TECHNICAL MEMORANDUM

To:		**At:**	Irish Concrete Federation
From:		**At:**	Dublin/Belfast
Date:	5th February 2015	**Ref:**	501.00264.00001
Subject:	MICA AND MICAEOUS ROCKS IN AGGREGATES FOR CONCRETE		

In relation to your queries on mica and micaceous rocks please see below:

What is Mica / What are Micas?

Micas are a group of complex silicate minerals that are exceptionally common, occurring in many rock types. They are especially common in igneous and metamorphic rocks and are also common as clay minerals or detrital particles (having been weathered and re-deposited) in sedimentary rocks.

Micas are sheet like in structure with an almost perfect basal cleavage, frequently forming stacked flat crystals which allows the mineral crystals or crystal stacks to split easily along these cleavages.

The most common micas are Biotite Mica and Muscovite Mica.

Muscovite

White, grey, silvery mineral

Chemical formula (Approximate)

$$K(Mg,Fe)_3AlSi_3O_{10}(F,OH)_2$$

Biotite

Dark brown, green-brown or almost black

Chemical formula (Approximate)

$$KAl_2(AlSi_3O_{10})(F,OH)_2, \text{ or}$$

$$(KF)_2(Al_2O_3)_3(SiO_2)_6(H_2O).$$

Micas may become problematic where they are concentrated in certain metamorphic rocks such as schists, mica schists or strongly foliated gneisses.

Muscovite Mica

Biotite Mica

Coarse grained granite specimen with coarse biotite mica (arrowed)

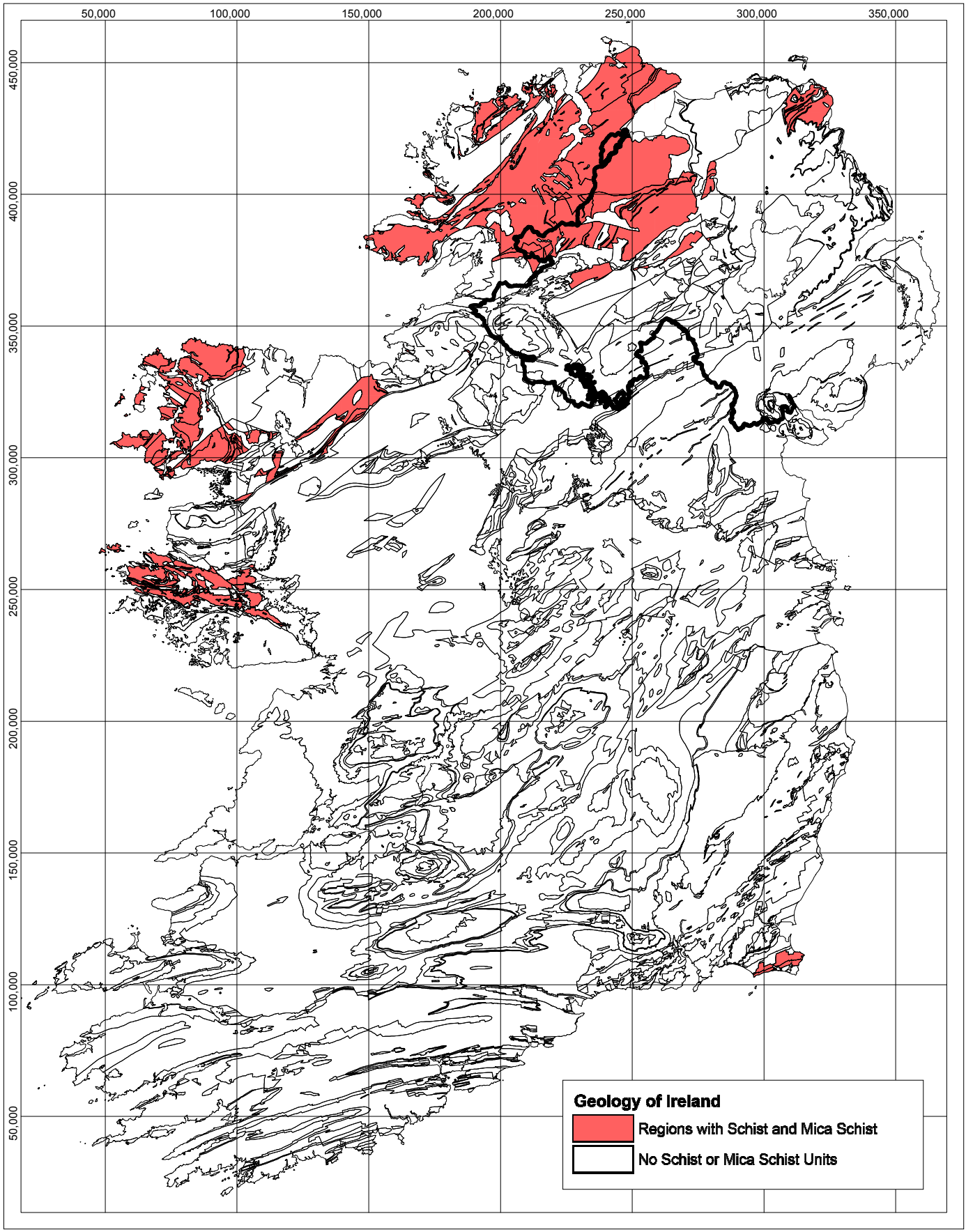
Stacked muscovite crystals showing perfect basal cleavage (planes of weakness)

Mica Schist Example. The micas have developed a preferred orientation giving the rock a foliated texture.

Where can it be found / particular areas / rock type etc.?

Schists and mica schists (and to a lesser degree, micaceous foliated gneisses) are primarily found in Donegal, Mayo and Connemara. The attached summary geology map of Ireland highlights geological REGIONS which MAY contain schist and mica schist formations.

The regions highlighted are not entirely composed of schists.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Geology of Ireland
Regions with Schist and Mica Schist
No Schist or Mica Schist Units

Is there a short term / long term / physical / mechanical / chemical issues with the presence of mica in aggregate / aggregates used for concrete products / blocks?

Schists and mica schists are considered to be potentially susceptible to freeze-thaw.

The micas are chemically inert. Any failure is mechanical in nature and primarily due to freeze thaw action.

Any degradation of the blocks due to the presence of schists and mica schists will be associated with:

- Use of aggregates that contain potentially susceptible lithologies that, when tested, fail to meet the required Freeze-Thaw resistance, Water Absorption and/or Magnesium Sulfate Soundness requirements for the proposed end use environment.

Should the presence of mica be taken into account in producing these end products? – How would you prevent any potential problems with mica?

The problem is not the presence of mica, the problem is the presence of certain mica-rich rock types with strong mica-controlled foliation (schists and mica schists) which fail the relevant tests and are susceptible to freeze-thaw action in the environment in which they are used.

The issue is well dealt with in the relevant standard and lithological assessment is referred to in section F.2.2 of the relevant standard.

I.S. EN 12620:2002+A1:2008

F.2.2 Petrographic examination

A petrographic examination of the aggregate according to the procedure specified in EN 932-3 can give an indication of the presence of weak and/or highly absorptive particles that can be susceptible to damage from freeze-thaw action. Where the presence of such particles is observed or suspected one of the physical tests given in F.2.3 and F.2.4 can be used to assess freeze-thaw resistance of the aggregate.

Susceptible aggregates derived from highly weathered rocks and some conglomerates and breccias can include for example some or all of the following:

Schist, mica schist, phyllite, chalk, marl, shale, porous flint, altered porous basalt or particles loosely cemented by clay minerals.

If the lithologies above are present, an assessment of the freeze-thaw susceptibility is required by the following tests to determine the freeze-thaw susceptibility of the aggregate and the end use environment of the aggregate.

- Freeze-Thaw Value determined to EN 1367-1
- Water Absorption Value
- Magnesium Sulfate Soundness Value

Is the environment in which products are used an issue?

The environment and end-use are critical in determining the freeze-thaw susceptibility requirements of the aggregate (see below).

Three environments are defined in the standard:

- Mediterranean
- Atlantic
- Continental

In addition, there are sub-categories for frost free or dry situations, road surfaces, airfield surfacings, degree of likely water saturation and likely salt content of the saturating solutions.

Table F1. Freeze-thaw severity category related to climate and end-use.

Environmental Conditions	**Climate**		
	Mediterranean	**Atlantic**	**Continental**
Frost Free or dry situation	Not required	Not required	Not required
Partial Saturation, no salt	Not required	F_4 *or* MS_{35}	F_2 *or* MS_{25}
Saturated, no salt	Not required	F_2 *or* MS_{25}	F_1 *or* MS_{18}
Salt (sea water or road surfaces)	F_4 *or* MS_{35}	F_1 *or* MS_{18}	F_1 *or* MS_{18}
Airfield Surfacings	F_2 *or* MS_{25}	F_1 *or* MS_{18}	F_1 *or* MS_{18}
The Continental category could also apply to Iceland, parts of Scandinavia and to mountainous regions where severe weather conditions are experienced			

Donegal would be considered to be an Atlantic environment, with many locations subject to partial or complete saturation and the presence of salt in coastal locations.

Therefore if the aggregate use in block manufacture is a schist or a mica schist, it would be expected to obtain F_2 *or* MS_{25} and F_1 *or* MS_{18} if the site is in a coastal location.

Have there been problems with mica in construction products in the past?

Yes.

The problem with micaceous rocks in concrete products which are used in an environment where they are not suitable and are exposed to freeze-thaw is well established and recognition and management of this issue to ensure that the product is suitable for the proposed end-use is dealt with in the relevant standard.

How would you find out what the cause(s) of problems with concrete blocks in Donegal are?

Petrographic assessment of the raw aggregate and testing for freeze-thaw to EN 1367-1, water absorption and magnesium sulfate soundness should be undertaken. The results from this testing should be compared to the environment of end-use to determine if the aggregate properties are suitable for that environment.

In addition, petrographic assessment of the failed blocks, mortar and render would be required to determine the aggregate type contained within the blocks, if the aggregate, binder, mortar or render is problematic or not and the mode of block failure.

It would be useful to assess a block of similar or identical composition as a failed block which has not failed for comparison.

Is there any limit set for the presence of mica in standards.

There is no assessment method defined in the standard to determine the quantity of mica present, and there are no numeric limits on mica content of a rock.

Presence of problematic micaceous lithologies with a preferred orientation (schists, mica schists) are to be determined by petrographic examination as per F.2.2.

If these lithologies are present they are not excluded, the freeze-thaw resistance of the aggregate is determined by Water Absorption, Magnesium Sulfate Soundness and Freeze-Thaw Value to EN 1367-1 must be determined and the values will determine which environments are suitable for these blocks to be used (see above).

If concrete products which are not strong enough or suitable for the proposed end-use and environment are used, there is potential for failure.

Appropriate Testing Methodology

It is essential to determine the nature of the aggregate and match the aggregate properties to the proposed end use. Schists and mica schists are not problematic per se, only where the aggregate properties do not meet the proposed end use requirements, or where concrete products are used in an environment where they are not suitable/adequate.

A typical testing and product design methodology would be:

1. Determine the nature of the aggregate to be used and, if lithologies outlined in F2.2 are present:

2. Undertake testing of the aggregate for:

    a. Freeze-thaw to EN 1367-1,
    b. Water Absorption,
    c. Magnesium Sulfate Soundness

3. Determine if other required testing requirements are adequate.

4. Determine end-use environment and ensure that the aggregate test results are appropriate to the end-use.

Glossary

Gneiss A coarse-grained, *foliated metamorphic rock* marked by bands of light-colored minerals such as quartz and feldspar that alternate with bands of dark-colored minerals. This alternation develops through *metamorphic differentiation*.

Mica Schist A metamorphosed shale containing abundant crystals of biotite or muscovite.

Micaceous Consisting of, containing or pertaining to mica.

Schist A metamorphic rock derived from shale or mudstone with a platy or foliated texture.

Schistose A rock texture consisting of a layered arrangement of platy minerals.