ATTACHMENT 1

ROCK QUALITY ANALYSIS

DAVROC
TESTING LABORATORIES INC.

CONSULTING ENGINEERS
Materials Testing and Inspection

File: L16-0429AT

MTE Consultants Inc.
520 Bingemans Centre Drive
P.O. Box 51
Kitchener, Ontario
N2B 3X9

June 22, 2016

Attention: **Jay Flanagan, B.E.S., B.Ed.**
Senior Project Manager
JFlanagan@mte85.com

Dear Sir;

Rock Core Sample Testing
Freymond Quarry

Further to receipt of the one (1) wooden box of rock core samples in our laboratory on May 13, 2016, Davroc Testing Laboratories Inc. is pleased to report the results of our tests.

The material was given the following designations.

- Davroc Lab Sample No: C830
- Client Sample Identification: Freymond Quarry - Rock Core Samples Run 3 & Run 4, from 11'10" to 21"9"

Test Program

The rock samples from both runs were crushed to passing a 20mm size sieve, and the crushed material was tested in accordance with the Canadian Standard Association, Standard A23.1-14/A23.2-14 test methods shown in the following Table No. 1.

Table No. 1
Summary of Tests Conducted

Laboratory Tests Conducted		Canadian Standards Laboratory Test Number
1.	Relative Density and Absorption of Coarse Aggregate	A23.2-12A
2.	Petrographic Examination of Aggregate	A23.2-15A
3.	Detection of Alkali-Silica Reactive Aggregate By Accelerated Expansion of Mortar Bars	A23.2-25A
4.	Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.	A23.2-29A

Test Results

The test results, together with the specifications limits where applicable, are given as follows:

Table No. 2
Coarse Aggregate Test Results

Test	Davroc Sample No. C830 Rock Core Samples - Freymond Quarry, Run 3 &4	*CSA Concrete Specifications Limits
Absorption (%)	0.5	No Limits
Relative Density (1) Bulk (Saturated Surface Dry) (2) Bulk (3) Apparent	 2.825 2.810 2.851	No Limits
Petrographic Number (See Attached Reports Appendix "A")	Report results	Report results
Alkali-Silica Reactivity (%) (*See Attached Sheets in Appendix "B")	0.116	**0.150 max
Micro-Deval Abrasion (loss %)	8.8	17 max.(1) 21 max.(2)

Table Notes:

*CSA Standards A23.1-14, Table 12 Limits for deleterious substances and physical properties of aggregates.

(1) Concrete exposed to freezing and thawing.
(2) Other exposure conditions.

** CSA Standard A23.2-27A Table 1 Expansion values for identifying potentially alkali-silica reactive aggregates.

Comments

Based on the results of tests conducted, the rock would be suitable for use as a concrete aggregate. Note that once a stockpile has been produced, we would recommend that the processed aggregate be sampled and tested for full compliance tests required by CSA A23.1-14 and the Ministry of Transportation, Ontario.

We trust this report provides you with the information you require at this time. If you have any questions, please do not hesitate to contact the undersigned.

Yours very truly,
Davroc Testing Laboratories Inc.

Kateryna Fiyalko, C.E.T.
Concrete Laboratory Supervisor

Sal Fasullo C.E.T.
Vice President

SF/kf
16-0429-2

Appendix A

Petrographic Examination

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Results of Petrographic Examination

Project Number:	L16-0429AT, Davroc Sample No. C830
Client:	MTE Consultants Inc.
Sample Identification:	Freymond Quarry-Rock Core Samples, Run 3 &4, from 11'10" to 21'9"
Sample Description:	Hornfels

Sample Properties

Lithology	Hornfels
Mineralogy	Probably quartz, feldspar, biotite, muscovite and calcite
Colour	Light brown
Particle Shape	Angular
Particle Surface Texture	Rough to smooth
Crystal Size	Fine-grained
Tenacity	Hard
Coating and Encrustations	None
Presence of Materials Deleterious to Concrete	No significant deleterious materials

DAVROC

Detailed Petrographic Examination of Coarse Aggregate (Sample Tested According to CSA – A23.2-15A Test Method)

Source Name:	Freymond Quarry, Run 3 & 4 from 11'10" to 21'9"	**Sieve Fraction**	5 mm +
Project Number:	L16 -0429AT, MTE	**Sample No:**	C830
Petrographer:	R. Ji	**Date Tested:**	June 6 , 2016

Petrographic Description and Quality	Mass (gram)	Percent by Mass	Petrographic Number Contribution
Good (PN Multiplier = 1)			
Hornfels	1064.2	92.1	92.1
Feldspar	35.2	3.1	3.1
Quartzite	40.2	3.5	3.5
Fair (PN Multiplier = 3)			
Feldspar	15.4	1.3	3.9
Poor (PN Multiplier = 6)			
Total	**1155.0**	**100.0**	**103**

Note:

(1) The PN is not related to the potential for alkali-aggregate reactivity (AAR) of the aggregate when used in Portland cement concrete. AAR potential must be separately assessed.

(2) Rock types indicated by * may have a potential for alkali-aggregate reaction (AAR). See CSA.A23.1 and A23.2 for information on the assessment of AAR in new concrete construction.

Appendix B

Alkali-Silica Reactivity Results

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File: L16-0429AT

Table No. 1
Alkali-Silica Reactivity
(CSA A23.2-25A Mortar Bar Expansion)

Aggregate Source	Expansion %				
	Prism No.	3 Day	7 Day	10 Day	14 Day
Davroc Sample No. C830 Freymond Quarry-Rock Core Samples, Run 3 & 4 from 11'10" to 21'9"	1	0.011	0.041	0.077	0.117
	2	0.012	0.043	0.080	0.116
	3	0.011	0.041	0.080	0.114
	Mean	**0.011**	**0.042**	**0.079**	**0.116**
Control Sample (Spratt) March 2016	1	0.098	0.227	0.296	0.400
	2	0.097	0.222	0.294	0.395
	3	0.095	0.222	0.292	0.399
	Mean	**0.097**	**0.224**	**0.294**	**0.398**

Note: See attached CSA Table No's. 1 and 2 for requirements.

The control aggregate expansion result falls within the 0.30 to 0.55% range at 14 days stated in the CSA Test Method A23.2-25A to ensure that the test procedure produces the required test conditions for expansion.

The above test results have been graphically presented on the attached graph.

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File: L16-0429AT

CSA A23.2-27A Standard Practice to Identify Degree of Alkali-Reactivity of Aggregates and to Identify Measures to Avoid Deleterious Expansion in Concrete

Table 1

Expansion Values for Identifying Potentially Alkali-Silica Reactive Aggregates

Concrete Prism Expansion Test CSA Test Method A23.2-14A (See Annex B, CSA Standard A23.1, Clause B.3.4)	Mortar Bar Accelerated Expansion Test CSA Test Method A23.2-25A* (See Annex B, CSA Standard A23.1, Clause B.3.3)
Greater than 0.040% at l year+	**Greater than 0.150% at 14 days±**

* This method is not appropriate for testing aggregates for alkali-carbonate reactivity.

+ In critical structures such as those used for nuclear containment or large dams, a lower expansion limit may be required.

± Several aggregates that expand more than 0.15% after 14 d have not caused deleterious expansion in field structures and expanded less than 0.040% when tested in accordance with CSA A23.2-14A. Therefore, expansion in excess of the recommended limit calls for further testing of concrete specimens.

A number of quarried siliceous limestone aggregates from the St. Lawrence Lowlands, which expand less than 0.150% after 14 d, have caused deleterious expansion in field structures and have expanded more than 0.040% in concrete prism tests. Therefore, a lower limit of 0.100% is recommended for this type of aggregate (Fournier and Berube 1991b).

Some dolostones from the Beekmantown Group expand significantly when tested in accordance with CSA A23.1-14A (>0.040% after one year), while expanding between 0.10% and 0.15% after 14 d when tested in accordance with CSA A23.2-25A. Deleterious expansion in field structures has not been confirmed (Berube et al., 2000).

There are reports of deterioration of field concretes made with quarried bedrock aggregates of Grenville Age in Ontario containing granites, gneisses, and granodiorites and also some horizons of the Potsdam sandstone, which exhibit less than 0.0100% expansion at 14 d in the CSA A23.2-25A test. Therefore such aggregates shall be tested in accordance with CSA A23.2-14A.

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File: L16-0429AT

CSA A23.2-27A Standard Practice to Identify Degree of Alkali-Reactivity of Aggregates and to Identify Measures to Avoid Deleterious Expansion in Concrete

Table 2

Degree of Alkali-Silica Reactivity of Aggregates

Classification of the degree of alkali-silica reactivity	One year expansion (%) in CSA Test Method A23.2-14A*+	14d expansion (%) in CSA Test Method A23.2-25A+±
Nonreactive	**<0.040**	**<0.150% (See Table 1)**
Moderately reactive	**0.040-0.120**	**
Highly reactive	**>0.120**	**>0.150% (see Table 1)**

* The degree of alkali-silica reactivity obtained in the CSA A23.2-14A test is that of a combination of the fine and coarse aggregates intended for use in concrete. If the results of the combination are not available, then the degree of alkali-silica reactivity to be used in this Table shall be that of the most expansive of the aggregates to be used.

+ When data obtained in accordance with CSA A23.2-25A conflict with those obtained with the same aggregate in accordance with CSA A23.2-14A, the results of the latter shall prevail.

± When the accelerated mortar bar test is used, each aggregate to be used shall be tested and the degree of alkali-silica reactivity based on the largest test value shall be obtained.

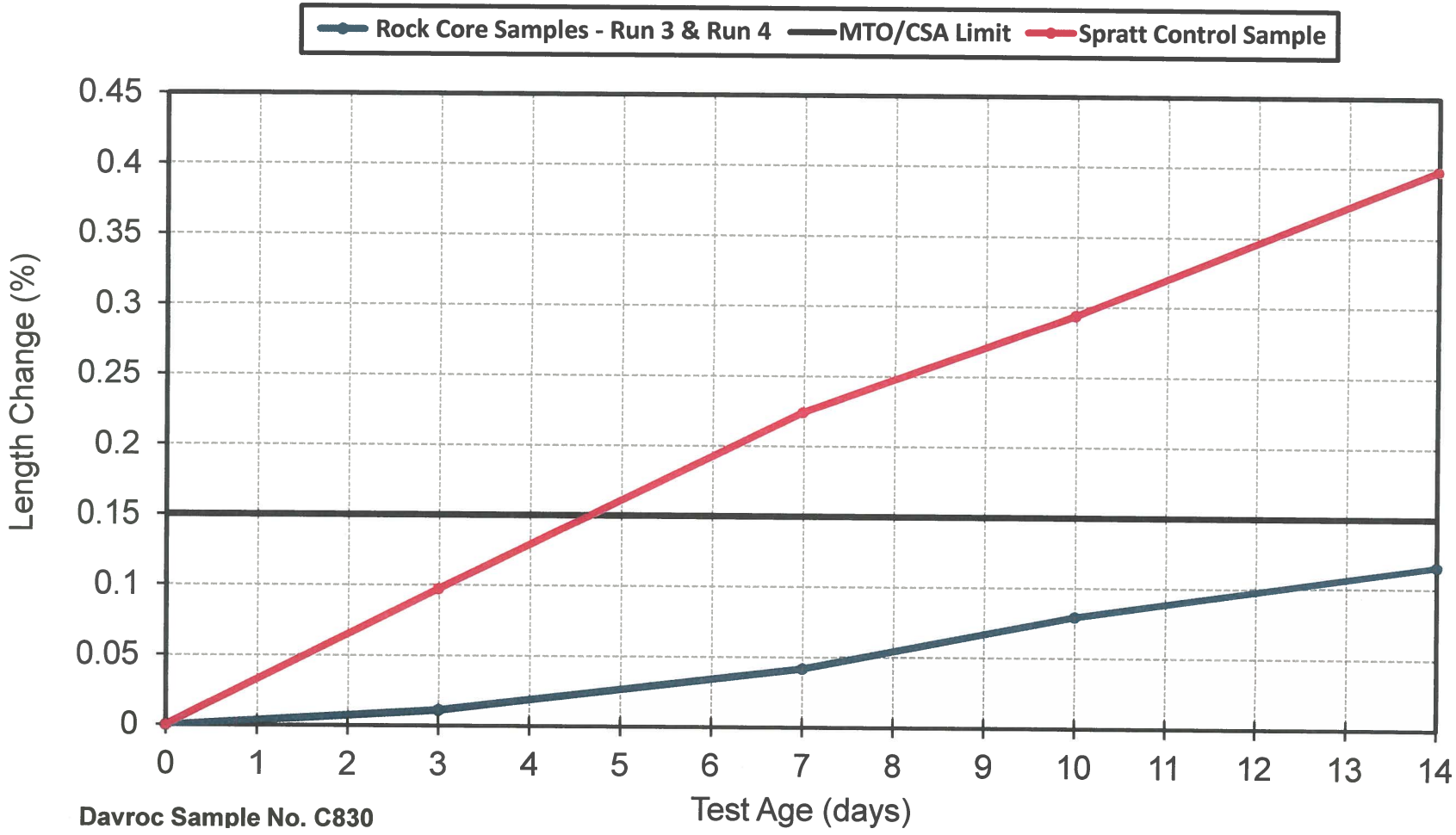
** The accelerated mortar bar test is not considered to be suitable for distinguishing between moderately and highly reactive aggregates. Consequently, in the absence of concrete prism test data, aggregates that produce >0.150% expansion at 14 days in the test are classified as highly reactive.

DAVROC

L16-0429MT

Graph No. 1
MTE Consultants Inc.
June 22, 2016

Plotting Alkali-Aggregate Expansion Test Results
A23.2-25A Test Method



Davroc Sample No. C830

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TESTING LABORATORIES INC.

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Materials Testing ▪
and Inspection

File: L16-0429AT

MTE Consultants Inc.
520 Bingemans Centre Drive
P.O. Box 51
Kitchener, Ontario
N2B 3X9

June 22, 2016

Attention: **Jay Flanagan, B.E.S., B.Ed.**
Senior Project Manager
JFlanagan@mte85.com

Dear Sir;

Rock Core Sample Testing
Freymond Quarry

Further to receipt of the one (1) wooden box of rock core samples in our laboratory on May 13, 2016, Davroc Testing Laboratories Inc. is pleased to report the results of our tests.

The material was given the following designations.

- Davroc Lab Sample No: C831
- Client Sample Identification: Freymond Quarry - Rock Core Samples Run 11 & Run 12, from 52' to 62'

Test Program

The rock samples from both runs were crushed to passing a 20mm size sieve, and the crushed material was tested in accordance with the Canadian Standard Association, Standard A23.1-14/A23.2-14 test methods shown in the following Table No. 1.

Table No. 1
Summary of Tests Conducted

Laboratory Tests Conducted		Canadian Standards Laboratory Test Number
1.	Relative Density and Absorption of Coarse Aggregate	A23.2-12A
2.	Petrographic Examination of Aggregate	A23.2-15A
3.	Detection of Alkali-Silica Reactive Aggregate By Accelerated Expansion of Mortar Bars	A23.2-25A
4.	Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.	A23.2-29A

Test Results

The test results, together with the specifications limits where applicable, are given as follows:

Table No. 2
Coarse Aggregate Test Results

Test	Davroc Sample No. C831 Rock Core Samples - Freymond Quarry, Run 11 & 12	*CSA Concrete Specifications Limits
Absorption (%)	0.8	No Limits
Relative Density (1) Bulk (Saturated Surface Dry) (2) Bulk (3) Apparent	 2.904 2.880 2.950	No Limits
Petrographic Number (See Attached Reports Appendix "A")	Report results	Report results
Alkali-Silica Reactivity (%) (*See Attached Sheets in Appendix "B")	0.017	**0.150 max
Micro-Deval Abrasion (loss %)	20.2	17 max.(1) 21 max.(2)

Table Notes:

*CSA Standards A23.1-14, Table 12 Limits for deleterious substances and physical properties of aggregates.

(1) Concrete exposed to freezing and thawing.
(2) Other exposure conditions.

** CSA Standard A23.2-27A Table 1 Expansion values for identifying potentially alkali-silica reactive aggregates.

Comments

Based on the results of tests conducted, the rock would be suitable for use as a concrete aggregate. The high Micro-Deval abrasion result obtained maybe due to the test sample crushing, and may not be representative of actual crushing equipment that will be employed at the Quarry. Note that once a stockpile has been produced, we would recommend that the processed aggregate be sampled and tested for full compliance tests required by CSA A23.1-14 and the Ministry of Transportation, Ontario.

We trust this report provides you with the information you require at this time. If you have any questions, please do not hesitate to contact the undersigned.

Yours very truly,
Davroc Testing Laboratories Inc.

Kateryna Fiyalko, C.E.T.
Concrete Laboratory Supervisor

Sal Fasullo C.E.T.
Vice President

SF/kf
16-0429-3

Appendix A

Petrographic Examination

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Results of Petrographic Examination

Project Number:	L16-0429AT, Davroc Sample No. C831
Client:	MTE Consultants Inc.
Sample Identification:	Freymond Quarry-Rock Core Samples, Run 11 & 12, from 52' to 62'
Sample Description:	Marble

Sample Properties

Lithology	Marble
Mineralogy	Probably calcite biotite, muscovite pyrite and quartz
Colour	Light grey
Particle Shape	Angular
Particle Surface Texture	Rough
Crystal Size	Fine to medium-grained
Tenacity	Medium hard
Coating and Encrustations	None
Presence of Materials Deleterious to Concrete	No significant deleterious materials

DAVROC

Detailed Petrographic Examination of Coarse Aggregate (Sample Tested According to CSA – A23.2-15A Test Method)

Source Name:	Freymond Quarry, Run 11 & 12 from 52' to 62'	**Sieve Fraction**	5 mm +
Project Number:	L16 -0429AT, MTE	**Sample No:**	C831
Petrographer:	R. Ji	**Date Tested:**	June 10 , 2016

Petrographic Description and Quality	Mass (gram)	Percent by Mass	Petrographic Number Contribution
Good (PN Multiplier = 1)			
Marble	810.8	70.9	70.9
Gneiss	147.2	12.9	12.9
Fair (PN Multiplier = 3)			
Marble	182.8	16.0	48.0
Gneiss	3.0	0.2	0.6
Poor (PN Multiplier = 6)			
Total	**1143.8**	**100.0**	**132**

Note:

(1) The PN is not related to the potential for alkali-aggregate reactivity (AAR) of the aggregate when used in Portland cement concrete. AAR potential must be separately assessed.

(2) Rock types indicated by * may have a potential for alkali-aggregate reaction (AAR). See CSA.A23.1 and A23.2 for information on the assessment of AAR in new concrete construction.

Appendix B

Alkali-Silica Reactivity Results

DAVROC

File: L16-0429AT

Table No. 1
Alkali-Silica Reactivity
(CSA A23.2-25A Mortar Bar Expansion)

Aggregate Source	Expansion %				
	Prism No.	3 Day	7 Day	10 Day	14 Day
Davroc Sample No. C831 Freymond Quarry-Rock Core Samples, Run 11 & 12 from 52' to 62'	1	0.004	0.007	0.011	0.018
	2	0.004	0.007	0.011	0.016
	3	0.005	0.007	0.012	0.018
	Mean	**0.004**	**0.007**	**0.011**	**0.017**
Control Sample (Spratt) March 2016	1	0.098	0.227	0.296	0.400
	2	0.097	0.222	0.294	0.395
	3	0.095	0.222	0.292	0.399
	Mean	**0.097**	**0.224**	**0.294**	**0.398**

Note: See attached CSA Table No's. 1 and 2 for requirements.

The control aggregate expansion result falls within the 0.30 to 0.55% range at 14 days stated in the CSA Test Method A23.2-25A to ensure that the test procedure produces the required test conditions for expansion.

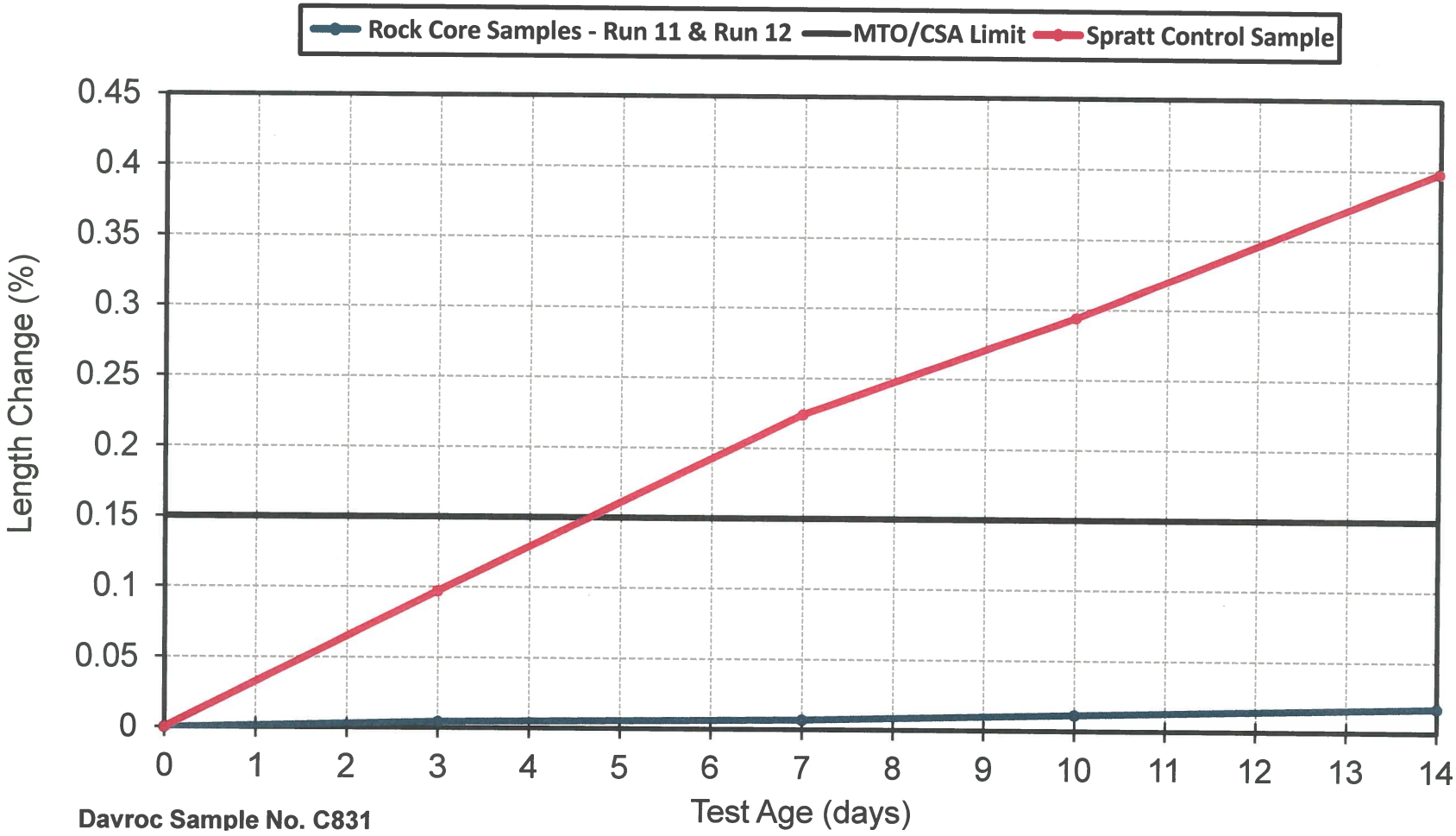
The above test results have been graphically presented on the attached graph.

DAVROC

L16-0429MT

Graph No. 1
MTE Consultants Inc.
Plotting Alkali-Aggregate Expansion Test Results
A23.2-25A Test Method

June 22, 2016



Davroc Sample No. C831

DAVROC

File: L16-0429AT

CSA A23.2-27A Standard Practice to Identify Degree of Alkali-Reactivity of Aggregates and to Identify Measures to Avoid Deleterious Expansion in Concrete

Table 1

Expansion Values for Identifying Potentially Alkali-Silica Reactive Aggregates

Concrete Prism Expansion Test CSA Test Method A23.2-14A (See Annex B, CSA Standard A23.1, Clause B.3.4)	Mortar Bar Accelerated Expansion Test CSA Test Method A23.2-25A* (See Annex B, CSA Standard A23.1, Clause B.3.3)
Greater than 0.040% at l year+	**Greater than 0.150% at 14 days±**

* This method is not appropriate for testing aggregates for alkali-carbonate reactivity.

+ In critical structures such as those used for nuclear containment or large dams, a lower expansion limit may be required.

± Several aggregates that expand more than 0.15% after 14 d have not caused deleterious expansion in field structures and expanded less than 0.040% when tested in accordance with CSA A23.2-14A. Therefore, expansion in excess of the recommended limit calls for further testing of concrete specimens.

A number of quarried siliceous limestone aggregates from the St. Lawrence Lowlands, which expand less than 0.150% after 14 d, have caused deleterious expansion in field structures and have expanded more than 0.040% in concrete prism tests. Therefore, a lower limit of 0.100% is recommended for this type of aggregate (Fournier and Berube 1991b).

Some dolostones from the Beekmantown Group expand significantly when tested in accordance with CSA A23.1-14A (>0.040% after one year), while expanding between 0.10% and 0.15% after 14 d when tested in accordance with CSA A23.2-25A. Deleterious expansion in field structures has not been confirmed (Berube et al., 2000).

There are reports of deterioration of field concretes made with quarried bedrock aggregates of Grenville Age in Ontario containing granites, gneisses, and granodiorites and also some horizons of the Potsdam sandstone, which exhibit less than 0.0100% expansion at 14 d in the CSA A23.2-25A test. Therefore such aggregates shall be tested in accordance with CSA A23.2-14A.

DAVROC

File: L16-0429AT

CSA A23.2-27A Standard Practice to Identify Degree of Alkali-Reactivity of Aggregates and to Identify Measures to Avoid Deleterious Expansion in Concrete

Table 2

Degree of Alkali-Silica Reactivity of Aggregates

Classification of the degree of alkali-silica reactivity	One year expansion (%) in CSA Test Method A23.2-14A*+	14d expansion (%) in CSA Test Method A23.2-25A+±
Nonreactive	**<0.040**	**<0.150% (See Table 1)**
Moderately reactive	**0.040-0.120**	**
Highly reactive	**>0.120**	**>0.150% (see Table 1)**

* The degree of alkali-silica reactivity obtained in the CSA A23.2-14A test is that of a combination of the fine and coarse aggregates intended for use in concrete. If the results of the combination are not available, then the degree of alkali-silica reactivity to be used in this Table shall be that of the most expansive of the aggregates to be used.

+ When data obtained in accordance with CSA A23.2-25A conflict with those obtained with the same aggregate in accordance with CSA A23.2-14A, the results of the latter shall prevail.

± When the accelerated mortar bar test is used, each aggregate to be used shall be tested and the degree of alkali-silica reactivity based on the largest test value shall be obtained.

** The accelerated mortar bar test is not considered to be suitable for distinguishing between moderately and highly reactive aggregates. Consequently, in the absence of concrete prism test data, aggregates that produce >0.150% expansion at 14 days in the test are classified as highly reactive.

DAVROC
TESTING LABORATORIES INC.

CONSULTING ENGINEERS •
Materials Testing ▪
and Inspection

File: L16-0429AT

MTE Consultants Inc.
520 Bingemans Centre Drive
P.O. Box 51
Kitchener, Ontario
N2B 3X9

June 22, 2016

Attention: **Jay Flanagan, B.E.S., B.Ed.**
Senior Project Manager
JFlanagan@mte85.com

Dear Sir;

Rock Core Sample Testing
Freymond Quarry

Further to receipt of the one (1) wooden box of rock core samples in our laboratory on May 13, 2016, Davroc Testing Laboratories Inc. is pleased to report the results of our tests.

The material was given the following designations.

- Davroc Lab Sample No: C832
- Client Sample Identification: Freymond Quarry - Rock Core Samples Run 21 & Run 22, from 101'10" to 111'11"

Test Program

The rock samples from both runs were crushed to passing a 20mm size sieve, and the crushed material was tested in accordance with the Canadian Standard Association, Standard A23.1-14/A23.2-14 test methods shown in the following Table No. 1.

Table No. 1
Summary of Tests Conducted

Laboratory Tests Conducted		Canadian Standards Laboratory Test Number
1.	Relative Density and Absorption of Coarse Aggregate	A23.2-12A
2.	Petrographic Examination of Aggregate	A23.2-15A
3.	Detection of Alkali-Silica Reactive Aggregate By Accelerated Expansion of Mortar Bars	A23.2-25A
4.	Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.	A23.2-29A

Test Results

The test results, together with the specifications limits where applicable, are given as follows:

Table No. 2
Coarse Aggregate Test Results

Test	Davroc Sample No. C832 Rock Core Samples - Freymond Quarry, Run 21 &22	*CSA Concrete Specifications Limits
Absorption (%)	0.3	No Limits
Relative Density (1) Bulk (Saturated Surface Dry) (2) Bulk (3) Apparent	 2.956 2.948 2.974	No Limits
Petrographic Number (See Attached Reports Appendix "A")	Report results	Report results
Alkali-Silica Reactivity (%) (*See Attached Sheets in Appendix "B")	0.046	**0.150 max
Micro-Deval Abrasion (loss %)	7.9	17 max.(1) 21 max.(2)

Table Notes:

*CSA Standards A23.1-14, Table 12 Limits for deleterious substances and physical properties of aggregates.

(1) Concrete exposed to freezing and thawing.
(2) Other exposure conditions.

** CSA Standard A23.2-27A Table 1 Expansion values for identifying potentially alkali-silica reactive aggregates.

Comments

Based on the results of tests conducted, the rock would be suitable for use as a concrete aggregate. Note that once a stockpile has been produced, we would recommend that the processed aggregate be sampled and tested for full compliance tests required by CSA A23.1-14 and the Ministry of Transportation, Ontario.

We trust this report provides you with the information you require at this time. If you have any questions, please do not hesitate to contact the undersigned.

Yours very truly,
Davroc Testing Laboratories Inc.

Kateryna Fiyalko, C.E.T.
Concrete Laboratory Supervisor

Sal Fasullo C.E.T.
Vice President

SF/kf
16-0429-4

Appendix A

Petrographic Examination

DAVROC

Results of Petrographic Examination

Project Number:	L16-0429AT, Davroc Sample No. C832
Client:	MTE Consultants Inc.
Sample Identification:	Freymond Quarry-Rock Core Samples, Run 21 & 22, from 101'10" to 111'11"
Sample Description:	Quartzite

Sample Properties

Lithology	Marble
Mineralogy	Probably quartz, magnetite, muscovite, biotite and pyrite
Colour	Dark grey
Particle Shape	Angular
Particle Surface Texture	Rough
Crystal Size	Fine-grained
Tenacity	Hard
Coating and Encrustations	None
Presence of Materials Deleterious to Concrete	No significant deleterious materials

DAVROC

Detailed Petrographic Examination of Coarse Aggregate (Sample Tested According to CSA – A23.2-15A Test Method)

Source Name:	Freymond Quarry, Run 21 & 22 from 101'10" to 111'11"	**Sieve Fraction**	5 mm +
Project Number:	L16 -0429AT, MTE	**Sample No:**	C832
Petrographer:	R. Ji	**Date Tested:**	June 15 , 2016

Petrographic Description and Quality	Mass (gram)	Percent by Mass	Petrographic Number Contribution
Good (PN Multiplier = 1)			
Magnetic Quartzite	1044.2	100	100
Fair (PN Multiplier = 3)			
Poor (PN Multiplier = 6)			
Total	**1044.2**	**100.0**	**100**

Note:

(1) The PN is not related to the potential for alkali-aggregate reactivity (AAR) of the aggregate when used in Portland cement concrete. AAR potential must be separately assessed.

(2) Rock types indicated by * may have a potential for alkali-aggregate reaction (AAR). See CSA.A23.1 and A23.2 for information on the assessment of AAR in new concrete construction.

Appendix B

Alkali-Silica Reactivity Results

DAVROC

File: L16-0429AT

Table No. 1
Alkali-Silica Reactivity
(CSA A23.2-25A Mortar Bar Expansion)

Aggregate Source	Expansion %				
	Prism No.	3 Day	7 Day	10 Day	14 Day
Davroc Sample No. C832 Freymond Quarry-Rock Core Samples, Run 21 & 22 from 101'10" to 111'11"	1	0.006	0.015	0.031	0.046
	2	0.008	0.017	0.030	0.046
	3	0.009	0.018	0.032	0.047
	Mean	**0.008**	**0.017**	**0.031**	**0.046**
Control Sample (Spratt) March 2016	1	0.098	0.227	0.296	0.400
	2	0.097	0.222	0.294	0.395
	3	0.095	0.222	0.292	0.399
	Mean	**0.097**	**0.224**	**0.294**	**0.398**

Note: See attached CSA Table No's. 1 and 2 for requirements.

The control aggregate expansion result falls within the 0.30 to 0.55% range at 14 days stated in the CSA Test Method A23.2-25A to ensure that the test procedure produces the required test conditions for expansion.

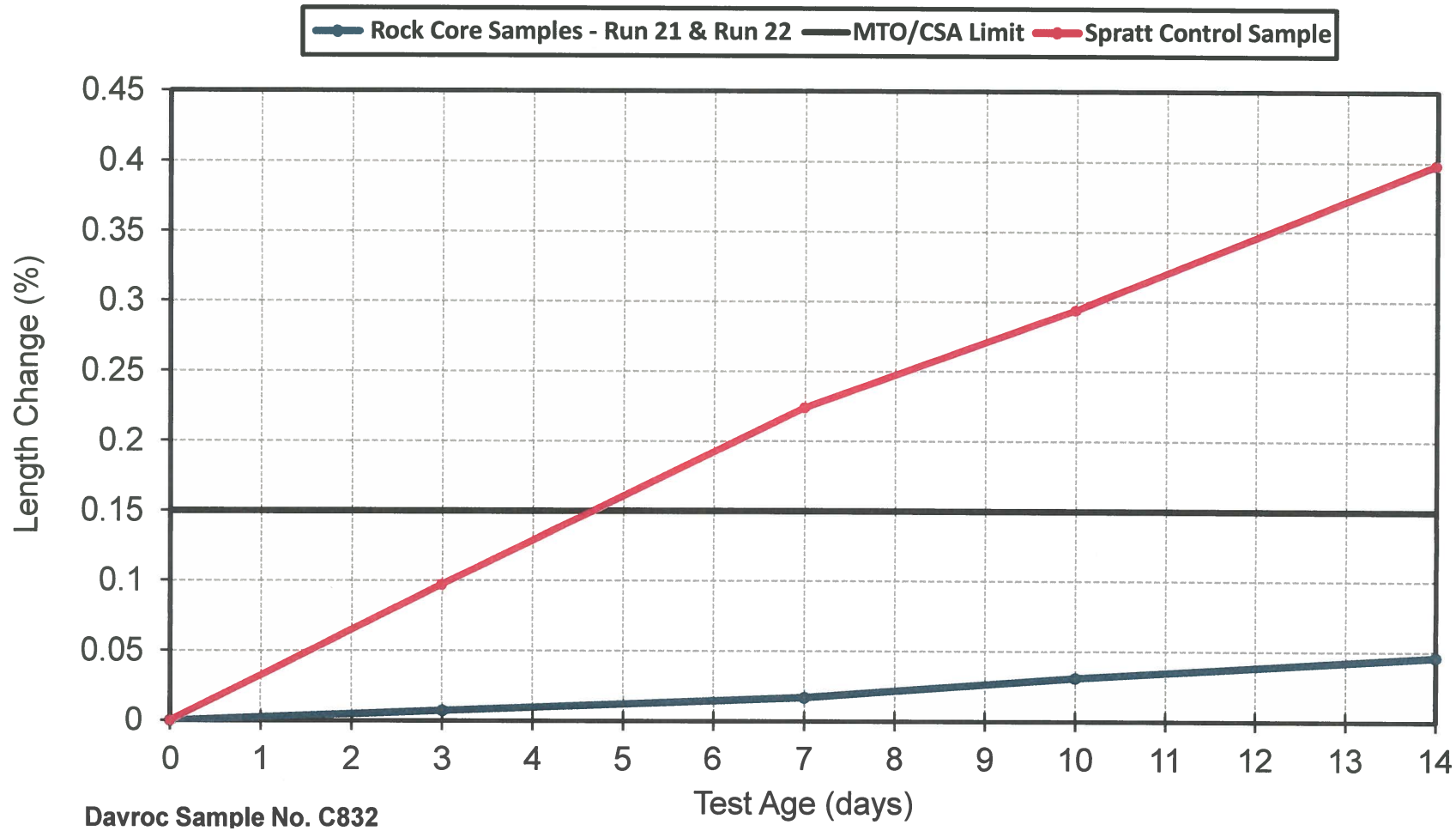
The above test results have been graphically presented on the attached graph.

DAVROC

Graph No. 1
MTE Consultants Inc.
Plotting Alkali-Aggregate Expansion Test Results
A23.2-25A Test Method

June 22, 2016

L16-0429MT



Davroc Sample No. C832

DAVROC

File: L16-0429AT

CSA A23.2-27A Standard Practice to Identify Degree of Alkali-Reactivity of Aggregates and to Identify Measures to Avoid Deleterious Expansion in Concrete

Table 1

Expansion Values for Identifying Potentially Alkali-Silica Reactive Aggregates

Concrete Prism Expansion Test CSA Test Method A23.2-14A (See Annex B, CSA Standard A23.1, Clause B.3.4)	Mortar Bar Accelerated Expansion Test CSA Test Method A23.2-25A* (See Annex B, CSA Standard A23.1, Clause B.3.3)
Greater than 0.040% at l year+	**Greater than 0.150% at 14 days±**

* This method is not appropriate for testing aggregates for alkali-carbonate reactivity.

+ In critical structures such as those used for nuclear containment or large dams, a lower expansion limit may be required.

± Several aggregates that expand more than 0.15% after 14 d have not caused deleterious expansion in field structures and expanded less than 0.040% when tested in accordance with CSA A23.2-14A. Therefore, expansion in excess of the recommended limit calls for further testing of concrete specimens.

A number of quarried siliceous limestone aggregates from the St. Lawrence Lowlands, which expand less than 0.150% after 14 d, have caused deleterious expansion in field structures and have expanded more than 0.040% in concrete prism tests. Therefore, a lower limit of 0.100% is recommended for this type of aggregate (Fournier and Berube 1991b).

Some dolostones from the Beekmantown Group expand significantly when tested in accordance with CSA A23.1-14A (>0.040% after one year), while expanding between 0.10% and 0.15% after 14 d when tested in accordance with CSA A23.2-25A. Deleterious expansion in field structures has not been confirmed (Berube et al., 2000).

There are reports of deterioration of field concretes made with quarried bedrock aggregates of Grenville Age in Ontario containing granites, gneisses, and granodiorites and also some horizons of the Potsdam sandstone, which exhibit less than 0.0100% expansion at 14 d in the CSA A23.2-25A test. Therefore such aggregates shall be tested in accordance with CSA A23.2-14A.

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Table 2

Degree of Alkali-Silica Reactivity of Aggregates

Classification of the degree of alkali-silica reactivity	One year expansion (%) in CSA Test Method A23.2-14A*+	14d expansion (%) in CSA Test Method A23.2-25A+±
Nonreactive	**<0.040**	**<0.150% (See Table 1)**
Moderately reactive	**0.040-0.120**	**
Highly reactive	**>0.120**	**>0.150% (see Table 1)**

* The degree of alkali-silica reactivity obtained in the CSA A23.2-14A test is that of a combination of the fine and coarse aggregates intended for use in concrete. If the results of the combination are not available, then the degree of alkali-silica reactivity to be used in this Table shall be that of the most expansive of the aggregates to be used.

+ When data obtained in accordance with CSA A23.2-25A conflict with those obtained with the same aggregate in accordance with CSA A23.2-14A, the results of the latter shall prevail.

± When the accelerated mortar bar test is used, each aggregate to be used shall be tested and the degree of alkali-silica reactivity based on the largest test value shall be obtained.

** The accelerated mortar bar test is not considered to be suitable for distinguishing between moderately and highly reactive aggregates. Consequently, in the absence of concrete prism test data, aggregates that produce >0.150% expansion at 14 days in the test are classified as highly reactive.