Durisol Foundation System Investigation

Drainage Characteristics of the Durisol Foundation Wall System

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SUMMARY

The changes to the Ontario Building Code and proposed additions to the National Building Code, have created a market for alternative foundation systems. The OBC now requires that below grade drainage be added to residential basements in the form of 19mm mineral fiber insulation,100mm minimum free draining backfill or an air gap membrane. Each system is to direct water to the perimeter weeping tiles at the footing. The OBC also requires that thermal resistance equal to R12 be extended to the bottom of the foundation wall. There now exists an opportunity for new foundation systems to be invented that would offer increased thermal insulation and free drainage capability. In this report moisture problems and issues will be discussed, as well as tests have been done to understand how a Durisol wall will function in a basement condition.

The purpose of this investigation is to concentrate specifically on the effects of moisture transfer through the Durisol wall in a foundation wall system. *"Through field observations it has been noted that the Durisol cement and fiber product does not "wick" or transmit moisture in a horizontal direction through a section of the product. In numerous above grade examples it was found that the penetration of wind born moisture would penetrate to approximately 1/4" and then migrate down to the base of the panel."* It is the purpose of this project to investigate, document, and demonstrate the drainage characteristics of a Durisol wall in a foundation wall system.

Durisol is a lightweight building material made of chemically mineralized and neutralized wood shavings, bonded together under pressure with portland cement. It has structural strengths in compression and tension. Its most useful characteristics are; **non combustibility, high fire rating, high thermal rating, acoustical absorption, resistance to common moisture born degradation, free-draining, low capillary suction and is vermin, insect and termite proof.** The product qualifies as being environmentally friendly.

The following aspects of Durisol's drainage characteristics were studied:

- drainage flow
- drainage rate and capillary retention
- capillary suction
- moisture and silt penetration of wall
- moisture penetration within web
- drainage layer in Durisol layer

Once these aspects are understood, further applications and innovations may be considered.

INTRODUCTION

The ingress of moisture is the most common problem to control in basements. Moisture can cause problems from a small leak to a large flood in the basement. Heat loss increases as heat is carried away by the high moisture content surrounding the basement. Other problems are freezing and thawing action on materials, decay of materials, and high relative humidity in the summer. It is necessary to control moisture in and around the basement wall. Types of moisture problems and solutions are summarized in this table.

Type of Moisture Transport	Associated Problems	Theoretical Solutions	Problems Encountered in Practice
Bulk water -hydrostatic pressure	-leakage through inevitable cracks -efflorescence -decay of wood based materials -corrosion of steel -increased heat losses -dampness	-good grading -top layer of "impermeable soil" -free draining backfill -perimeter drain at footing level -parging plus impermeable membrane -draining, insulating board	-less than perfect land grading (ponding) -cracks in walls -inadequate draining layer (small draining capacity) -perimeter drain improperly installed or clogged up -storm sewers not able to accept water from the perimeter drain
Capillary water	-spalling of masonry and crumbling of mortar -efflorescence on walls -rotting of timber floors, joists and other wood products -corrosion of steel -increased heat losses -dampness	-capillary breaking backfill -damp proof coarse (low permeability-capillary breaking, e.g. asphalt coatings) -capillary breaking insulating board	-drainage layer not fully capillary breaking due to presence of fine soil -damp proof coarse not effective -poor materials, improperly installed, or damaged during construction -cracks in walls
Water vapour -diffusion	-spalling of masonry and crumbling of mortar -efflorescence on walls -rotting of timber floors, joists and other wood based products -corrosion of steel -increased heat losses -dampness NOTE: same problems as capillary water except rate is lower	-diffusion resistant membranes(vapour barriers) -external insulation (improves vapour movement towards soil)	-vapour resistant membranes not effective (poor installation, or damaged) - porous walls
Water of construction	Same as capillary water except once water of construction is lost problems are over	-wall to dry out before placing of moisture barriers -good seasoning of timber -reduced quantity of mixing water in concrete	-structure not dry enough when barriers are placed, locking in moisture of construction -high concrete slump obtained by excessive -quantities of mix water
Water from inside the basement -deliberate humidification -window opened in hot humid summer			

-water evaporated through basement floor	-condensation on walls, floors and in concealed spaces	-provide effective vapour barriers
-metabolic moisture	-dampness	-attempt to control inside vapour pressure(adequate ventilation, control amount of water entering inside)
-laundry	-decay of wood based products	
-showers		
-cooking		

Lennard M. Tenende,*"Drainage Characteristics of Mineral Fibre Insulationn,"* Department of Civil Engineering University of Toronto, 1982

MOISTURE MIGRATION THROUGH BASEMENT WALLS

There are three ways water migrates through walls:

1.)hydrostatic pressure
2.)capillary action
3.)vapour pressure

"Effects of bulk water, such as leakage, are dramatic but usually relatively easy to control. On the other hand the effects of capillary water and vapour are more subtle. They are difficult to control and therefore require much more care in selection of materials, detailing and construction. Water vapour is especially troublesome in that it can come from both the soil outside as well as the inside environment."

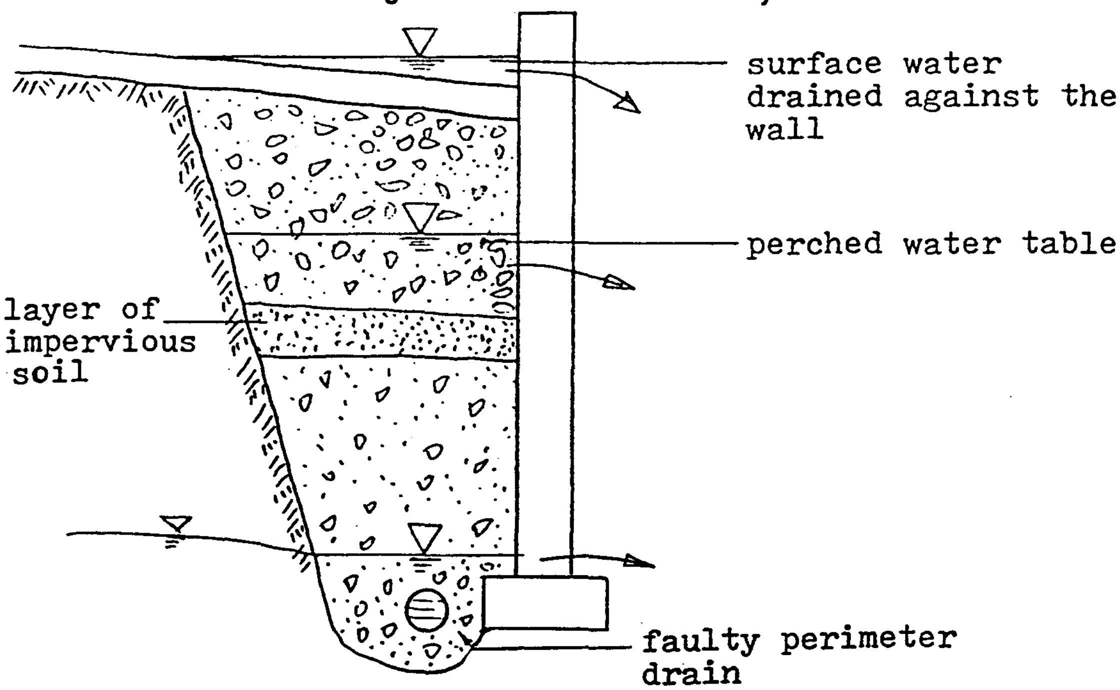
Journal of Performance of Constructed Facilities, Vol. 8, No. 1, Feb. 1994, Robert W. Day

Hydrostatic Pressure

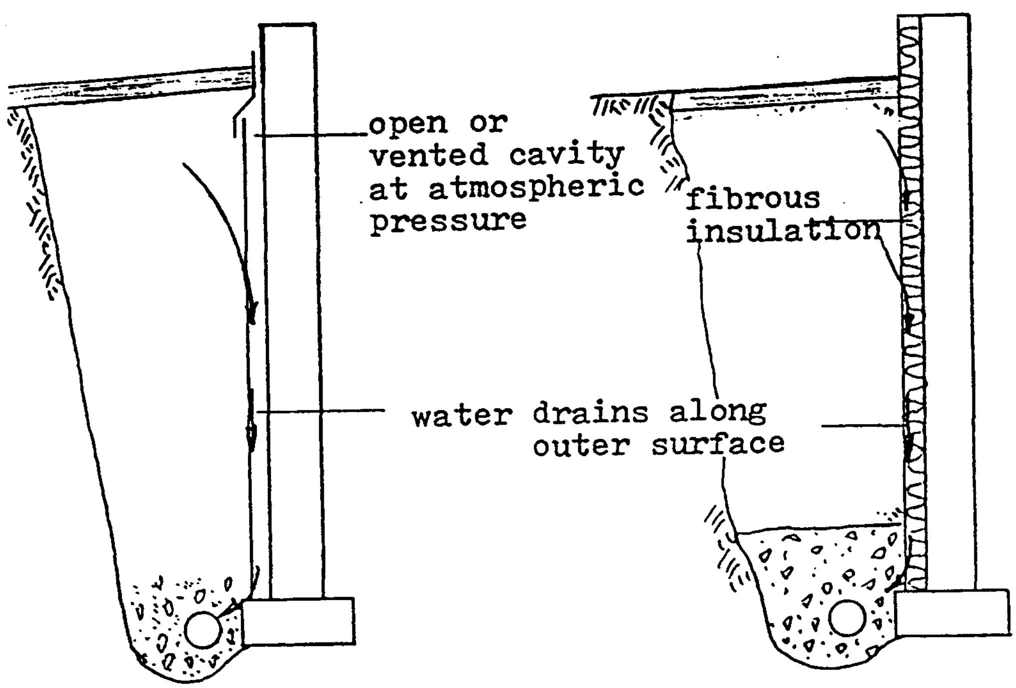
Hydrostatic pressure is a result of the force of gravity. A buildup of water against the basement wall will cause a pressure against the wall. Any cracks within the wall will allow water in due to the pressure present. Free draining backfill has been used traditionally with a layer of gravel around the perimeter to act as a better drain. Sometimes this free draining material is mixed with fine soil which lowers the backfill's draining capacity.. A faulty perimeter drain will also create draining problems. These factors can create a perched water table resulting in bulk water pressure against the basement wall.

New methods have been suggested to help prevent hydrostatic pressure. A layer around the wall is to be installed to maintain an atmospheric pressure on the wall. A vented space or a draining layer between the wall and the soil, are two options. This space will provide a path for free water to migrate down to a perimeter drain without contact to the basement wall.

Traditional Methods For Solving Moisture Problems Due To Hydrostatic Pressure



New Methods For Solving Moisture Problems Due To Hydrostatic Pressure



Lennard M. Tenende, *"Drainage Characteristics of Mineral Fibre Insulationn,"* Department of Civil Engineering University of Toronto, 1982

Capillary Water

Water can be drawn above the water table by capillarity. Capillary water is under negative pressure with respect to atmospheric pressure and is therefore in tension. This surface tension can draw water into hydrophilic materials. Capillary head is the height of the water column. The size of the spaces between the particles in a material is a factor in its capillarity.

Capillary characteristics of the soil placed against the basement wall will determine the amount of capillary water drawn to it. Coarse gravel or sandy gravel performs well as a capillary breaking layer because it has a very low capillary suction. Often we find that gravel will contain large amounts of fine sand and silt. This prevents the gravel from being a good capillary breaking layer.

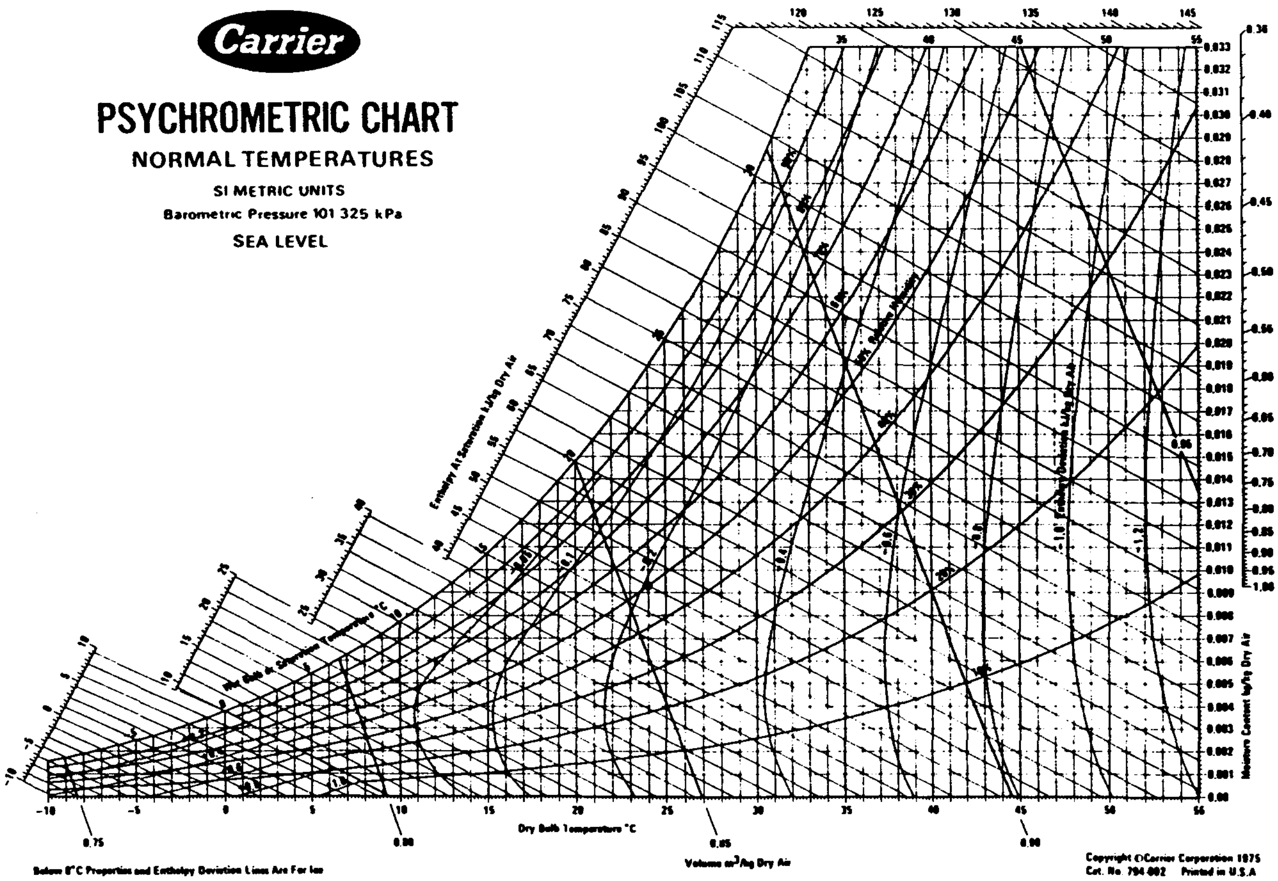
Material	Particle Size	Capillary Head
concrete		10 km
coarse gravel	0.82mm	54 mm
fine gravel	0.30	194
sandy gravel	0.20	284
silty gravel	0.06	1060
coarse sand	0.11	820
medium sand	0.02	2396
fine sand	0.03	1655
silt	0.006	3592

T.W. Lambe and R.V. Whitman

The pores in the typical basement wall are finer than the ones in the soil. Once bulk water or capillary water in the soil gains contact with the wall it will draw the water into itself and become saturated. A concrete wall can draw water to a height of 10km. The materials used must be allowed to evaporate. If drying is prevented by sealing the wall surfaces, i.e. damp proofing, capillary water can rise to the top of the wall. The materials that may come in contact with this moisture will rot and decay.

Vapour Diffusion

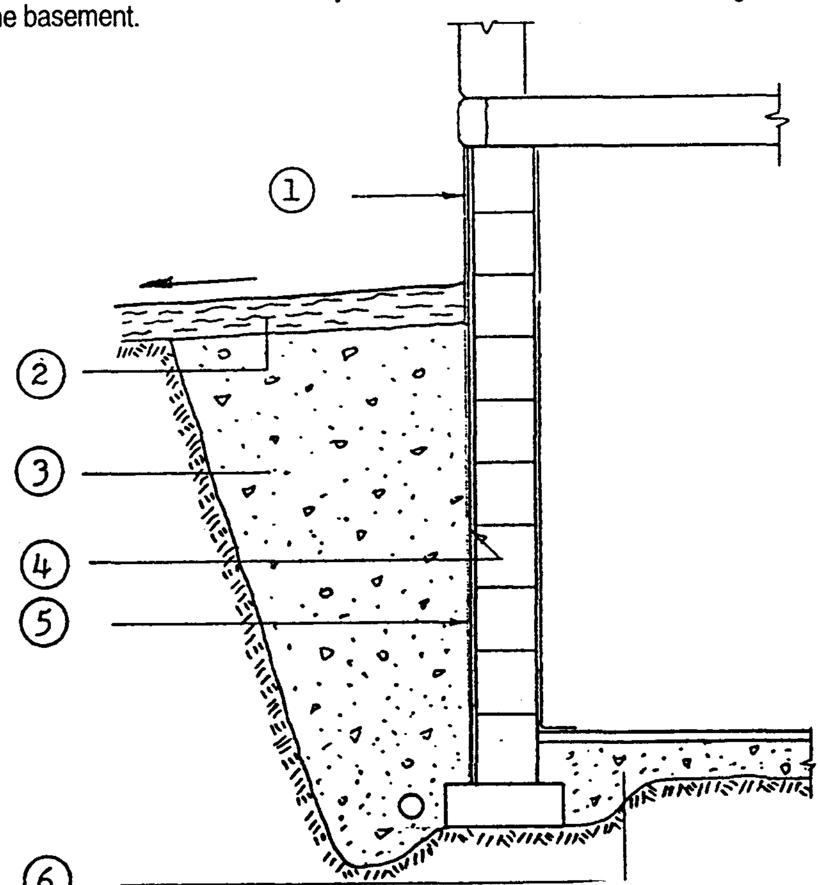
Vapour diffusion takes place due to a change in vapour pressure. Vapour transport takes place in the direction of low vapour pressure. The psychometric chart shows the interaction between temperature, moisture content and the relative humidity of the air. The curved lines represent constant relative humidity.



A basement wall that has been fully protected against bulk and capillary water can still absorb water from the soil or the interior through vapour diffusion. Due to a temperature gradient within a basement wall condensation will occur. The location of insulation will control the area of condensation within the wall. Insulation placed on the exterior will allow the water in the wall to dry out toward the soil. There is no danger of decay towards the inside of the wall. The wall will be warmer and there is no freezing damage to the masonry or concrete.

CONTROL OF MOISTURE TRANSPORT

Traditional methods of controlling moisture problems are very vulnerable. They depend on the critical links and if one of the links fails the whole system fails. New methods are being used to manage moisture in the basement.



Control of moisture in the traditional basement wall.
1. rendering 2. top soil 3. free draining backfill
4. parging 5. damp-proof membrane
6. gravel or crushed stone

Lennard M. Tenende, *"Drainage Characteristcs of Mineral Fibre Insulation,"* Department of Civil Engineering University of Toronto, 1982

The perfectly functioning basement wall has no hydrostatic pressure against the wall, no capillary suction into the wall, and no vapour diffusion in the wall. This barrier system allows no flaws in construction or material. We must take steps to control or modify the environment of the basement condition. New materials must be looked at that can begin to offer these conditions that are required from a basement wall, that will relieve the forces that are acting on the basement wall. Materials that work solely or in combination to be insulating, draining, capillary-breaking and self-filtering.

Durisol is a material that has many properties that could be exploited to the benefit of basement wall construction. Through further research and testing we will be able to tell whether this new material can create a new environment in the management of moisture in the basement wall system.

DURISOL MATERIAL

Durisol is a lightweight building material made of chemically mineralized and neutralized wood shavings, bonded together under pressure with portland cement. It is an open-textured product, highly durable, rated practically incombustible, vermin proof, and does not rot or decay. The wall forms are manufactured entirely of Durisol. They are available in a number of shapes and sizes. Different wall thicknesses are offered to accommodate differing load carrying requirements. Shapes, such as corner forms and square end forms expedite and simplifiy construction. The fill concrete and reinforcement must meet all construction and design requirements as recommended within the Building Code Requirements for Reinforced Concrete.

DURISOL MATERIAL PROPERTIES

The characteristics that make Durisol a practical material to be used in a basement wall system as follows :

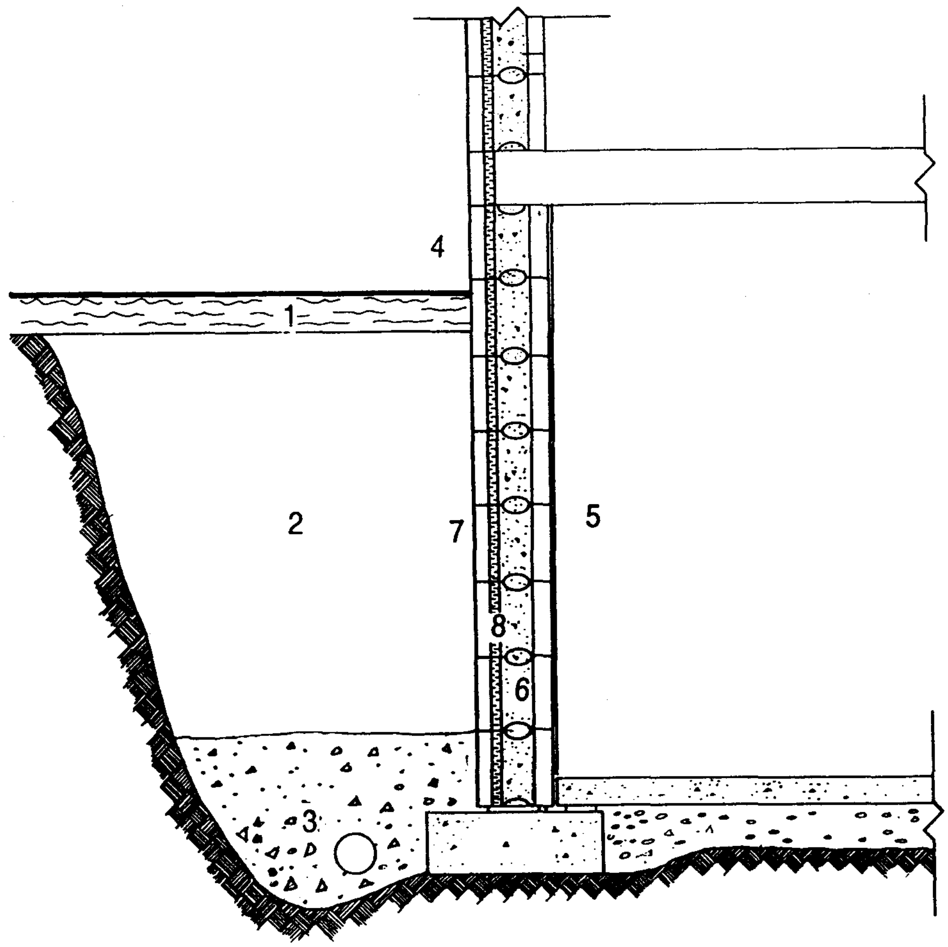
density	30-35 lbs./cu.ft.
strength	
compressive	200-500 psi
tensile	100-140 psi
shear	330-500 psi
modulus of elasticity	50 000 psi
thermal concuctivity (K)	0.571 Btu in/sq.ft.h. 'F
coefficient of thermal expansion	0.000008 in./in./'F
surface burning characteristics	
flame spread	5
smoke developed	0
fuel contributed	0-5
water vapour permeability	no resistance
water absorbtion	18%by weight @95%R.H.
capillary	slight
toxicity	none
degradation due to:	
temperature	none below 500'F
freeze/thaw	negligible if drained
moisture	none
fungal/bacterial	does not support growth
termites/insects	none
rodents	none
age	none
weathering	negligible loss of surface material
sound absorbtion (NRC)	0.75

Durisol, "*Technical Notes - Durisol Wall Form System Design Data and Recommended Practices,*" Durisol Materials Limited

These conditions do suffice to lead into an investigation of Durisol functioning within the below grade condition of the basement.

DURISOL MATERIAL WALL

Durisol material has many characteristis that allow it to function within a basement wall condition.



1. top soil 2. back fill 3. gravel or crushed stone
4. Durisol Form Wall 5. interior surface
6. concrete core 7. Durisol surface
8. insulated foam inserts

Advantage of the Durisol system is the wall acts as a complete system with insulation found within the wall and the free draining characteristic of the Durisol surface. This report further tests this possiblity for this new material within the basement condition. The investigation looks at the drainage flow, free drainage, capillary suction, moisture penetration and the thickness of Durisol involved in the drainage process.

The invetigation of the unique properties of Durisol make it a very interesting possibility for the basement wall condition.

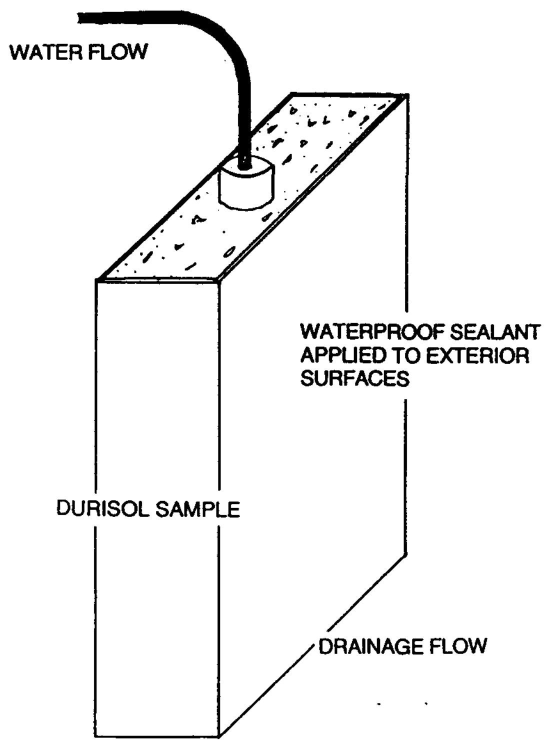
EXPERIMENTS

Drainage Flow in Durisol Material

The purpose of this test was to evaluate how large the drainage capacity of Durisol is and how water entering at a point is able to flow. If the discharge capacity of the board is small hydrostatic pressure may develope against the wall. If drainage occurs uniformaly in the whole plane through which water has been introduced there may be a substantial reduction in its insulating capacity. The test is important to establish the suitability of Durisol as a draining-insulating layer.

PROCEDURE

A Durisol wall section 90X200X3450mm was suspended vertically. Water was introduced into the specimen thrugh a 40mm diameter tube inserted into the top of the specimen. Water was supplied at an increasing rate to determine the drainage capacity.



Water began to drain from the bottom of the panel. As the rate of water flow into the panel was increased to 1760ml/minute before overflow occurred and the specimen was not able to direct water into the section at the point of insertion.

Free Drainage and Capillary Retention

On occasion the draining layer in the basement will be required to drain large amounts of water as a result of a short rainstorm or a surge of water from other sources. Durisol is tested for its ability to handle the amount of run-off involved in such a situation. There are two parameters looked for in this test. First was to establish the rate at which a saturated specimen will drain all of its free water into air under the influence of gravity only. The second was to establish the amount of capillary retained water. The rate of drainage will establish the suitability of Durisol to quickly conduct water when it has become saturated by a surge of run-off flowing to it. If water is not conducted quickly to the footing drain tile damage may occur to the basement, also the insulation quality may be reduced.

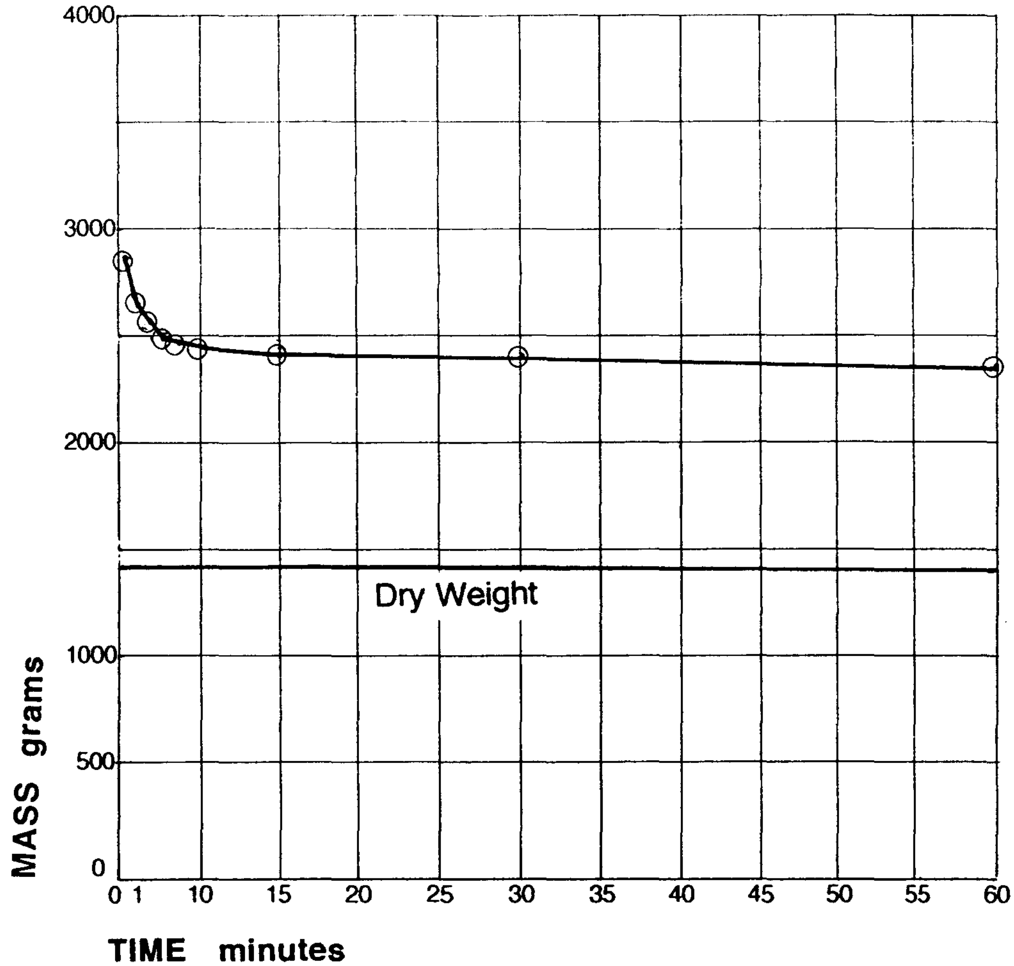
PROCEDURE
A sample measuring 300x300x35mm was weighed dry and then soaked in water until fully saturated. It was then allowed to drain freely in air and weighed at different time intervals while water was draining from it.. The amount of weight retained in the specimen was determined by the difference of the weight of the sample at the end of the drainage test and its initial dry weight.

OBSERVATIONS

dry weight 1477.61 g

soaked in basin

time (minutes)	wet mass (grams)	moisture absorbed (grams)
0.5	2699.12	1221.51
1	2599.33	1121.72
2	2517.69	1040.08
3	2472.32	994.71
4	2454.18	976.57
5	2440.58	922.97
10	2422.43	944.82
15	2413.36	935.75
30	2399.75	922.14
60	2395.21	917.60



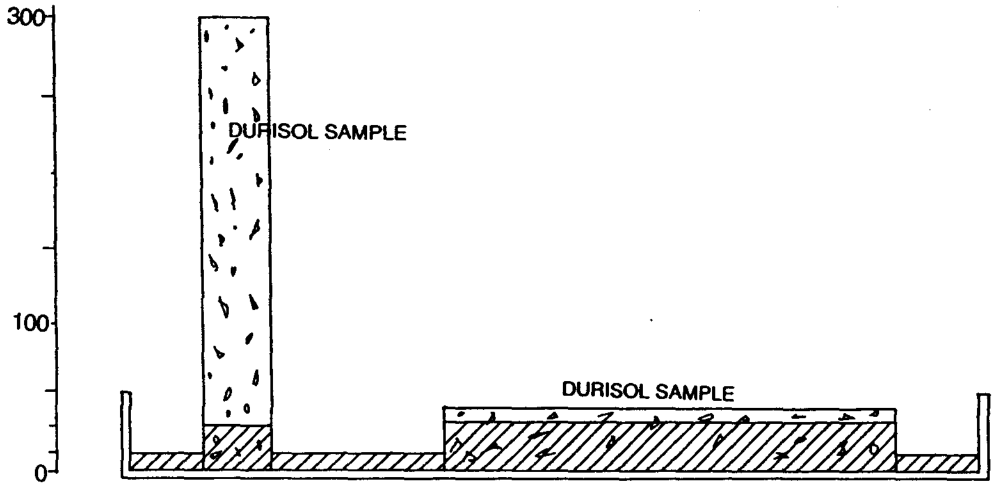
The results showed that most of the free water was drained within the first ten minutes. The capillary water retained after one hour was 38 % moisture content. The 300mmX300mmX35mm sample drained 99.8g of water in the first 30 seconds, and 181.43g in the first minute. After one hour 38% moisture content remained in the sample.

A 15 minute storm as proposed by the Ontario Building Code, would cause a discharge of about 80ml/sec/meter. Durisol can drain 11.09g/sec/meter of a 35mm thick durisol wall. The drainage capability of a material may be high, yet it is dependent on the perimeter drain to conduct the water away. Further test need to be performed to see how much of the insulating capacity is lost in comparison to the amount of moisture retained through capillary suction in comparison to the drainage capacity of the material.

Capillary Suction

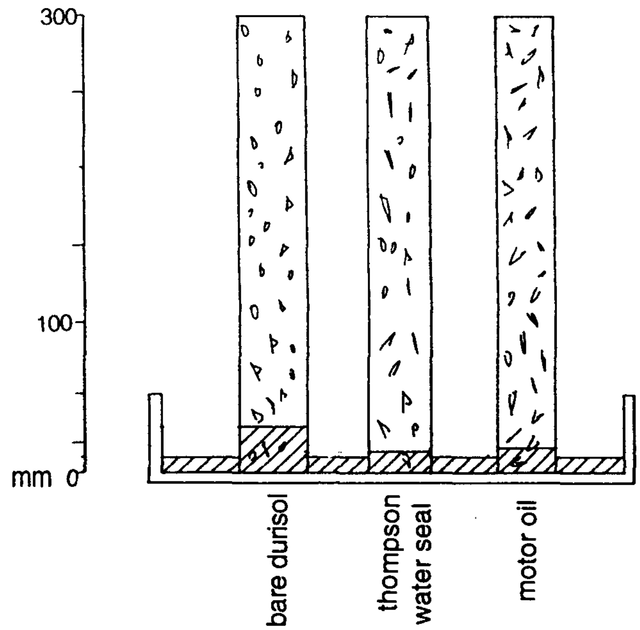
This experiment was conducted to test the capillary suction of Durisol. One face of the Durisol will always be in contact with wet soil. Horizontal and vertical capillary suction will occur in the Durisol wall with its relation to the horizontal and vertical in the case of a rainstorm or raised water table. The ability of a material to absorb moisture will change very little by its orientation due to the random orientation of the fibres in the Durisol block. The force of gravity is negligible in relation to capillary suction. Surface evaporation must be considered.

PROCEDURE
Two pieces of Durisol 300mmX35mmX35mm were placed horizontally and vertically in a basin with 10mm of water. They were left for 48 hours to allow capillary suction to occur. The capillary profile was observed. The vertical piece has a capillary rise of 30mm and the horizontal piece has a capillary rise of 35mm.



Three differently treated specimens 300X35X35mm were placed vertically in a basin containing 10mm of water. The water level did not drop significantly as the samples absorbed water. The specimens were left in the water for 72 hours to allow capillary suction to occur. The specimens were weighed before and after the experiment and the capillary profile was observed.

The untreated specimen has a capillary rise of 27.0mm, the Thompson'S Water Seal treated specimen had a capillary rise of 13.0mm, and the motor oil specimen had a capillary rise of 15.5mm.

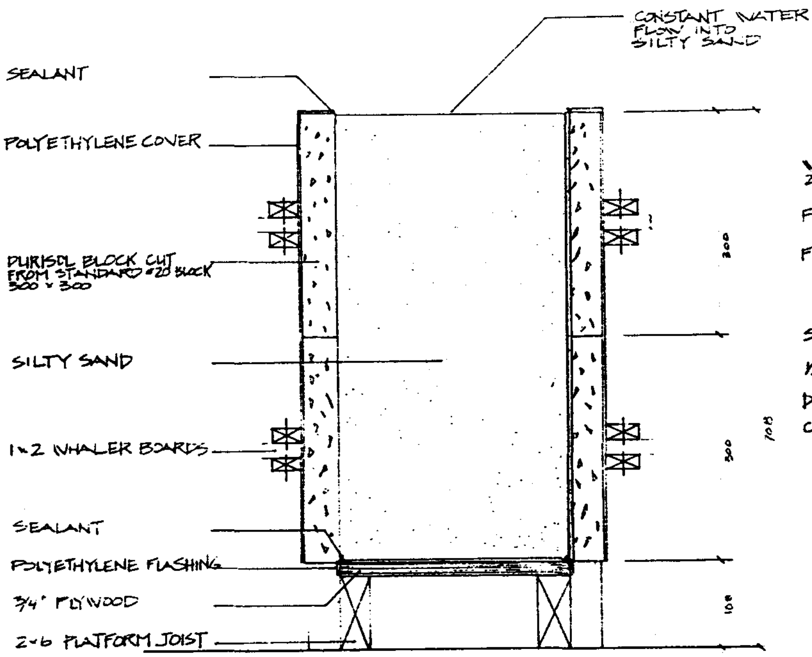


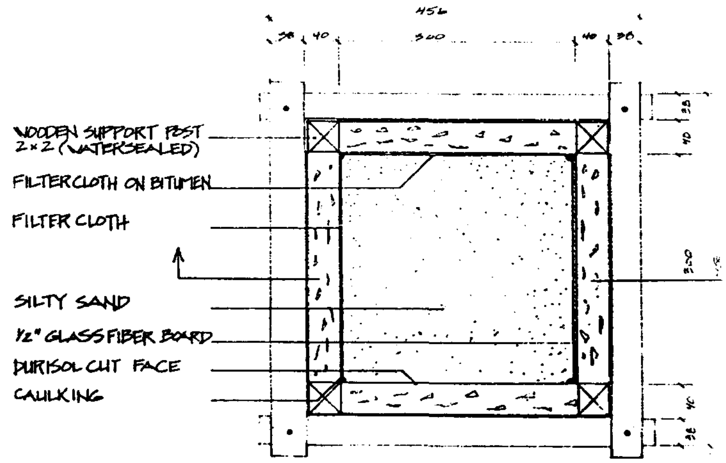
SPECIMEN	TREATMENT	DRY MASS	WET MASS	CAPILLARY MOISTURE
1- coated	bare	370.92 g	423.76 g	52.84 g
	bare	283.07	343.48	60.41
2-coated	motor oil	449.31	465.68	16.37
	motor oil	326.78	358.63	31.85
3-coated	thompson water seal	426.65	437.03	10.38
	thompson water seal	350.43	373.07	22.64

Using the results regarding the sealed specimens, the Thompson's Water Seal provided the best water repellant treatment to the Durisol specimens, although capillary rise is very low in Durisol.

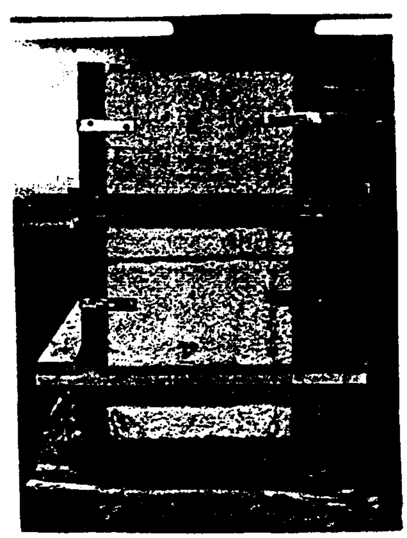
Moisture Penetration

Durisol has been proven to drain water and to have a very small capillary suction. The purpose of this experiment was to test Durisol in a simulated foundation situation with saturated soil. This was to test how Durisol behaves under different surface treatments and under moist soil conditions and its application in a basement wall system. 300mm X 300mm X 35mm block specimens of Durisol were taken from the same stock pile and run through tests with different surface treatments.





Each block was treated with a rubber like, seamless waterproof membrane, vapour barrier / radon migration sealant made of a synthetic rubber / acrylic / urethane formula to prevent moisture evaporation towards the exterior of the box, and weighed before and after the experiment's duration. A wooden frame was constructed to hold each panel and to run each test simultaneously. Given four different interior surfaces within the frame, four different interior surface treatments were used. Water was introduced at a constant flow into the top of the box. The experiment was left to run for five days, as to allow silt to penetrate into the surfaces. Drainage was observed and collected at the bottom of each test panel.



OBSERVATIONS

BLOCK	SURFACE TREATMENT	DRY MASS	WET MASS	MOISTURE ABSORBED	MOISTURE PERCENTAGE
1	drain clad	1940.53 g	2020.89 g	80.36 g	4.00 %
2	drain clad	1970.75	2302.28	331.53	14.41
3	geo-textile on bitument	2206.85	2219.97	130.58	0.60
4	geo-textile on bitument	2044.57	2134.44	89.87	4.21
5	geo-textile	1964.40	2153.68	189.28	8.97
6	geo-textile	1994.30	2512.31	518.01	20.62
7	bare	2491.01	3118.45	627.44	20.12
8	bare	2496.82	3152.47	1655.65	20.80

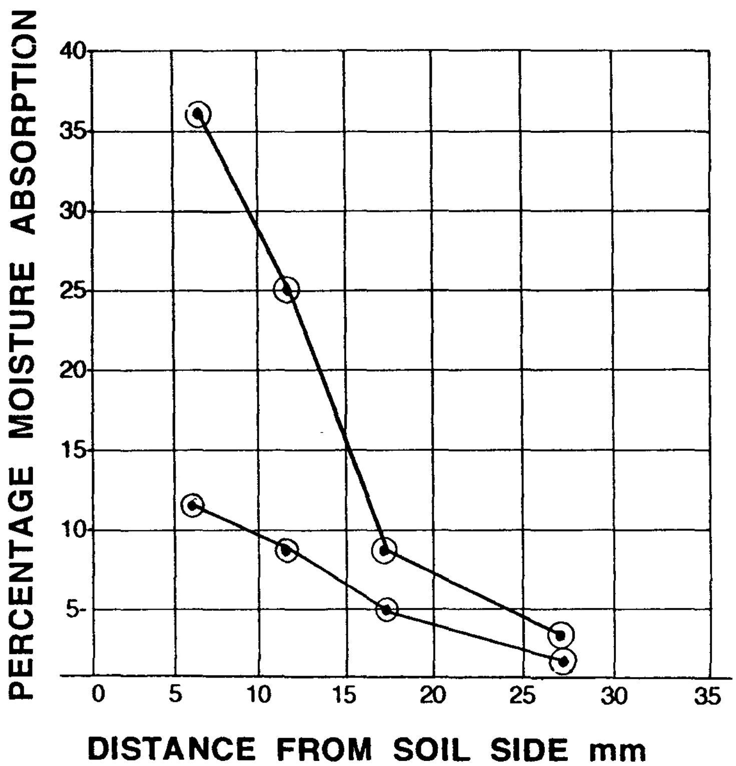
Water drained from all four sides. The bare Durisol wall drained water first in a cloudy gray , followed by the geo-textile with clearer water. The drain clad side drained the water next with a distinct yellow tinge. The geo-textile on bitument coated Durisol was the last to drain and a considerable time later. The water was very clear . This may very well have been the geo-textile draining only. The most water drained from the bare Durisol side of the experiment, which did slow down slightly over time (many factors may be involved). The least amount of water was drained from the geo-textile on bitument-coated Durisol side.

Silt penetrated into the bare Durisol. Further tests must be conducted to determine the silt penetration into the wall and its effect on drainage. No apparent clogging was observed at this time. The bare Durisol absorbed the most moisture. Followed by the geo-textile. This experiment proved that Durisol can be used in a basement wall application as for the fact that drain-clad was able to keep a large amount of moisture away from the Durisol surface and act as a free draining layer. Geo-textile on bitument allowed very little moisture through, yet is set in a very ideal situation with a very generous application of bitument onto a very porous surface.

Bore Holes - moisture penetration

Bore hole samples were taken from the bare Durisol surface side panels. They were weighed and then allowed to dry.

Sample	Wet Weight	Dry Weight	Moisture Absorbed	Moisture Percentage
7-1-1	9.42 g	6.88 g	2.54 g	37%
7-1-2	6.36	5.08	1.28	25
7-1-3	6.97	6.45	0.52	8
8-1-1	7.56	6.79	0.77	11
8-1-2	7.36	6.77	0.59	8.7
8-1-3	8.37	8.51	0.14	1.6

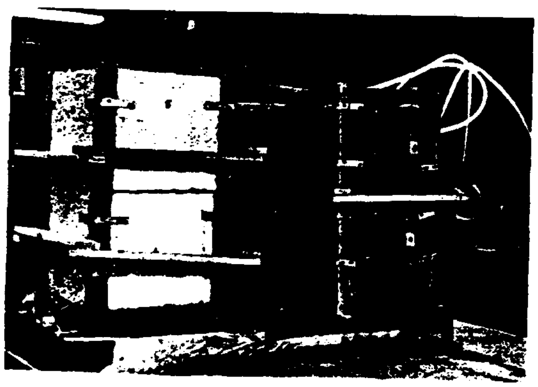


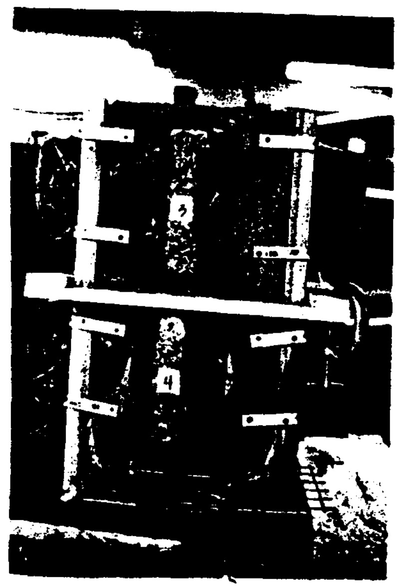
DISTANCE FROM SOIL SIDE mm

The samples were taken at different heights in the panels. It is very clear that moisture does decrease significantly into the panel.

Moisture Penetration Within the Web

Considering the construction of the Durisol block wall, the web is the part of the construction that would migrate moisture directly into the interior. The web may be used to form a capillary break. By treating the webs with different materials we are able to see how each treatment differs to help prevent moisture migration through the wall.





300mm X 300mm block specimens of Durisol, including their webs were taken from the same stock pile. Each block was parged with a cement paste before experiment was run. The webs were wrapped with polyethylene to keep moisture in. The specimens were blocked in a wooden frame similar to Box #1.

OBSERVATIONS

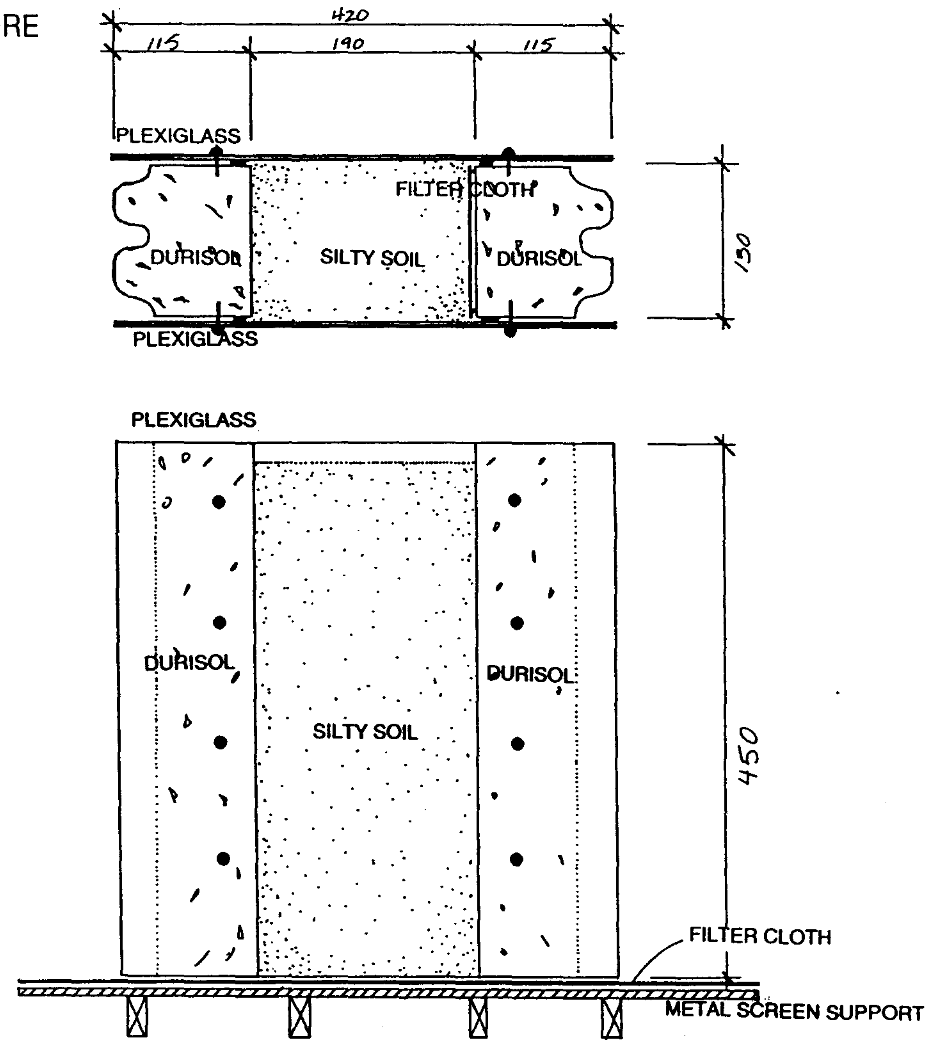
BLOCK	WEB	INTERIOR	DRY MASS	WET MASS	MOISTURE ABSORBED	MOISTURE PERCENTAGE
1&2	bare	bare	16.370lb	21.935 lb	5.857lb	25.37%
3&4	thompson water seal	geo-textile	15.370	16.620	1.250	7.50
5&6	parged	bare	23.111	27.205	4.095	15.00
7&8	motor oil	geo-textile	15.820	16.750	0.930	5.56

Moisture was observed to have entered into the seam between the two panels. This may be due to the means of applying the cement parging in a horizontal layer rather than the realistic vertical fashion. Sides 1&2 had vapour condensation in the polyethylene that covered the web. This is the bare Durisol side with untreated webs and unparged surface. This can show us that parging does form a capillary break and the treatment of the web would be crucial to the wicking process that occurs within the Durisol block. Thompson Water Seal proved to have absorbed the least amount of moisture. Thompson Water Seal also has shown us previously to help lower the capillarity of Durisol. Further investigation must be done into the manufacturing process and construction techniques that can possibly help create a capillary break within the Durisol wall.

Experiment to determine the thickness of Durisol involved in the draining process

This experiment was carried out to determine the actual thickness of Durisol Material that is involved in the drainage process. In the actual basement wall foundation system there will be moisture migration and evaporation through the wall to the interior when the soil does reach saturation.

PROCEDURE

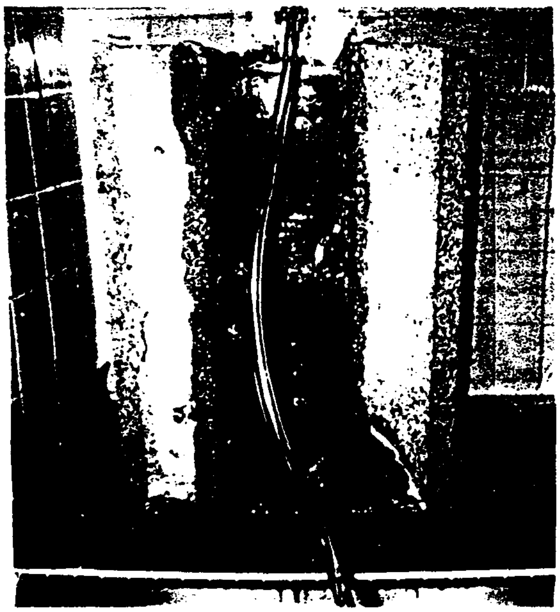


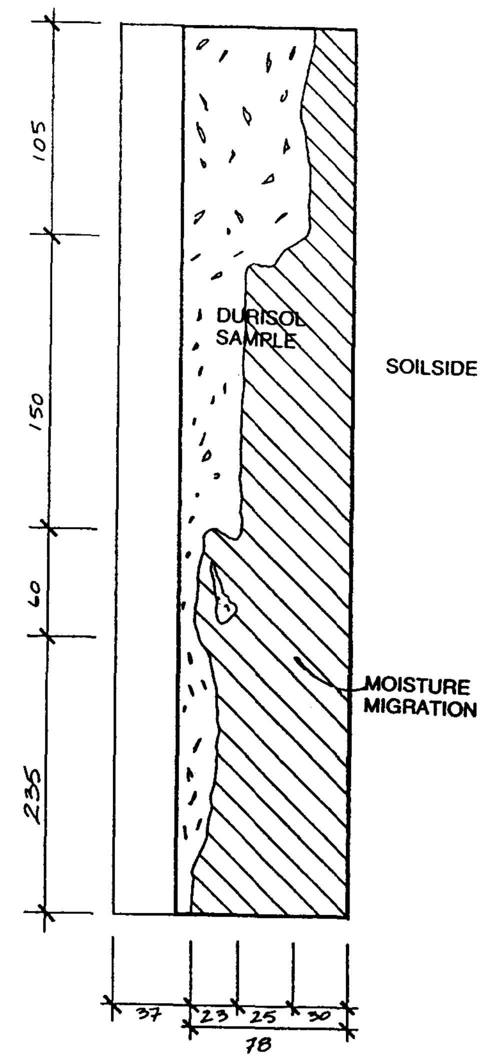
Having already confirmed that water is drained through Durisol, the next requirement was to determine the thickness of the layer acually involved in the drainage process and how this layer changes towards the bottom of the wall section. Two wall section specimens were cut from a Durisol wall panel measuring 450mmX130mmX130mm. One surface was left bare, the other was covered by filter cloth. Two plexi-glass sheets were used as frames that were anchored to the panels. The frame was placed on a screen and a layer of filter cloth to allow drainage to occur. Silty sand was placed into the frame, moistened and lightly compacted. Water was introduced to the top of the experiment until all the soil inside was saturated. The flow was regulated so that a pool of water did not form on top of the soil. The set up was left to run for 3 days and the moisture migration pattern was observed. The wall specimens were weighed before and after the experiment.

OBSERVATIONS

sample	dry mass	wet mass	moisture absorbed
bare face	11.65 lb.	13.64 lb.	1.99 lb.
filter clothed	11.75 lb.	12.61 lb.	0.87 lb.

MOISTURE PROFILE





This experiment once again shows that filter cloth lowers the amount of moisture absorbed. Both specimens were wet on their soil side. The bare specimen had silt imbedded into the pores of its surface. The bare specimen absorbed more moisture from the soil than the filter clothed speciemen. The water sprinkled onto the top of the soil ran at a constant rate as did the draining process from the bottom of the frame. The moisture could be seen through the plexi-glass, as it moved horizontally across the surface of the specimen. This process equalized after 12 hours. The profile can be seen above. The outer edge of the moisture limit is very rough. This is due to the random orientation and the varying size of the particles and pores. The profile extended to the outer most limit of 78mm towards the bottom 295mm of the panel. Visual signs of further moisture migration did not occur. The outer layer of the panel did remain dry.

OBSERVATIONS AND CONCLUSIONS

The purpose of this study was to investigate a new material or product that would meet its performance requiremetns in a basement wall system.Through the testing, it has been confirmed that the Durisol wall will behave in a basement wall application. Tests were carried out to confirm that Durisol can act as a free draining layer. It has been determined that Durisol has a low capillary suction and a sufficient layer of Durisol does remain dry when exposed to saturated soil, therefore allowing a sufficient thickness to act as an effective thermal insulator. The poured concrete core and treated interior webs of a Durisol block wall may very well act as a capillary break to the moisture that is to migrate from the exterior to the interior. The single condition is that the perimeter drain must work if the construction is to function.

application

The initial moisture migration test box was to show the practical application of Durisol in a simulated basement condition. Four different scenarios were tested. Drainclad did prove that the application of Durisol in a foundation wall would be possible with first of all the use of drainclad fiberglass insulation. This material added to the exterior, will act as a free draining layer to the foundation system. Further tests have shown that Durisol itself will act as a free-draining layer. Drainclad's advantage is its 2-dimensional orientation to drainage. Durisol's random orientation of fibers creates a deeper drainage layer than Drainclad. Once again the capillary head of Durisol was observed to be low. With all properties in mind, Durisol would be very possible within a basement wall application.

cost

It has been found that Fiber Glass Canada's drainclad is able to act as a free-draining layer on the exterior of foundation walls. This 10mm thich layer prices at $0.41 per sq. ft. The ability of Durisol to act as a draining layer attached to the exterior of existing foundation wall systems may be less conceivable due to a higher cost of $2.__ per sq. ft. and the weight of the material to be handled in conparison to drainclad. Further study is to be done into this application.

In a cost analysis of foundation walls for single and semi-detached house in Brampton, John Semon Construction priced an 8" poured concrete wall against an 8" Durisol wall. The cost came out to be $12.17 for the poured concrete and $13.17 for the Durisol wall. This difference in price may be augmented by the completeness of the Durisol system. The Durisol wall system has an inherent draining and insulating characteristics. Baseclad or insulation must be added to typical basement wall construction. This is already inherent in the Durisol Form Wall. Construction time is greatly reduced. It is more economical as the Durisol Wall functions as a complete system in the basement condition.

RECOMMENDATIONS FOR FURTHER STUDY

The characteristics of Durisol that make it probable within a basement application are free-draining capacity, low capillary suction, compressive strength, thermal resistance, negligible freeze / thaw, negligible weathering, and resistance to fungal / bacterial growth. Further study must be done on the effect of moisture in relation to its thermal resistance. In the experimental test, a dry layer still remained that could suffice thermal resistance while evaporation was allowed to occur. Durisol does have no resistance to water vapour permeability. This should be studied further as to the treatment of the interior surface of the basement wall. The footing condition must be designed as to allow water to move freely from the base of the Durisol wall to the crushed stone and gravel. The moisture of construction must also be considered as to not trap unwanted moisture during construction.

manufacturing

Hydrophobic Materials have a high resistance to water and moisture. The product Rockwool Mineral Wool is an insulating material consisting of 99% air and 1% mineral wool. Rockwool mineral wool is impregnated to make it water-repellent yet porous. The surface of the threads are coated with a water repellent film. The result is that they will not absorb water. It will absorb water only when it is pressed or forced into the material. When the pressure is relieved, the water will evaporate and the material will become dry again and restored to its original insulating value. Moisture in an insulating material reduces the insulation value of the material. Tests done in accordance with British Standard BS 2972, mineral wool of glass fibers will absorb approximately 1.0% by volume of moisture.

As seen in our tests, Thompson Water Seal did help reduce capillary suction once the Durisol samples had been treated. This product is only an example of a water repellent. The disadvantage of this product is that it will break down in time in such an application. The nature of the manufacturing of a Durisol block does allow many possibilities in regards to its possible treatment to make it water-repellent in the web condition. This must be looked at in further studies.

full-scale experimental foundation wall

Experiments should be conducted regarding the thermal resistance while Durisol is saturated at different moments and the moisture migration patterns within the concrete core. A full-scale experimental application may help to diagnose possible design solutions not yet looked at in a typical foundation wall. The single most important condition is that the perimeter drain must work if the free-draining layer is to function properly.

rain screen principle

Because of the porosity and open nature of the Durisol wall, vapour diffusion does get into the wall and if allowed to dry out will function very well under the basement condition. The design of the wall may require the wall to open at the top to allow air into the wall to circulate and dry it out and an effective drainage system to allow water to drain away from the surface. With a material such as Durisol, the rain screen principle were to be applied to the basment condition as it is currently to exterior wall construction.

Durisol does meet performance requirements in its application as a typical foundation wall system. With its very unique characteristics and further investigation and invention, it has great potential to creating a very unique solution to the problem of moisture in the basement wall condition.

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