively, which is the first week of August 2024. The clarity of the graphs distinctly demonstrates the analogous influence of both substances on the surrounding atmosphere across a substantial range, underscoring their formidable containment challenges.

The X-axis represents time in hours, while the Y-axis corresponds to the HI. This divergence emerges from the asynchronous relationship between temperature and humidity, where one reaches its zenith while the other experiences a decline.

The temperature and humidity measurements appear to be inversely related, exhibiting a butterfly effect. The data clearly show that both variables, temperature and humidity, are in conflict relation, therefore, the use of the HI-EQ₃.

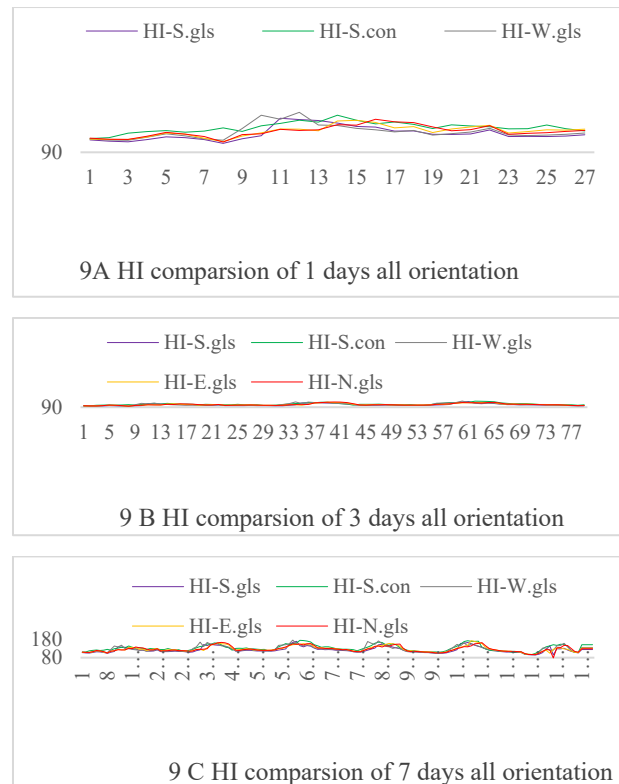
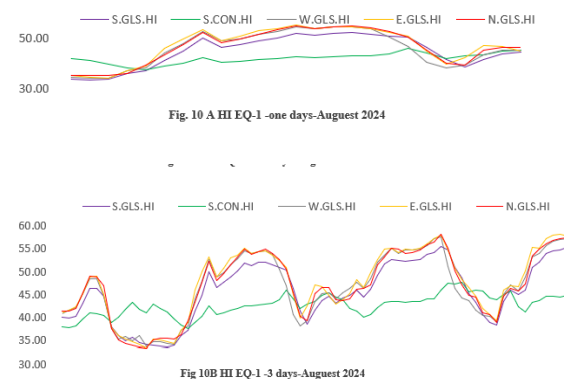


Figure 9. C shows 7 day HI-EQ₃, indicating that concrete and glass are overlapping within the same range. The same pattern is observed in the three-day data and is more clearly shown in the one-day data. The data shows a temperature and humidity conflict, with one high when the other is low, like a butterfly effect.

Comparing HI-EQ₃ to HI-EQ₁, Figures 10 A, B, and C show that mean values can be deceptive due to orientation invariance. Graphs explain that heat and humidity are similar to HI-EQ₁ giving humidity as a key discomfort indicator. Various metrics stress the need for statistical tools and subjective experiences to evaluate outdoor environments and human-climate interactions. HI-EQ₁ is uninformative and misleading, requiring individual feedback for further investigation. The document was set aside and stored for information.



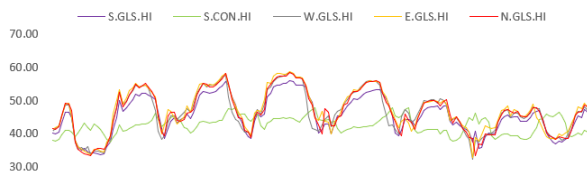


Fig 10C HI EQ-1 -7 days-August 2024

Figure 10. A,B,C relate the heat and humidity as numbers, regardless of their impact upon each other, as if they are both accounts to deal with thus, no accuracy is available; it is neglected totally.

The results of HI-EQ-2 and the accompanying graphs in Figure 11 A,B,C illustrate that all material surfaces undergoing testing fell within a limited range of degrees and exhibited a uniform pattern. The graphs reveal a preeminence of conventional materials over all four varieties of glass, a portrayal that is misleading due to its orientation toward the south.

Figures 11 A, B, and C show the material's response to heat and humidity as a unified construct, with the denser

solid receiving a superior assessment. The material pattern is similar to HI-EQ₁; lacks accuracy for consideration.

The northern aspect is perpetually shrouded in shade, except when influenced by reflection or glare. Distinct materials exhibit varying thermal masses contingent upon their placement, which profoundly impacts their capacity to absorb or dissipate heat in unique ways. The research priority gathered HI-EQ₃ results data, but the Python program took the three equations to ensure a better outcome. The data points were systematically compiled through a Python script designed for comparative evaluation. The theoretical framework posits that the northern direction serves as a constant in alignment with Dubai regulations, while other orientations are viewed as variables. Figure 12.

Using the Heat Index, results indicated that the microclimates in close proximity to glass and concrete displayed subtle variations, each showcasing its unique characteristics.

Table 9 illustrates that the efficacy of low-E glass surpasses that of concrete when positioned to the south.

Orientation	HI Times best nearest		HI Times better than North	
	APRIL until June 19th.	JUNE Until September 30th.	APRIL Until June 19th	JUNE Until September 30th.
South glass.	909	1411	730	1315
South concrete.	489	579	390	575
West glass.	602	250	412	199
East glass.	313	137	256	106

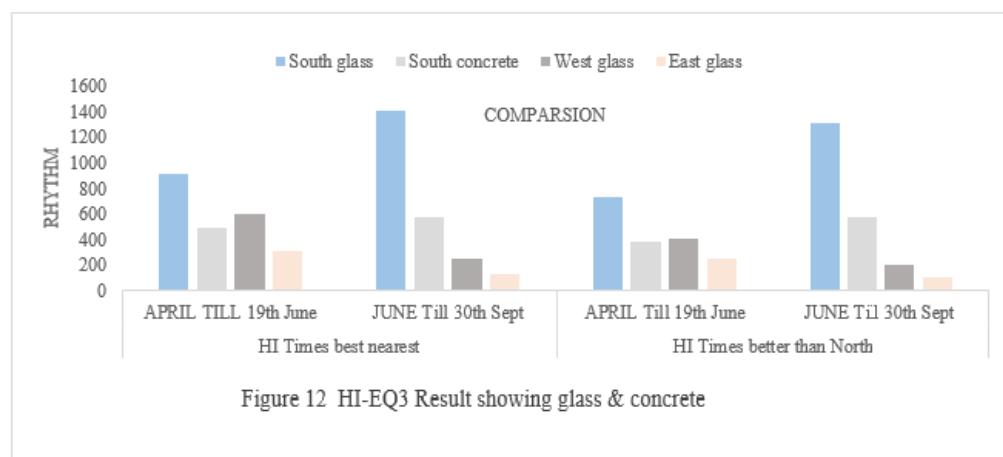
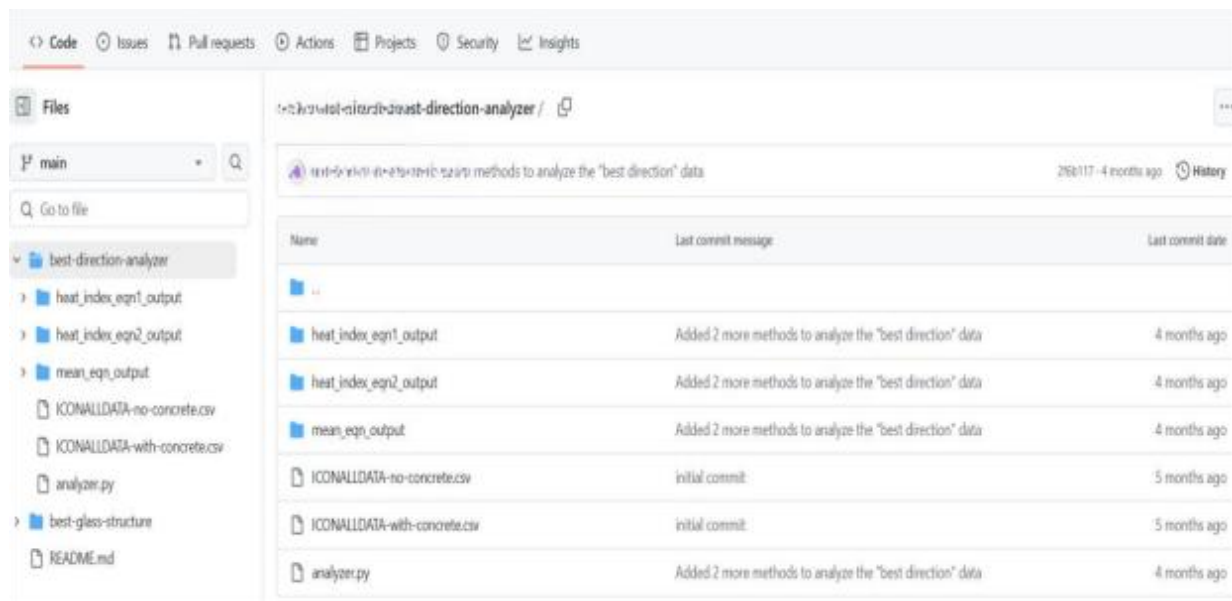


Figure 12 HI-EQ3 Result showing glass & concrete

The program evaluated results and data in GitHub, depicted in Figure 13, and compared them with the optimal northern benchmark.



Name	Last commit message	Last commit date
..		
heat_index_eqn1_output	Added 2 more methods to analyze the "best direction" data	4 months ago
heat_index_eqn2_output	Added 2 more methods to analyze the "best direction" data	4 months ago
mean_eqn_output	Added 2 more methods to analyze the "best direction" data	4 months ago
ICONALLDATA-no-concrete.csv	initial commit	5 months ago
ICONALLDATA-with-concrete.csv	initial commit	5 months ago
analyzer.py	Added 2 more methods to analyze the "best direction" data	4 months ago

The data from Figure 13 is saved as CSV saved in github.com with results

The program aimed to determine how many times a variable, such as the HI result, was either closest to, equal to, or better than the constant HI line in the north. The frequency of repetition was calculated for both glass and concrete, as well as glass per orientation.

The analysis demonstrated that all surfaces mirrored the ambient air temperature in relation to solar intensity and orientation, rather than being dictated by the material characteristics themselves. The heat logger, securely affixed in an insulated base, served as an exemplary instrument for measuring the surrounding environment.

The clear finding is that glass has a better impact than concrete on the urban heat island, as their ambient air heat index shows. Glass, along with concrete, was evaluated based on performance, with glass demonstrating comparable scores to concrete but showing superiority in the southern orientation. The research adhered to fundamental mathematical principles, yielding results analogous to those observed in the northern regions, thereby qualifying it as a superior contributor.

In Figure 12, data presented as columns show one group from April to June and another from June to September.

Data collected from April to June 19th at one location were not continuous due to heat logger replacement. Results show low-E glass outperforms concrete in the southern direction. The timeline highlights instances of tampering with concrete heat loggers.

5. Conclusion & Recommendation

Dubai's urban planning harmonizes skyscrapers with natural wind patterns, zoning along the coast. Shamal winds shape this approach, peaking at 200 meters. Setback regulations create routes for heat to move away, mimicking those in foreign coastal metropolises. Accusations suggest glass edifices may exceed acceptable energy conservation thresholds. Ambiguity surrounds this assertion, especially in light of research on the glass's impact on urban heat islands (UHI).

The evidence shows how anti-glare glass can help with the urban heat island effect. Concrete has a high thermal mass but similar reflectivity to glass. No negative impact seen from glass.

Figure 14. illustrates the collective endeavor to embrace sustainable practices that seamlessly integrate environmental considerations with economic viability, societal welfare, and innovative progress, presenting an effective solution.



Figure 20. illustrates that the collective pursuit of sustainable practices is the solution.

The heat, humidity, and sea breeze in Dubai make daytime temperatures cooler. Glass has no significant impact in this case study. Research found Dubai to be an oasis in the desert, with water, greenery, and buildings providing shade. The experiment showed that intelligent glass differs in thermal properties from concrete or stone, having moderate thermal conductivity. Intelligent glass insulation, like low-E double-layer with an air gap, shows unique behaviors in heat retention, thermal insulation, and conductivity. No evidence was found to remove glass from the city. The city reflects available materials at this time. The correlation between passive glass and the urban heat island phenomenon is complex and open to debate. Further investigation across diverse locales is

needed to incorporate additional influencing factors. The urban heat island phenomenon is shaped by urban planning methodologies and myriad variables; glass is not the principal contributor.

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