Clayworks

CLAY PLASTER AND
RELATIVE HUMIDITY

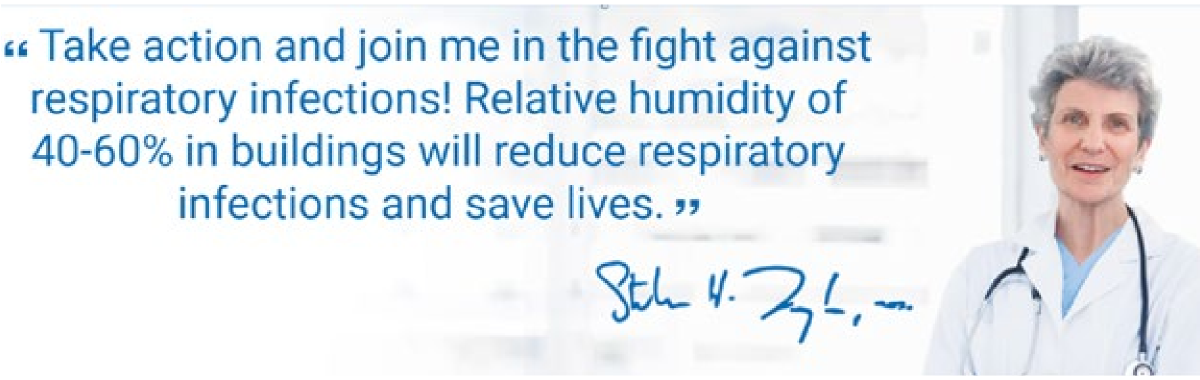
Natural Clay Plasters

2. OVERVIEW

There is now overwhelming scientific evidence that maintaining indoor air humidity of between 40-60%, has **significant benefits [1]** for human health.

> *'Relative humidity beneath 40% increases concentration of noxious chemicals in the air, which exposes people to respiratory infections and skin diseases. In contrast, RH above 60% alter the temperature perceptions in the room and provide conditions for the proliferation of viruses and mould spores.'*
>
> Cascione, Maskell, Shea, Walker, 2018. [2]

'Most importantly, it is the optimal level for our respiratory immune system. **Scientists around the world [3]** are calling on the World Health Organisation to recognise this humidity range as a critical factor for health.'



'There is now overwhelming scientific evidence that a mid-range air humidity has significant benefits for human health. It is very possible for us to be managing the indoor air quality of our public buildings in line with this evidence.

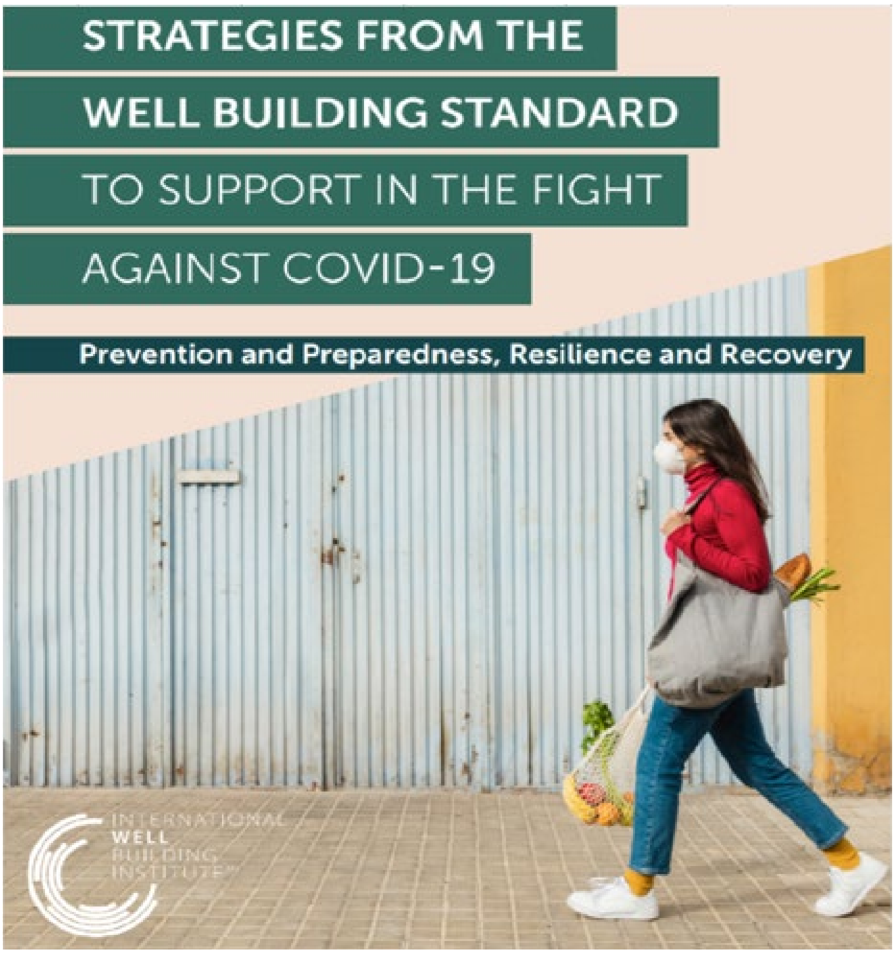
The time has come for regulations on indoor air quality to include a humidity level of 40-60% RH. This is the optimal level for our respiratory immune system, and will reduce the spread of seasonable respiratory illnesses and their burden on society.

I am calling on the World Health Organization to review the scientific evidence on humidity and health, and recommend a minimum lower limit of indoor humidity in public buildings to reduce espiratory infections.'

Dr. Stephanie Taylor
Infection Control Consultant at Harvard Medical School
ASHRAE Distinguished Lecturer & Member of the ASHRAE Epidemic Task Group

3. WELL BEING

The International **WELL Being Institute [4]** recognises indoor moisture management and humidity control as key factors for Covid-19 recovery across the world.



There is also evidence that humidity can play a role in the survival of viruses suchas Covid-19. As such, maintaining relative humidity between 40% and 60% may help to limit the spread and survival of Covid-19. Organisations should weigh the effectiveness and complexity of humidification systems against other air purification strategies.

4. WELL STRATEGIES

- Reduce indoor air quality issues by providing adequate ventilation and filtration
- Manage humidity and control sources of indoor moisture

Moisture Management – WELL Feature W07
Implementing design strategies to limit moisture accumulation and the potential of mould growth from water infiltration and condensation within buildings.

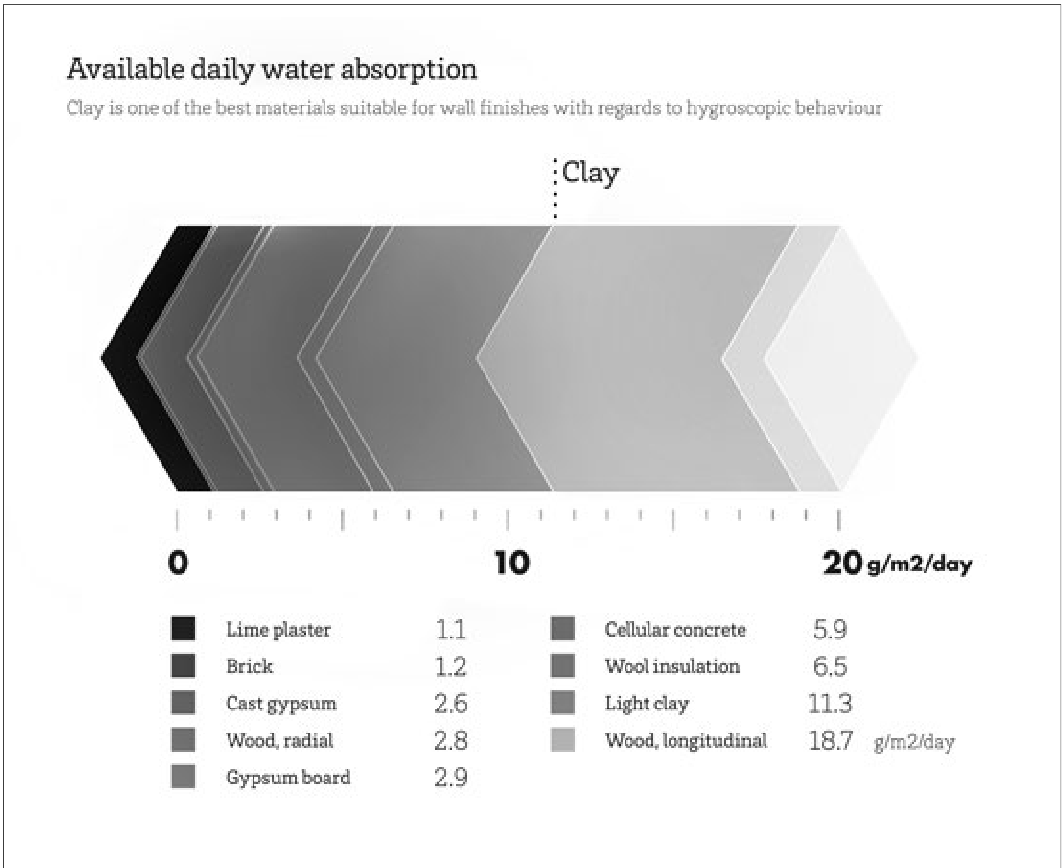
Humidity Control – WELL Feature T07
Limit the growth of patogens and maintain relative humidity levels that are conductive to human health and well-being.

Source: The International Wellbeing Institute 2020. [4]

5. PASSIVE, HEALTHY & SUSTAINABLE

The use of humidifiers provides a solution, but these use substantial amounts of operational energy, significantly contributing to the climate crisis. Such systems demand regular maintenance, good understanding of their operation and performance, can be noisy, expensive and will have a high carbon footprint. An additional, or alternative, more sustainable, and passive solution is to use natural clay plasters for wall and ceiling finishes in buildings.

> *'Clay (and wood) are hygroscopic: that is, they have the ability to passively control the indoor climate, reducing operational energy. Absorbing and de-absorbing moisture from the air is a process known as Moisture Buffering.'*



Clay Plasters, which replace gypsum plaster and paint, are known to maintain indoor RH at around 50- 60% [5], (depending upon several variables including temperature, ventilation, plaster thickness) and provide a low carbon, readily available, long term solution to helping to retrofit poor quality, high density housing – the conditions where we know that Covid-19 is spread. Clay Plasters can contribute to the problem of keeping workers healthy in the workplace and indeed all occupants of buildings that host multiple occupants such as schools, medical facilities and commercial buildings.

> *'Earth plasters largely exceed the absorption capacities of common building materials'.*

McGregor et al, 2016. [6]

6. INDOOR AIR QUALITY AND INDOOR HEALTH

There is growing interest in passive, healthy & sustainable ways of regulating RH and there is a real opportunity to refit existing damp buildings and finish new ones with materials that create the conditions in which viruses are unlikely to survive long.

High levels of indoor humidity can have a major impact in terms of stimulating the growth of bacteria, mould, fungal spores and house dust mite allergens. These stimulate respiratory conditions, particularly asthma, making people particularly susceptible to viral and bacterial disease.

The move towards small tight dwellings in urban environments has had a profound and negative impact on indoor air quality and indoor health. Combined with restrictions on opening windows, and the lack of outdoor space, leading to laundry being dried indoors, these relatively tight, energy efficient, modern dwellings will be subject to progressive and cumulative moisture build ups during winter months, creating the conditions in which viruses survive. *Building Back Better* means building healthier, more sustainable new buildings and retrofitting millions of existing buildings.

To *Building Back Better* we can use more sustainable, healthier materials, to ensure more sustainable, healthier buildings. Clay Plasters are unprocessed blends of readily available natural materials and are considered the lowest carbon interior wall finish available. On average, their use will save approximately 2.4 kg of carbon per meter squared of surface compared to standard gypsum & paint. They are all natural, with no toxins, no synthetics and they are all made in Cornwall. Clay plasters are also compostable.

Clay plasters can also be affordable: unlike mechanical systems they have a long life and once installed are practical.

> *'Small, 'tight' modern dwellings are highly likely to present with exceptionally poor IAQ that will, in turn, have an increasingly negative impact on occupant health. At present IAQ is being prejudiced by the drive to reduce carbon emissions.'*
>
> Howieson, Sharp, Farren, 2014. [7]

The moisture buffering quality of clay plasters has the potential to create interior spaces where viruses find it difficult to survive, to improve IAQ to such an extent that respiratory illness is significantly reduced (reducing vulnerabilities to viral and bacterial sickness), improve indoor thermal comfort without the use of HVAC and filters and their consequent financial & environmental costs. Research [8] shows that it may be possible to reduce heating and cooling energy consumption by up to 30% with the application of hygroscopic materials such as clay.

There is also significant evidence that clay plasters help to remove pollutants that are a hazard to health, such as ozone, formaldehyde and VOCs. (Corsi & Darlin, 2016). [9]

The implications of the benefits of maintaining healthy RH mean that building standards and professional codes will likely be revised to prioritise moisture control as being key to health. Refitting old social housing stock, private homes and the building of new homes and offices could be done with sustainable, healthy clay plasters rather than energy consuming mechanical equipment that has a high carbon footprint due to its manufacturing process and that will be disposed of in landfills at end of life.

In 2019 RIBA published its Sustainable Outcomes report calling for the prioritisation of building refits (rather than new build), carbon analysis of building elements, the ethical & responsible sourcing of all materials and the prioritisation of healthy materials with low embodied carbon.

Clay plasters are one of the only, if not the only, internal surface finish that meets all of the above criterion.

7. RELATIVE HUMIDITY & ASTHMA

The UK has the highest prevalence of asthma symptoms in 13-14 year olds in the world. **(Howieson et al, 2003) [10]**. Around £1 billion a year is spent by the NHS in treating asthma.

There is compelling evidence that underpins the hypothesis that our dwellings are the single most important independent variable driving the current asthma pandemic. Combined with the level of chemicals now prevalent in building and furnishing materials, tight dwellings are likely to have a profound and negative impact on IAQ and respiratory health. (Howieson et al, 2003) **[10]**. Tighter construction techniques are likely to have resulted in a warmer and more humid domestic environment: conditions in which the dust mite species can thrive.

> *'80% of children with asthma are skin prick sensitive to House Dust Mite (HDM) allergens. HDMs thrive in high humidity and their allergens cause asthma... There is now a compelling body of evidence that underpins the hypothesis that our dwellings are the single most important independent variable driving the current asthma pandemic. Maintaining internal RH below 60% will inhibit HDM colonisation and proliferation'.*
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> **Colloff M, Ayrs J, Carwell F et al, 1992. [11]** **Platts-Mills TAE and de Week AL, 1989. [12]**

- **The ideal conditions for mites to proliferate are at a temperature of 25º C and relative humidity of 80%.**
- **Removing excess vapour will reduce the likelihood of creating conditions that support the germination and growth of mould, harmful bacteria, pathogens and allergies.**
- **Improving ventilation is always important for indoor air quality.**

8. RELATIVE HUMIDITY AND THERMAL VARIATION

The moisture content of raw clay plasters also influences its thermal properties. In particular the thermal conductivity and apparent heat capacity tend to increase with the amount of water within the material.
(Allinson and Hall, 2010 [13]. This can affect the energy performance of the building.

The hygroscopicity of raw earth drives the material to achieve equilibrium with the vapour pressure in its environment. The sorption – desorption of water molecules induces latent heat that can significantly impact the thermal behaviour of the material.

> *'Historically, the industrial revolution led to new materials and new building methods and much of the vernacular relation between indoor climate, building materials and architecture was lost. A corresponding mechanised approach to control indoor climate was adopted and existing passive methods were discarded in much of modern architecture.*
>
> *Passive control does not depend on energy input and human supervision; it therefore represents a more resilient and sustainable option in many situations as the energy consumption of ventilation systems and dehumidifiers can be reduced.*
>
> *To obtain passive control of temperature and humidity the nature of building materials is of major performance. Earth building materials are widely perceived to be excellent passive humidity regulating materials'.*
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> **McGregor et al, 2016. [14]**

9. RELATIVE HUMIDITY, CLAY PLASTER & HEMP

In tests by the University of Bath, the introduction of hemp shiv and fibres yielded a moisture buffering capacity 54% greater than that for the reference base coat plaster. Clayworks has long been using Hemp in its Arakabe Range of Plasters.

10. RELATIVE HUMIDITY: MUSEUMS AND ARCHIVING

In library museum or archive storage, where the environment has to be controlled to avoid damage to any stored works, the mechanical control of the climate without buffering material is only as reliable as the operators vigilance. The use of buffering material allows a more resilient system where passive control can reduce fluctuations in RH and reduce energy costs.

Success is dependent upon many other variables such as external environmental factors, size of rooms, occupant behaviour, building fabric.

11. RELATIVE HUMIDITY AND ENERGY USE

Moisture buffering has direct and indirect effects on the energy use in buildings. As a direct effect, in winter, it may reduce heating energy consumption due to the latent heat generated by hygroscopic materials when absorbing moisture from the air.

In summer, hygroscopic materials reduce the use of energy to cool the room as they keep the humidity lower and decrease the room enthalpy.

The results can be improved if good temperature and ventilation control strategies are also applied.

Indeed, it may be possible to reduce heating and cooling energy consumption by up to 5% and 30%, respectively, when applying hygroscopic materials with well-controlled HVAC systems according to studies by **Osanytintola & Simonson, 2006. [15]**

The impact of hygroscopic materials depends on many factors: the amount and type of materials in a given room, the outdoor climate, the outdoor ventilation rate and the moisture production rate, which also depends on the indoor temperature. During warm and humid outdoor conditions, hygroscopic materials may reduce the peak humidity in a bedroom by up to 35%, 30% and 20% RH when the ventilation rate is 0.1, 0.5 and 1 ach, respectively At a ventilation rate of 0.5 ach, these reductions in peak indoor relative humidity result in a 10–20% reduction in the percent dissatisfied with warm respiratory comfort and a 20–30% reduction in the percent dissatisfied with perceived air quality. The hygroscopic materials used in these studies were wood based products and clay would be hypothesised to be a little less. **[15]**

12. CLAY PLASTER THICKNESS AND MOISTURE BUFFERING

Water vapour will only penetrate to a certain depth of the plaster according to studies at Bath University in 2018 **(Maskell, Thomson, Walker, Lemke). [16]**

The scientists determined that there is no apparent additional benefit to moisture buffering beyond a 10mm thickness of the plasters they tested.

13. RELATIVE HUMIDITY AND CHEMICALS OF CONCERN

Relative humidity beneath 40% increases concentration of noxious chemicals in the air, which exposes people to respiratory infections and skin diseases.

14. HOW TO USE THIS INFORMATION

As yet, there is not an agreed interpretation of moisture buffering due to the complexity of moisture exchange between materials and the environment. Ongoing research into quantifying the relationship between material properties and full-scale testing to better understand moisture buffering is underway.

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