4.

PROJET NO: 84 11 01

REUNION DES PARTICIPANTS DU PROGRAMME D'ECHANGE INTERLABORATOIRE CANADIEN SUR LES MELANGES BITUMINEUX ET LES BITUMES

Préparé par: Jean-Claude Moreux, chim.
Section Mélanges Bitumineux

Sainte-Foy, le 25 août 1987.

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INTERLABORATOIRE CANADIEN SUR LES
MELANGES BITUMINEUX ET LES BITUMES

1.0 IDENTIFICATION DU PARTICIPANT

1.1 Nom : Jean-Claude Moreux
1.2 Fonction : Chimiste
Section Mélanges Bitumineux
1.3 Direction : Sols et Matériaux
Service du Lab. Central

2.0 DESCRIPTION DU VOYAGE

2.1 Endroit : Toronto
Hôtel Skyline, Rexdale
2.2 Durée : La rencontre a eue lieu le 28 avril 1987 et s'est déroulée toute la journée.
2.3 Autorisation: 87 C 403

3.0 CARACTERISTIQUES DES REUNIONS

3.1 Type de réunion:

Rencontre regroupant les représentants des organismes canadiens ayant participé au programme d'échange national. (Organismes gouvernementaux des provinces et firmes privées).

3.2 Le programme d'échange a été organisé par le Ministère des Transports de la province de Terre-Neuve, sous la direction de M. Eric Thériault, ing. et Joe English, ing. Vous trouverez en annexe les personnes qui ont assisté à la réunion.

3.3 Contenu de la réunion

3.3.1 Liste des thèmes abordés:

L'agenda prévu se trouve placé en annexe de ce document. En réalité, la matinée et le début de l'après-midi ont été consacrés à l'examen et aux commentaires des résultats des essais sur les mélanges bitumineux et aux modifications souhaitables pour le prochain programme. Le reste de l'après-midi a été réservé à l'examen des résultats du programme d'échange sur les bitumes.

3.3.2 Résumé des discussions.

3.3.2.1 Résultats du programme d'échange sur les mélanges bitumineux.

Cette réunion a été présidée par Joe English pour les mélanges bitumineux et par Joe Szafron pour la partie bitume du programme d'échange.

Trente échantillons ont été envoyés partout au Canada et vingt-sept laboratoires ont répondu. Les résultats des essais ont été statistiquement analysés. Après une première analyse, les résultats situés à l'extérieur de l'intervalle de confiance de 95% ont été éliminés et la même analyse a été répétée.

L'examen du tableau 1 montre que la plupart des résultats se trouve dans l'intervalle de confiance de 95%. En fait, l'écart-type et l'intervalle dans lequel se trouve les résultats concernant la densité et l'absorption en eau du gros granulat sont aussi précis que les valeurs suggérées par l'ASTM dans le cas d'échange interlaboratoire.

L'écart-type pour la densité et l'absorption des granulats est un peu plus élevé. Ceci peut être attribué aux différentes méthodes employées dans le séchage des granulats. On recommande de suivre pour les prochaines années les règles suivantes:

- Ne pas utiliser de chaleur ou de ventilation pour sécher les granulats;
- les granulats fins devraient être à nouveau lavés après la période d'immersion de 24 h.

La moitié seulement des organismes ont effectué les mesures sur le sable (blend sand). Il n'y avait pas d'espace pour ce résultat dans la feuille de réponse mais cette valeur aurait dû être incluse dans le calcul de la densité et de l'absorption en eau du combinat.

Les valeurs de l'absorption en bitume figurent aussi dans la table 1. Il convient de noter que le pourcentage d'absorption en bitume est le pourcentage par rapport à la masse des granulats séchés à l'étuve présents dans l'enrobé.

Certains laboratoires déduisent l'absorption en bitume directement de la teneur en eau, d'autres cependant, la calcule. On peut utiliser cinq formules différentes pour calculer l'absorption en bitume et toutes sont justes; des problèmes cependant peuvent survenir quand on fait la détermination de valeurs dans lesquelles la teneur en bitume est exprimée en pourcentage par rapport au mélange total. Il est alors suggéré que les laboratoires participants calculent l'absorption suivant la norme ASTM D 4469-85: "Standard Method for Calculating Percent Asphalt Absorption by the Aggregates in an Asphalt Pavement Mixture" Cette méthode donne une détermination de l'absorption en bitume soit en tant que pourcentage par rapport à la masse totale du mélange soit par rapport à la masse totale des granulats. On notera que les tables 1 et 2 de cette norme montrent l'influence des erreurs faites sur chacune des quatre variables: densité maximale, teneur en bitume, densité brute, densité du bitume.

Le tableau 2 résume les résultats obtenus avec les éprouvettes compactées. Peu de laboratoires se trouvent à l'extérieur de l'intervalle de confiance de 95%. On observe que l'écart-type des éprouvettes compactées mécaniquement est souvent plus élevé que celui des éprouvettes compactées manuellement. Cette différence peut être attribuée aux variations de masse des marteaux, le nombre de coups de compactage, le profil de la semelle.

Il y a eu beaucoup de discussions sur la confection et l'essai Marshall sur les éprouvettes. Suivant la norme ASTM D 2726-83 "Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Saturated Surface dry Specimens" la masse de l'éprouvette saturée et sèche en surface est mesurée tout comme la masse sèche pour déterminer la densité brute. Or, tous les laboratoires ne tiennent pas compte de la masse de l'éprouvette saturée sèche en surface.

Durant cette rencontre, les participants se sont mis d'accord sur les points suivants qui seront suivis lors de la compaction des éprouvettes afin de minimiser les variations dans les résultats des essais:

1. Le socle de compactage devra suivre les spécifications de l'ASTM D 1559 et être solidement ancré sur bloc de béton de ciment.

2. Les éprouvettes compactées seront refroidies à l'air durant une heure avant d'être retirées du moule.

3. Les éprouvettes ne seront pas retirées du moule par application de coups sur l'une des faces mais plutôt par application d'une pression constante.

4. Les granulats devront être chauffés pendant un minimum de 12 h avant qu'on ajoute le bitume.

5. Les éprouvettes devront être confectionnées une par une.

6. La densité brute, la stabilité et le fluage ne seront mesurés qu'une journée après la confection des éprouvettes.

7. Le fluage sera mesuré en utilisant un micromètre placé sur chaque tige de guidage de la mâchoire et le fluage moyen sera retenu dans ce cas. Préciser la méthode en usage, si elle est différente.

8. Les laboratoires devront préciser si la face de la semelle de la dame de compactage est plane ou biseautée et si le moule effectue une rotation durant le compactage.

9. Dans le cas d'une semelle de compactage ayant un biseau important, l'épaisseur la plus grande sera placée face à la chaîne du compacteur mécanique avant de commencer le compactage.

Le tableau 3 résume les résultats des essais Marshall effectués sur les éprouvettes. Une très bonne corrélation est visible pour toutes les valeurs calculées. On a suggéré que l'échantillon de mesure de la densité maximale fait sur une éprouvette devrait être placé à nouveau à l'étuve pendant une heure après l'essai de stabilité, et laissé refroidir à l'air ambiant avant d'effectuer l'essai.

Le tableau 4 est une compilation des résultats obtenus avec le compacteur mécanique. La majorité des laboratoires participants n'ont pas de marteau de compactage ayant une masse satisfaisant aux exigences de la norme, ni une hauteur de chute libre telle que requise par la norme ASTM D 1559-82. L'épaisseur de la semelle de la dame de compactage a une certaine importance: la majorité des participants font usage d'une semelle bisautée alors que les autres utilisent une semelle ayant une surface plane.

Le programme de 1987 sera le même que celui de 1986 avec les additions notées précèdemment. Cependant aucun des participants présents ne s'est offert pour organiser le programme de 1987 car aucun ne pouvait endosser cette responsabilité.

Frank Gervais du Ministère des Transports de la Nouvelle Ecosse entreprendra une démarche auprès de la CTAA pour savoir s'il serait possible que cet organisme finance en partie les frais encourus par les laboratoires s'offrant pour organiser les futurs programmes d'échange.

3.2.2.2 Résultats du programme d'échange sur les bitumes:

Cette partie de la réunion a été plutôt décevante, car les résultats présentés ont été analysés à l'aide d'un programme informatique erroné. Le travail a consisté essentiellement à feuilleter le cahier d'analyse et à relever les erreurs les plus flagrantes. La méthode d'analyse statistique est inspirée de celle développée par Youden. Là, encore aucune décision n'a été prise en ce qui concerne l'organisation du prochain programme d'échange.

3.4 Documentation recueillie

Frank Gervais (Ministère des Transports de Nouvelle-Ecosse) fait part de l'existence d'un produit moins toxique que le trichloroéthylène et utilisable dans l'essai d'extraction, par exemple: Bioact. Une documentation à ce sujet pouvait être envoyée à chaque participant qui en exprimait le désir. Une copie de cette documentation est jointe à ce compte-rendu.

4.0 NATURE DE MA PARTICIPATION

4.1 Sessions techniques

Ma présence à cette réunion l'a été en tant que représentant du Ministère des Transports du Québec, organisme ayant participé à ces programmes d'échange.

4.2 Nature des interventions

J'ai participé à l'élaboration des recommandations techniques applicables au prochain programme et j'ai eu à répondre à plusieurs questions sur le sujet de la dernière communication faite à la CTAA sur l'influence de la chaleur sur les bétons bitumineux.

5.0 POINTS D'INTERET POUR LE MTQ

La participation du Ministère à cette activité lui donne un moyen d'évaluer la qualité des essais qui sont faits au Laboratoire Central par rapport à un groupe de participants très diversifiés.

Il serait souhaitable que l'administration des échanges interlaboratoires fait au Québec soit modifiée par l'introduction d'un programme d'échange fait sur le modèle du programme d'échange canadien. Le fait de fournir les combinés de granulats aux participants en leur confiant le soin d'exécuter le malaxage permettrait de mieux contrôler les résultats obtenus et de faire une analyse de la qualité du tamisage en l'absence de toute variation d'usine comme cela peut être le cas d'un mélange produit en usine.

Un second programme fait sur le modèle de ceux en cours en ce moment pourrait être maintenu sans qu'il soit besoin d'effectuer une analyse de la granulométrie.

6.0 AUTRES INFORMATIONS

Je trouve que la réunion qui a permis cette confrontation a été bien organisée; cependant, que l'analyse qui est faite des résultats du programme d'échange n'est pas assez poussée et ilserait souhaitable de présenter pour les mélanges bitumineux une analyse analogue à celle des bitumes.

ANNEXE A

AGENDA DE LA RENCONTRE

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
DEPARTMENT OF TRANSPORTATION

ST. JOHN'S
Soils & Paving Division
278 LeMarchant Road
A1E 1P7
1987 03 18

5/3297

Jean-Claude Moreux
Ministere des Transports
Laboratoire Central
2700, rue Einstein
Sainte-Foy, Quebec
G1P 3W8

Dear Participant:

RE: 1986 Canadian Asphalt Mix Exchange

The 1986 Canadian Asphalt Mix Exchange has been completed and a meeting has been arranged for April 28, 1987 at the Skyline Hotel, 655 Dixon Road, Toronto. We would ask that you complete the attached form and return it to us as soon as possible so we will know the number of participants to expect.

You will be required to make your own reservations at the Skyline (416-244-1711) if you plan to stay there. Please mention that you are attending the Canadian Asphalt Mix Exchange and your rate shall be $63.00 single and $68.00 double.

A proposed agenda for the meeting is attached and the Mix Design report should be mailed within two to three days. I hope to see you in Toronto.

Yours truly,

Eric Theriault, P. Eng.
Soils and Paving Engineer

1986 CANADIAN ASPHALT MIX EXCHANGE
SKYLINE HOTEL, TORONTO, ONTARIO

AGENDA - TUESDAY, APRIL 28, 1987

9:00	-	Welcome
9:10	-	Introductions
9:20	-	Mix Design Exchange
10:00	-	Break
10:20	-	Mix Design Exchange
11:30	-	Recommendations for 1987
12:00	-	Lunch
1:00	-	Asphalt Exchange
3:00	-	Break
3:20	-	Recommendations for 1987
3:40	-	Nomination(s) of 1987 Coordinator(s)
4:00	-	Adjournment

ANNEXE B

LISTE DES PARTICIPANTS PRESENTS A LA RENCONTRE

Joe English	- Newfoundland Department of Transportation
Joe Szafron	- Saskatchewan Department of Transportation
Brian Adams	- Esso Research - Sarnia
Doreen Burdey	- Manitoba Department of Transportation
Keith Davidson	- McAsphalt Industries Ltd.
John Dickson	- Ontario Ministry of Transportation
Frank Gervais	- Nova Scotia Department of Transportation
Ted Harrison	- Alberta Transportation
Dick Hartt	- New Brunswick Department of Transportation
John Kuchak	- Independent Test Lab - Winnipeg
Rudy Labay	- Transport Canada Airports Authority Group - Winnipeg
Bob Laird	- National Testing Laboratories - Winnipeg
Doug Lingley	- New Brunswick Department of Transportation
Jean-Claude Moreux	- Quebec Ministry of Transportation
Randy Sill	- Public Works Canada - Yukon Territory
Andros Tamm	- Koch Materials Company Ltd.

ANNEXE C

NORME ASTM POUR LE CALCUL DE L'ABSORPTION

Standard Method for
CALCULATING PERCENT ASPHALT ABSORPTION BY THE AGGREGATE IN AN ASPHALT PAVEMENT MIXTURE[1]

This standard is issued under the fixed designation D 4469; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This method provides equations for calculating percent asphalt absorption by the aggregate in an asphalt paving mixture, expressed as percent of the oven dry mass of the aggregate in the paving mixture. This calculation is based on measured values for components and properties of an oven-dry asphalt paving mixture.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Applicable Documents

2.1 *ASTM Standards:*

C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate[2]
C 128 Standard Test Method for Specific Gravity and Absorption of Fine Aggregate[2]
C 136 Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates[2]
D 979 Methods for Sampling Bituminous Paving Mixtures[2]
D 1559 Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
D 1560 Standard Test Method for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveen Apparatus[2]
D 1856 Test Method for Recovery of Asphalt from Solution by Abson Method[2]
D 2041 Test Method for Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures[2]
D 2172 Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures[2]
D 3289 Test Method for Specific Gravity of Semi-Solid and Solid Bituminous Materials by Nickel Crucible[2]
E 12 Definitions of Terms Relating to Density and Specific Gravity of Solids, Liquids and Gases[3]

3. Summary of Method

3.1 The percent asphalt absorption for an oven-dry paving mixture (expressed as percent of the oven dry mass of the total aggregate in the paving mixture) can be calculated by means of equations in which measured values for the theoretical maximum specific gravity of an oven dry paving mixture, its asphalt content (expressed either as percent of the total mass of a sample of oven-dry paving mixture, or as percent of the mass of oven dry aggregate in a sample of oven dry paving mixture), the apparent specific gravity of the asphalt and the weighted average ASTM bulk specific gravity of the oven dry total aggregate in the paving mixture (Note 1), has been substituted.

NOTE 1—Whenever it is referred to in this method, the phrase, "weighted average ASTM oven-dry bulk specific gravity of the aggregate," refers to the weighted average of the ASTM oven-dry bulk specific gravities

[1] This method is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.51 on Aggregate Tests.

Current edition approved March 29, 1985. Published September 1985.

[2] *Annual Book of ASTM Standards*, Vol 04.03.

[3] *Annual Book of ASTM Standards*, Vol 15.05.

of the coarse and fine aggregates as determined by Test Methods C 127 and C 128. The fine aggregate ordinarily includes the mineral dust portion of the fine aggregate that passes the No. 200 sieve. The weighted average ASTM oven-dry bulk specific gravity of the total aggregate is to be calculated by means of the equation given in Section 9 of Test Method C 127.

4. Significance and Use

4.1 The amount of asphalt absorbed by the aggregate contributes little or nothing to the durability of an asphalt pavement in service other than possibly providing greater resistance to stripping in the presence of water.

4.2 Percent asphalt absorption can be an indicator of changes that may occur in plant mix production during construction.

4.3 The calculated percent asphalt absorption can be used for calculating percent air voids during paving mixture design.

5. Procedure

5.1 Determine percent asphalt absorption by the aggregate in a paving mixture for a sample of oven-dried paving mixture that is prepared in a laboratory, taken from a pavement, or obtained for quality control during construction.

5.2 Establish percent asphalt absorption by the aggregate in a sample of oven dried paving mixture from values for the sample that have been obtained in accordance with the following ASTM test methods:

5.2.1 Test Method D 2041, theoretical maximum specific gravity of the sample of oven dry paving mixture.

5.2.2 Test Methods D 2172, asphalt content. For samples of paving mixture obtained for quality control during construction, or taken from a pavement, determine the asphalt content of each sample by Test Methods D 2172. For samples of hot-mixed asphalt paving mixture prepared in the laboratory with oven-dried aggregate according to Test Methods D 1559 and D 1560, use the asphalt content that was added during the preparation of the paving mixture.

5.2.3 Test Method D 3289, the apparent specific gravity of the asphalt in the sample of paving mixture.

5.2.4 Test Methods C 127 and C 128, the respective ASTM Dry bulk specific gravities of the coarse and fine aggregates in the sample of paving mixture.

5.2.5 Test Method C 136, to establish the percentages of coarse and fine aggregates employed for or recovered from the sample of paving mixture, and thereby enable the weighted average ASTM oven-dry bulk specific gravity for the total aggregate in the sample of paving mixture to be calculated (using the equation given in Section 9 of Test Method C 127).

6. Calculation

6.1 *Paving Mixtures for Which Asphalt Content is Expressed as Percent by Mass of the Total Mix in a Sample of Oven-dry Paving Mixture.*

6.1.1 When the values for the various items in 5.2 become available, calculate the asphalt absorption as percent of the oven dry mass of the total aggregate in the sample of oven dry paving mixture, by substituting the relevant values in the following equation:

$$Aac = 100\left[\frac{P_{tac}}{100 - P_{tac}} + \frac{G_{ac}}{G_{ag}} - \frac{100G_{ac}}{(100 - P_{tac})G_{tm}}\right] \quad (1)$$

where:

Aac = absorbed asphalt as percent by mass of the oven dry paving mixture.

P_{tac} = asphalt content as percent by mass of the total mix in the sample of oven dry paving mixture.

G_{ac} = apparent specific gravity of the asphalt in the paving mixture sample.

G_{ag} = weighted average ASTM oven dry bulk specific gravity of the total aggregate in the sample of paving mixture.

G_{tm} = theoretical maximum specific gravity of the sample of oven-dry paving mixture.

6.2 *Paving Mixtures for Which Asphalt Content is Expressed as Percent of the Mass of the Oven-Dry Total Aggregate in a Sample of Oven-Dry Paving Mixture.*

6.2.1 When the values for the various items in 5.2 become available, calculate the asphalt absorption as percent of the oven dry mass of the aggregate in the sample of oven dry paving mixture by substituting the relevant values in the following equation:

$$Aac = 100\left[\frac{P_{tac}}{100 - P_{tac}} + \frac{G_{ac}}{G_{ag}} - \frac{(100 + P_{aac})(G_{ac})}{100\,G_{tm}}\right] \quad (2)$$

where:

P_{aac} = asphalt content as percent of the mass of the oven dry total aggregate in a sample of oven dry paving mixture.

and

the other symbols have the significance designated for them in 6.1.1.

NOTE 2—The calculated percent asphalt absorption increases with an increase in theoretical maximum specific gravity of a paving mixture, increases with an increase in its asphalt content, decreases with an increase in the apparent specific gravity of the asphalt, and decreases with an increase in the total aggregate's weighted average ASTM oven-dry bulk specific gravity.

7. Report

7.1 Report asphalt absorption as percent of the oven dry mass of the total aggregate in the sample of oven-dry paving mixture to the nearest 0.1 %.

7.2 Report the value for each of the four variables that are included either in Eqs 1 or 2 as follows:

7.2.1 Theoretical maximum specific gravity of the oven dry sample of paving mixture.

7.2.2 Asphalt content as percent of the mass of the oven dry sample of paving mixture, Eq 1, or asphalt content as percent of the mass of the oven dry total aggregate in a sample of oven dry paving mixture, Eq 2.

7.2.3 Apparent specific gravity of the asphalt in the sample of paving mixture.

7.2.4 Weighted average ASTM oven dry bulk specific gravity for the total aggregate in the sample of paving mixture.

8. Precision

8.1 Both Eqs 1 and 2 for calculating asphalt absorption as percent of the mass of oven-dry aggregate in a sample of oven dry paving mixture are mathematically exact.

8.2 The precision of the reported value for percent asphalt absorption depends on the accuracy of the value measured for each of the four variables that are included in either Eqs 1 or 2. Errors in these measured values can have a major influence on the value for percent asphalt absorption. The influence of these errors on the calculated value for percent asphalt absorption is illustrated by the data in X1.2.1 in Appendix X1.

APPENDIX

(Nonmandatory Information)

X1. SAMPLE CALCULATIONS

X1.1 Sample Calculations for Percent Asphalt Absorption

X1.1.1 The usefulness and bias of Eqs 1 and 2 for determining the percent asphalt absorption by the aggregate in a sample of asphalt paving mixture is illustrated by the following sample calculations:

X1.1.2 *Numerical Calculation*—Assume the following:

X1.1.2.1 Theoretical maximum specific gravity of an oven-dry sample of paving mixture = 2.501.

X1.1.2.2 Asphalt content of oven-dry paving mixture sample expressed as percent by mass of total mix = 6.2 (for use with Eq 1).

X1.1.2.3 Corresponding asphalt content of oven-dry paving mixture sample expressed as percent by mass of the oven-dry total aggregate in the sample

$$= \frac{6.2}{93.8} \times 100 = 6.61 \text{ (for use with Eq 2).}$$

X1.1.2.4 Apparent specific gravity of asphalt in paving mixture sample = 1.015.

X1.1.2.5 Weighted average ASTM oven-dry bulk specific gravity of the total aggregate in the paving mixture sample = 2.673.

X1.1.2.6 Basis of calculation—100 cc of paving mixture at its theoretical maximum specific gravity.

X1.1.2.7 Mass of 100 cc of paving mixture = 250.1 g

X1.1.2.8 Mass of asphalt $= \frac{6.2}{100} \times 250.1 = 15.51$ g

X1.1.2.9 Volume of asphalt $= \frac{15.51}{1.015} = 15.28$ cc

X1.1.2.10 Mass of aggregate $= \frac{93.8}{100} \times 250.1 = 234.59$ g

X1.1.2.11 Volume of aggregate $= \frac{234.59}{2.673} = 87.76$ cc

X1.1.2.12 Volume of asphalt plus volume of aggregate = 15.28 + 87.76 = 103.04 cc

The difference between 103.4 cc and the original 100 cc represents the volume of asphalt absorbed into the international capillary porosity of the individual aggregate particles.

Consequently:

Volume of absorbed asphalt = 103.04 − 100 = 3.04 cc

Mass of absorbed asphalt = 3.04 × 1.015 = 3.09 g

$$\text{Percent asphalt absorption} = \frac{3.09}{234.59} \times 100 = 1.32$$

NOTE—The above sample calculation employed asphalt content expressed as percent of mass of oven-dry total mix. An identical percent asphalt absorption value is obtained when the calculations are based on asphalt content expressed as percent by mass of the total oven-dry aggregate in the oven dry paving mixture sample.

X1.1.3 *Substitution in Eq 1*

$$Aac = 100\left[\frac{P_{tac}}{100 - P_{tac}} + \frac{G_{ac}}{G_{ag}} - \frac{100G_{ac}}{(100 - P_{tac})G_{tm}}\right]$$

$$Aac = 100\left[\frac{6.2}{93.8} + \frac{1.105}{2.673} - \frac{(100)(1.015)}{(93.8)(2.501)}\right]$$

$$= 100(0.066 + 0.380 - 0.433)$$

$$= 100(0.446 - 0.433)$$

$$= 100(0.013) = 1.3\ \%$$

X1.1.4 *Substitution in Eq 2*

$$Aac = 100\left[\frac{P_{aac}}{100} + \frac{G_{ac}}{G_{ag}} - \frac{(100 + P_{aac})}{100G_{tm}}(G_{ac})\right]$$

$$= \left[\frac{6.61}{100} + \frac{1.015}{2.673} - \frac{(106.61)(1.015)}{(100)\ (2.501)}\right]$$

$$= 100(0.0661 + 0.3797 - 0.4326)$$

$$= 100(0.4458 - 0.4326)$$

$$= 100(0.013) = 1.3\ \%$$

Therefore, by means of either Eqs 1 or Eq 2, the percent asphalt absorption into the internal capillary porosity of the aggregate particles in a sample of asphalt paving mixture can be determined as soon as each of the four variables that are included in these equations have been evaluated.

X1.2 Influence of Errors in Each of the Four Variables Included in Either Eq 1 or Eq 2 on Percent Asphalt Absorption

X1.2.1 The influence of errors in the measurement of each of the four variables (a) the theoretical maximum specific gravity of an oven dry paving mixture, (b) its asphalt content expressed either as percent of the mass of the sample of oven-dry paving mixture, Eq 1, or as percent of the mass of oven-dry total aggregate in the sample of oven-dry paving mixture, Eq 2, (c) the apparent specific gravity of the asphalt in the paving mixture, and (d) the weighted average ASTM bulk specific gravity of the oven-dry total aggregate in the paving mixture, is illustrated for each variable in turn in the following table, for which it is assumed that the correct value for each of these four variables for a typical asphalt paving mixture is listed in the first row (previously used for the sample calculations in X1.1.2). It should be particularly noted that the relatively small range of errors recorded for each variable in the table that follows, is within the limits of the ASTM precision statement for reproducibility for that variable. In Table X1.1, the effect on asphalt absorption of these limited errors in each of the four variables, is shown for each variable in turn while the other three variables are held constant. Each variable being changed in turn within its range of reproducibility is marked by the symbol (a).

The minimum and maximum values of percent asphalt absorption that could occur on the basis of the data in Table X1.1 due to the most fortuitous combination of errors listed for the determination of the four variables are shown in Table X1.2.

Consequently, even when errors in each variable in Eqs 1 or 2 for asphalt absorption are within the ASTM reproducibility precision limits for that variable, in the case of the sample calculations illustrated in X1.1.2, X1.1.3, and X1.1.4, the reported value for percent asphalt absorption could range from −0.38 to 3.05 as extreme limits.

TABLE X1.1 Effect of Measurement Errors on Calculated Percent Asphalt Absorption

Theor. Max. Spec. Grav.	Asphalt Content %[A]	Asphalt App. Spec. Grav.	Weighted Average ASTM Oven-Dry Bulk Spec. Grav. of Total Agg.	% Asphalt Absorption
2.501	6.2	1.015	2.673	1.32
2.482(a)	6.2	1.015	2.673	0.98
2.491(a)	6.2	1.015	2.673	1.14
2.511(a)	6.2	1.015	2.673	1.49
2.520(a)	6.2	1.015	2.673	1.64
2.501	5.39(a)	1.015	2.673	0.77
2.501	5.7(a)	1.015	2.673	0.98
2.501	6.7(a)	1.015	2.673	1.66
2.501	7.01(a)	1.015	2.673	1.85
2.501	6.2	1.013(a)	2.673	1.33
2.501	6.2	1.017(a)	2.673	1.31
2.501	6.2	1.015	2.615(a)	2.16
2.501	6.2	1.015	2.635(a)	1.86
2.501	6.2	1.015	2.653(a)	1.61
2.501	6.2	1.015	2.663(a)	1.46
2.501	6.2	1.015	2.683(a)	1.18
2.501	6.2	1.015	2.693(a)	1.03
2.501	6.2	1.015	2.713(a)	0.76
2.501	6.2	1.015	2.731(a)	0.51

[A] Based on mass of a sample of oven-dry total mix (kg of asphalt per 100 kg of oven dry total mix).

TABLE X1.2 Minimum and Maximum Calculated Percent Asphalt Absorption Due to Measurement Errors

Theor. Max. Spec. Grav.	Asphalt Content %[A]	Asphalt App. Spec. Grav.	Weighted Average ASTM Oven Dry Bulk Spec. Grav. of Total Agg.	% Asphalt Absorption
		For Minimum Asphalt Absorption		
2.482	5.39	1.017	2.731	−0.38
		For Maximum Asphalt Absorption		
2.520	7.01	1.013	2.615	3.05

[A] Based on mass of a sample of oven-dry total mix (kg of asphalt per 100 kg of oven dry total mix).

ANNEXE D

DOCUMENTATION SUR LE BIOACT

BIOACT®
NATURALLY SAFE CLEANING

BIOACT® INDUSTRIAL DG-1
TECHNICAL DATA SHEET

DESCRIPTION

Petroferm's degreaser, Bioact Industrial DG-1, represents a totally new approach to film-stripping/degreasing. The formulation is a blend of specially selected solvents and surface active agents engineered to be an efficient stripping package for hydrocarbons. It has very low toxicity, and when used as directed, can be used with confidence that it will not harm workers or environment. Furthermore, it will not corrode metal surfaces. Its nonalkaline pH eliminates the hazard often associated with other degreasers resulting from their highly caustic nature. This formulation contains no petroleum solvents, chlorides, or heavy metals.

FEATURES/BENEFITS

- safe to use
- noncorrosive
- very easy to handle — excellent for spray application; may also be brushed, mopped or used as soak cleaner in dip tanks (not suited for vapor degreasing)
- pleasant smell
- free rinsing — leaves no oily residue
- concentrated penetrating cleaning power requires less labor; may be diluted with water
- cold cleaning — reduces heating cost often associated with other degreasers
- biodegradable; does not chelate heavy metals

USES

Bioact Industrial DG-1 is a specialty degreaser designed especially for use in cleaning oily films from metal parts and surfaces. It works extremely well in cleaning oily residues from tank walls/bottoms, concrete floors, glass, machinery, equipment and transportation vehicles. It is capable of stripping even the heaviest oils such as #6 oil or asphaltic tars. A surface treated with DG-1 can be cleaned sufficiently for welding, painting, or coating. DG-1 can be used to render a tank gas-free and allow product change without fear of contamination.

Petroferm USA

5400 First Coast Hwy. Fern. Beach, FL 32034 • (904) 261-8286 Telex: 803628

Material Safety Data Sheet
May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910.1200. Standard must be consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY (As Used on Label and List) BIOACT® * DG-1

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name: PETROFERM INC.	Emergency Telephone Number: Poisindex--1-800-332-3073
Address (Number, Street, City, State, and ZIP Code): 5400 First Coast Highway	Telephone Number for Information: 1-904-261-8286
Suite 200	Date Prepared: 10/20/86
Fernandina Beach, FL 32034	Signature of Preparer (optional): [signature]

Section II — Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)
Terpene Hydrocarbons CAS # 138-86-3	Not Est.	Not Est.	Not Est.	65 - 95

All ingredients are listed either on the GRAS or as an approved substance for use either as an indirect food additive or for use in the manufacture of metal food containers as described in the code of Federal Regulations, Title 21, Part 178, Section 3400 or Section 3910.

Section III — Physical/Chemical Characteristics

Boiling Point	340 - 372°F	Specific Gravity (H_2O = 1)	0.85
Vapor Pressure (mm Hg.) at 70°F	1.6	Melting Point	< 0°F
Vapor Density (AIR = 1)	> 1	Evaporation Rate (Butyl Acetate = 1)	< 1

Solubility in Water: Emulsifiable

Appearance and Odor: Clear free flowing liquid, Citrus odor.

Section IV — Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL
145°F COC	at 302°F	0.7%	6%

Extinguishing Media: Dry Chemical, Foam, CO_2

Special Fire Fighting Procedures: Precautions used in oil fires.
Use self-contained breathing apparatus.

Unusual Fire and Explosion Hazards: None

(Reproduce locally)

OSHA 174, Sept. 1985

* "BIOACT" IS A REGISTERED TRADEMARK OF PETROFERM INC.

deck construction, so that full deflection of a span due to the weight of the concrete, takes place before the concrete sets. Since the setting of concrete is naturally slower in cool temperatures, the specifications permit the use of plain water reducers when temperatures are low and a retarder would cause excessive delays in setting. MDOT approves only retarders that are also water reducers, officially named 'water-reducing retarders.'

Accelerators speed up the setting and strength gain of concrete. They usually are used to offset the effect of low temperatures, but are also used for early strength development in fast-set pavement patching or other situations where early strength is required. The usual material is calcium chloride, but its use is restricted to plain concrete or in concrete without significant reinforcing steel. Non-chloride, non-corrosive accelerators have been developed recently but are not used generally because of their high cost.

Precaution on the use of admixtures. Use of excessive quantities of admixtures can produce unusual results: water reducers can cause retardation, retarders can delay set for days or cause very rapid setting. Refer to the "Admixtures Approval List" for minimum addition rates. Maximum addition rates generally should not be more than twice the minimum rates unless recommended by the admixture supplier or indicated satisfactory by test. While these chemical admixtures can be beneficial in providing improved concrete, they are not a substitute for normal care in maintaining moderate concrete placement temperatures, maintaining lowest practical water/cement ratio, control of rapid evaporation of water from slab surfaces, and providing for good early (and continued) curing of the concrete.

-Ralph Vogler

GOODBYE TRICHLOR

In 1976, Congress passed the Resource Conservation and Recovery Act which directed the Environmental Protection Agency (EPA) to develop and implement a program to protect human health and the environment from improper hazardous waste management practices. This program was then designed to control hazardous waste from its generation to its ultimate disposal—from 'cradle to grave.' In 1984, amendments to the Act were signed into law requiring that small generators of hazardous waste (between 100 and 1,000 kilograms per month) be brought into the regulatory systems. For quantities smaller than 100 kg, the Michigan Department of Natural Resources has its own control procedures, that we must follow.

In order to minimize the problems associated with controlling and disposing of hazardous waste, MDOT has begun a vigorous campaign to reduce the use of such materials. One of the first to go is trichloroethylene as used in the field for extraction testing of bituminous paving mixes. Trichlor can continue to be used in the laboratory, because of the extensive air handling equipment and disposal facilities located there.

Once the decision was made to eliminate trichloroethylene from the field, a search was begun immediately for a substitute method of quality control. The Bituminous Technical Services Unit looked at alternate solvents (almost all of which are also considered to be hazardous materials), nuclear gages for measuring asphalt content, and other methods of carefully controlling the materials before they were mixed, in order to eliminate the need for field extractions.

Although development of all three of the preceding general methods are continuing, we were fortunate enough to find a substitute solvent that will not generate hazardous waste. The solvent, called BIOACT, has been used as a replacement for trichloroethylene as an industrial degreaser. BIOACT has been tested in the bituminous laboratory and found to work effectively in extraction testing; thus, field extraction testing can continue as a primary method of quality control. Daily samples and lab samples for verification of materials indicated by field tests to be out-of-specification, will continue to be tested in the laboratory by the Bituminous Technical Services Unit using trichloroethylene.

Although extraction test procedures using BIOACT are similar to those using trichloroethylene, there are some important differences. Therefore, our Bituminous Technical Services Unit is scheduling seminars to be given in each District to the persons involved with extraction testing. To get this information to our field personnel as quickly as possible, initial seminars will involve only MDOT employees; however, these seminars will be available also to local government, contractor, and consultant personnel, once our in-house needs are served.

Field Engineers will be receiving a letter listing dates for the schools and asking their cooperation in making this changeover a success. We were very fortunate to find such a relatively painless way to eliminate the use of a hazardous material. With the cooperation of everyone involved, it will work! Questions regarding the schools can be directed to Gary Chapman (517) 322-1216.

-Fred Copple

TECHADVISORIES

The brief information items that follow here are intended to aid MDOT technologists by advising or clarifying, for them, current technical developments, changes or other activities that may affect their technical duties or responsibilities.

RUDY KETOLA

Rudy Ketola is retiring this month after more than 40 years of service with the Department. Rudy joined MDOT in 1946, working in the Construction Division. In 1951 he began his long career with the Materials & Technology (then Testing & Research) Division as the traveling bituminous mix technologist for the entire Upper Peninsula, and for 36 years thereafter Rudy represented the best interests of the Department, while maintaining a cooperative and helpful relationship with the contractors.

Rudy's career paralleled the State's use of hot-mix bituminous material; he started about the time that hot-mix plants and paving equipment were introduced (and in those days his job involved street, as well as plant inspection) and his technical expertise grew as the industry did. With such a long and pioneering career in the field, Rudy has many unique experiences to relate; however, the most challenging was the paving of the Mackinac Bridge. Paving operations took place in November, and the Governor had promised that the bridge would be open in time for deer season; thus, conditions were less than ideal and time was of the essence. Further, paving over such a structure with its movements, its steel grid surface, etc., entailed special mix, equipment, and construction procedures. The job was a success, and Rudy's part in it was no small one.

Rudy has played an integral part in the technical advancements in bituminous paving throughout the State in his years as a traveling bituminous mix technologist, and he has literally overseen the design and quality asssurance of thousands of miles of flexible pavements. Though the loss of his knowledge and experience is one that will be keenly felt, it's his presence on the job—as Rudy—that will be missed by his many friends in the Department and the industry. Thanks, Rudy, for all you've done, and best wishes for many happy retirement years ahead!

This document is disseminated as an element of MDOT's technical transfer program. It is intended primarily as a means for timely transfer of technical information to those MDOT technologists engaged in transportation design, construction, maintenance, operation, and program development. Suggestions or questions from district or central office technologists concerning MATES subjects are invited and should be directed to M&T's Technology Transfer Unit.

Technology Transfer Unit
Materials and Technology Division
Michigan DOT
P.O. Box 30049
Lansing, Michigan 48909
Telephone (517) 322-1637

ANNEXE E

TEXTE DU PROGRAMME D'ECHANGE

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
DEPARTMENT OF TRANSPORTATION

ST. JOHN'S
Soils and Paving Division
278 LeMarchant Road
A1E 1P7
1986 10 14

5/3172

Jean-Claude Moreux
Ministere des Transports (Quebec)
Laboratoire Central
2700 Rue Einstein
St. Foy, Quebec
G1P 3W8

Dear Sir:

The Soils and Paving Division of the Department of Transportation, Government of Newfoundland and Labrador, is proud to be hosting the 1986 Canadian Asphalt Mix Design Exchange.

We apologize for any inconvenience caused by the delay in sending this letter but we have recently gone through a labour dispute involving Government employees. Enclosed is a form regarding the Mix Design Exchange.

The following is a schedule of submission deadlines:

November 14, 1986	-	Return of Form
December 12, 1986	-	All Participants to Receive Samples by This Date
January 31, 1987	-	All Data Must Reach This Office

Samples for this years mix exchange will be shipped collect. Please indicate the carrier preferred.

Yours truly,

Joe English

Joe English, P. Eng.
Engineer III

JE/bjk
Encl.

GOVERNMENT OF NEWFOUNDLAND AND LABRADOR
DEPARTMENT OF TRANSPORTATION

ST. JOHN'S

Soils and Paving Division
278 LeMarchant Road
A1E 1P7
1986 11 27

5/3220

Jean-Claude Moreux
Ministere des Transports
Laboratoire Central
2700, rue Einstein
Sainte-Foy, Quebec
G1P 3W8

Dear Participant:

Enclosed please find, information and instructions for the 1986 Canadian Asphalt Mix Exchange. This year's exchange follows the same format as last years except that the fine aggregate and blending sand will be washed on the 75 μm sieve for fine aggregate relative densities.

This container should contain nineteen (19) aggregate samples and two (2) samples of asphalt cement. Please inform us of any discrepancies.

If you have any questions, please inform Mr. Tom Wall or Mr. Joe English of this office - (709) 576-2443.

Please forward your test results to us by January 31, 1987.

Yours truly,

Eric Theriault, P. Eng.
SOILS & PAVING ENGINEER

ET/bjk

1986 CANADIAN ASPHALT MIX EXCHANGE INSTRUCTIONS

Mix Ingredients

The mix, consisting of crushed coarse and fine aggregate and a blending sand, was used in a 1986 Newfoundland Department of Transportation (NFLD DOT) project. The blending sand is from a different source. All the asphalt cement samples are from the same batch.

Sample Container

Your container contains the following:

- 19 Aggregate Samples
- 2 Samples of Asphalt Cement

These aggregate samples are to be used as follows:

Twelve 1180 g	Samples for Marshall Briquettes
One 1500 g	Sample for Maximum Theoretical Density (MTA)
Two 2000 g	Samples for Coarse Relative Density
Two 1000 g	Samples for Fine Relative Density
Two 1000 g	Samples for Blending Sand Relative Density

Aggregate Samples are ready for use with the following exceptions:

a) The coarse relative density samples must be washed and sieved on the No. 4 sieve as ASTM C127 requires.

b) The fine relative density samples (blending sand included) shall be tested according to ASTM C128. They must be washed on the No. 200 sieve.

Marshall Briquettes and MTD Samples

Aggregate for the 12 Marshall Briquettes have been labelled:

1,2,3	Hand, unsupported
4,5,6	Hand, unsupported, return to sender (NFLD DOT)
7,8,9	Mechanical
10,11,12	Mechanical, return to sender (NFLD DOT)

1986 CANADIAN ASPHALT MIX EXCHANGE INSTRUCTIONS

The aggregate has been preweighed to 1180g and 74g of asphalt cement will be added (5.9% Asphalt Content Total Mix Basis).

Aggregate for the MTD sample has been preweighed to 1500g to which 94g of asphalt cement will be added to achieve a content of 5.9% (Total Mix Basis).

Note: If for some reason the aggregate mass varies from that specified, the asphalt cement mass should be calculated based on the new aggregate mass to equate to a 5.9% (Total Mix Basis) asphalt cement content.

Asphalt Cement

Two cans of 150/200 (penetration grade asphalt cement) have been provided.

To ensure consistency, the following values should be used:

Specific Gravity	-	1.015
Mixing Temperature (°C)	-	140°
Compaction Temperature (°C)	-	130°

Tests to be Performed and Reported

Aggregate Relative Density & Water Absorption

Two determinations are to be made on each of the coarse, fine, and blending sand aggregates using the individual pre-weighed samples. The coarse relative density shall follow ASTM C127. The fine relative density shall follow ASTM C128. Aggregate relative density is to be reported for four (4) significant figures.

The water absorption for the three aggregates shall be determined during the relative density testing and reported.

The combined percentage water absorption is based on a blend of 35% of the average held on 4.75mm, 56% of the average passing 4.75mm, and 9% of the average passing 4.75mm of the blending sand.

1986 CANADIAN ASPHALT MIX EXCHANGE INSTRUCTIONS

Asphalt Cement Absorption

For those agencies that use a percentage of the water absorption for the asphalt cement absorption, please indicate the percentage used and the asphalt cement absorption you would normally use calculating for percentage of air voids and voids filled.

For those agencies that determine asphalt cement absorption using MTD, two values are required. The first MTD value is to be determined using fresh mix (the 1500g sample provided). The second MTD value is to be determined using briquette #3 (hand compacted, unsupported) and heating it to 100°C after Marshall stability and flow testing.

Asphalt Cement Content and Briquette Preparation

Twelve (12) briquettes with an asphalt cement content of 5.9% (Total Mix Basis) are to be prepared separately by adding 74g of asphalt cement.

One MTD sample with an asphalt cement content of 5.9% (Total Mix Basis) is to be prepared separately by adding 94g of asphalt cement.

The following procedures are to be followed to ensure uniformity:

1). Mixing should be done at 140°C using a "buttered" mixing pan. The mixing pan should not be totally clean but should contain the residue from previous mixing that is left after scraping with a spoon and/or spatula.

2). The asphalt cement added should be the percentage specified and no allowance should be made for asphalt cement that is left sticking to the sides of the mixing pan.

3). All mixing is to be performed using a spoon and spatula.

1986 CANADIAN ASPHALT MIX EXCHANGE INSTRUCTIONS

Compaction

A total of twelve (12) briquettes will be manufactured; six (6) hand compaction, six (6) mechanical compaction. Three of the hand compacted unsupported briquettes and three mechanically compacted briquettes shall be shipped to NFLD DOT after densities have been calculated and recorded.

Hand compaction shall be 75 blows to each face at 130°C following procedures in ASTM D1559. Mechanical comapction shall be the equivalent blow count to each face that your laboratory correlates to the 75 blows of the hand hammer. Compact at 130°C.

To be reported:

The average bulk density in kg/m^3 of -

Briquettes 1,2,3 - hand compacted, unsupported
Briquettes 4,5,6 - hand compacted, unsupported, return to sender (NFLD DOT)
Briquettes 7,8,9 - mechanical compacted
Briquettes 10,11,12- mechanical compacted, return to sender (NFLD DOT)

The MTD of Briquette #3 (kg/m^3)

Stability (kN) and flow (mm) of briquettes 1,2,3 (hand) and 7,8,9 (mechanical).

Mechanical Compaction Data

Number of Blows

Mass of Compaction Hammer (kg)

Drop of Hammer (mm)

Thickness of Compaction Foot (mm) (High and Low thickness, if bevelled).

Type and trade name of mechanical compactor (eg. homemade, Soiltest, double acting, etc.)

Date of compaction of briquettes 4,5,6 (hand) and 10,11,12 (mechanical) that are shipped to NFLD DOT.

Note: These briquettes should be well packaged and labelled "Fragile" to reduce damage when shipped to NFLD DOT)

1986 CANADIAN ASPHALT MIX EXCHANGE INSTRUCTIONS

Calculated Data - VMA, Air Voids and Voids Filled

The above design data is to be calculated for the three hand compacted briquettes (1,2,3) and the three mechanically compacted briquettes (7,8,9) using the bulk relative density of the aggregate, the bulk density of the briquettes and the asphalt cement absorption which your laboratory has calculated.

Note: The VMA briquettes shall be calculated using the asphalt cement content of 5.9%

Data

All tests and calculation sheets shall be submitted for a review. In those cases where calculations are prepared by a computer, a copy of the printout shall be submitted.

Rejection Criteria

Select data shall include only the values that fall within the 95% confidence limits of the average.

Submission Data

All data shall be returned by January 31, 1987. If testing cannot be completed by this date, please advise NFLD DOT in order to eliminate delays in compiling the report.

ANNEXE F

RESULTATS DU PROGRAMME D'ECHANGE

TABLE I

1986 CANADIAN ASPHALT MIX EXCHANGE

AGGREGATE DATA

LAB NO.	NAME	SPECIFIC GRAVITY AGGREGATE +4	SPECIFIC GRAVITY AGGREGATE -4	SPECIFIC GRAVITY BLENDING SAND	SPECIFIC GRAVITY COMB.	WATER ABSORPTION AGGREGATE +4	WATER ABSORPTION AGGREGATE -4	WATER ABSORPTION BLENDING SAND	WATER ABSORPTION COMB.	% WATER USED	ASPH. ABS. MIX CALC.
1	-	2.655	2.666	2.643	2.660	.59	.42	.42	.48	65	.30
2	-	2.644	2.656	2.644	2.651	.41	.60		.54		.23
3	-	2.661	2.663	2.646	2.661	.45	.47	.45	.46		.46
4	-	2.656	2.654	2.630	2.652	.45	.77	.86	.66		.41
5	TRANS.CAN.MAN.	2.654	2.646	2.548 *	2.640	.66	.64	.46	.63		.41
6	WARNOCK&HERSEY NS	2.660	2.660	2.649	2.659	.39	.48	.53	.45		.49
7	D.O.T. LAB. N.S.	2.633 *	2.650	2.625	2.642	.70	.60	.80	.65		.63
8	MARITIME TESTING	2.647	2.646	2.624	2.644	.50	.50		.50		.26
9	ESSO SARNIA	2.653	2.647	2.632	2.648	.52	.52		.52		.44
10	MIN.TRANS.QUE.	2.653	2.686 *	2.640	2.670	.46	.30		.39		.51
11	SASK. D.O.H.	2.664	2.632	2.607	2.641	.60	.47	.57	.53		.72
12	TERRA ENG. B.C.	2.654	2.654	2.652	2.654	.36	.50	.44	.45		.43
13	N.B.D.O.T.	2.674 *	2.674	2.652	2.672 *	.36	.28		.31 *		.19
14	-	2.649	2.625 *	2.632	2.634	.58	.62	.40	.59	60	.35
15	M.T.H.KAMLOOPS	2.633 *	2.651	2.556 *	2.636	.73	.59	1.68 *	.74 *		.73
16	-	2.654	2.658	2.647	2.656	.66	.67	.71	.67		.60
17	ALBERTA TRANS.LAB	2.668	2.658	2.652	2.660	.31	.49	.34	.41		.33
18	McASPHALT	2.659	2.653	2.637	2.654	.41	.57		.51		.47
19	-	2.637	2.667	2.646	2.654	.86 *	.38	.26	.54		.43
20	NFLD.D.O.T.	2.649	2.650	2.635	2.648	.45	.29	.60	.38		.39
21	M.H.T. MAN.	2.648	2.656	2.635	2.651	.52	.54	.41	.52		.29
22	-										
23	-	2.634	2.651	2.645	2.652	.40	.44		.42		.56
24	M.T.H.BURNABY	2.652	2.658	2.644	2.655	.53	.54	.44	.53		.48
25	-										
26	-	2.638	2.642	2.629	2.646	.41	.57	.53	.51	60	.30
27	-										
28	-	2.663	2.641	2.634	2.648	.52	.56		.59		.19
29	-	2.653	2.634	2.633	2.643	.25	.82 *	.53	.60		.60
30	-	2.669	2.665	2.638	2.664	.40	.70		.70		.70
All Data											
n		27	27	27	27	27	27	18	27	3	22
Mean		2.654	2.653	2.632	2.652	0.50	0.53	0.58	0.53	61.67	0.44
St. Dev.		.010	.013	.025	.009	0.14	0.13	0.31	0.11	2.89	0.16
95% Range (low-end)		2.634	2.628	2.583	2.634	0.23	0.27	0.00	0.32	56.00	0.13
(high-end)		2.674	2.679	2.681	2.669	0.77	0.79	1.19	0.73	67.33	0.75
Data Range (lowest)		2.633	2.625	2.548	2.634	0.25	0.28	0.26	0.31	60	0.19
(highest)		2.674	2.686	2.652	2.672	0.86	0.82	1.68	0.74	65	0.73
Selected Data (*Data Rejected)											
n		24	25	25	26	26	26	17	25	3	27
Mean		2.655	2.653	2.638	2.651	0.49	0.52	0.51	0.53	61.67	0.44
St. Dev.		.007	.010	.011	.009	0.12	0.12	0.16	0.09	2.89	0.16
95% Range (low-end)		2.641	2.634	2.616	2.633	0.25	0.28	0.21	0.35	56.01	0.13
(high-end)		2.669	2.673	2.660	2.669	0.72	0.76	0.82	0.71	67.33	0.75
Data Range (lowest)		2.637	2.634	2.607	2.634	0.25	0.28	0.26	0.38	60	0.19
(highest)		2.669	2.674	2.652	2.670	0.73	0.77	0.86	0.67	65	0.73

1986 CANADIAN ASPHALT MIX EXCHANGE

BRIQUETTE DATA

LO NO.	BULK HAND	SPECIFIC MECH	GRAVITY RTS. HAND	RTS. MECH	HAND STAB.	MECH. STAB.	R.T.S. HAND STAB.	R.T.S. MECH. STAB	HAND FLOW	MECH. FLOW	MECH. BLOWS USED
1	2.363	2.361	2.365	2.367	9.96	8.51	9.56	8.60	8.9	9.1	75
2	2.358 *	2.377	2.363 *	2.383	10.53	12.63	7.31 *	10.00	12.3	10.8	75
3	2.405	2.413	2.408	2.416	14.45	16.47 *	11.41	14.06	13.6	15.9	60
4	2.383	2.377	2.388	2.382	10.50	10.30	10.90	10.64	11.5	11.5	75
5	2.396	2.409	2.394	2.413	11.73	14.15	11.88	13.55	[illegible]	14.7	51 *
6	2.394	2.377	2.399	2.390	10.99	8.67	11.01	9.76	6.7 *	11.3	70
7	2.381	2.375	2.393	2.388	13.50	13.50	12.31	12.29	12.0	12.0	75
8	2.372	2.352	2.371	2.353	11.50	9.30	9.61	8.67	13.7	13.6	75
9	2.407	2.401	2.413	2.403	13.20	12.80	13.71	12.20	13.7	13.5	60
10	2.369	2.369	2.384	2.383	10.10	10.34	11.86	11.94	9.2	10.3	60
11	2.391	2.403	2.392	2.406	12.22	13.75	10.80	12.11	14.0	14.0	60
12	2.368	2.354	2.370	2.351	9.04	8.14	8.37	7.21	12.1	10.8	75
13	2.371	2.400	2.381	2.403	9.89	13.05	8.28	10.74	13.0	13.0	60
14	2.384	2.382	2.385	2.381	11.21	10.90	9.49	9.28	11.3	10.8	60
15	2.365	2.370	2.378	2.380	7.82 *	8.69	8.97	8.83	9.1	8.5	76
16	2.405	2.400	2.396	2.393	10.50	10.50	13.41	13.48	11.0	11.3	75
17	2.392	2.386	2.400	2.393	12.10	10.60	11.15	11.23	13.1	11.2	75
18	2.401	2.417	2.405	2.415	13.22	15.25	11.54	14.77	15.1	14.2	65
19	2.398	2.331 *	2.391	2.345 *	15.50	9.30	10.42	8.12	19.2 *	9.3	75
20	2.368	2.362			10.44	10.66			11.5	13.0	75
21	2.400	2.380	2.339	2.374	14.00	10.30	11.17	8.60	14.0	13.3	100 *
22											
23	2.409	2.413	2.402	2.410	12.30	13.40	10.30	11.10	10.8	12.1	75
24	2.392	2.401	2.385	2.398	9.17	10.77	9.72	11.74	12.0	12.5	75
25											
26	2.406	2.417	2.403	2.416	13.70	14.70	12.43	13.91	16.0	17.0 *	65
27											
28	2.386	2.350	2.395	2.357	15.50	9.10	10.65	7.50	16.3	14.3	75
29	2.401	2.406	2.409	2.403	13.57	15.19	13.59	12.20	15.0	15.7	75
30	2.380	2.386	2.387	2.400	11.30	11.70	10.94	10.74	10.8	10.2	75
All Data											
n	27	27	26	26	27	27	26	26	27	27	27
Mean	2.388	2.384	2.390	2.389	11.81	11.59	10.80	10.95	12.6	12.4	71
St. Dev.	.0149	.0232	.0134	.0209	2.00	2.368	1.62	2.16	2.6	2.2	9
95% Range	2.358	2.339	2.364	2.348	7.89	6.95	7.63	6.72	7.5	8.1	52
	2.417	2.430	2.416	2.430	15.73	16.23	13.97	15.18	17.7	16.6	89
Data Range	2.358	2.331	2.363	2.345	7.82	8.14	7.31	7.21	6.7	8.5	51
	2.409	2.417	2.413	2.416	15.5	16.47	13.71	14.77	19.2	17.0	100
Selected Data (*Data Rejected)											
n	26	26	25	25	26	26	25	26	25	26	25
Mean	2.389	2.386	2.391	2.391	11.96	11.40	10.94	10.95	12.5	12.2	70
St. Dev.	.0139	.021	.0124	.0193	1.87	2.20	1.48	2.16	2.0	2.0	7
95% Range	2.361	2.345	2.367	2.353	8.30	7.09	8.03	6.72	8.6	8.3	57
	2.416	2.427	2.416	2.428	15.62	15.71	13.85	15.18	16.5	16.1	83
Data Range	2.365	2.35	2.365	2.351	9.04	8.14	8.28	7.21	8.8	8.5	60
	2.409	2.417	2.413	2.416	15.50	15.25	13.71	14.77	16.3	15.9	76

TABLE-3
1986 CANADIAN ASPHALT MIX EXCHANGE

CALCULATED DATA

LAB NO.	VMA-%	AIR VOIDS-%	VOIDS FILLED-%	M.T.D. FRESH	M.T.D. AGED
1	16.08	2.17	86.57	2.425 *	* 2.407
2	15.98	2.42	84.89	2.444	2.447
3	14.82	1.87	87.41	2.454	2.461
4	15.57	2.62	83.19	2.445	2.444
5	14.37	1.32	90.80		2.436
6	15.57	2.78	82.18	2.454	2.458
7	15.30	2.90	81.10	2.449	2.459
8	15.94	2.49	84.46	2.429	2.431
9	14.57	1.59	89.11	2.443	2.452
10	16.52	3.35	79.77	2.451	2.457
11	14.59	2.26	84.54	2.452	2.454
12	16.28	3.50	78.53	2.447	2.451
13	16.00	2.57	84.09	2.448	2.448
14	14.87	2.21	85.20		
15	15.49	3.33	78.52	2.449	
16	14.86	2.21	85.13	2.457	2.460
17	15.54	2.32	85.07	2.446	2.454
18	14.59	1.64	88.85	2.449	2.453
19	16.17	3.36	79.72	2.458	2.461
20	15.97	3.08	80.70	2.440	2.440
21	15.16	1.92	87.44	2.437	2.459
22					
23	14.45	1.68	88.39	2.452	2.454
24	15.06	2.18	85.56	2.450	2.448
25					
26	14.29	0.94 *	93.50 *	2.464	2.427
27					
28	15.86	2.53	84.26	2.429	2.423
29	14.44	1.87	87.09	2.449	2.452
30	15.80	3.54	77.65		2.442
All Data					
n	27	27	27	24	25
Mean	15.34	2.39	84.58	2.447	2.447
St. Dev.	0.68	0.68	3.94	.009	.013
95% Range	14.01	1.05	76.86	2.429	2.422
	16.67	3.74	92.30	2.465	2.472
Data Range	14.29	0.94	77.65	2.425	2.407
	16.52	3.54	93.50	2.464	2.461
Selected Data (*Data Rejected)					
n	27	26	26	23	24
Mean	15.34	2.45	84.24	2.448	2.449
St. Dev.	.68	.63	3.58	.008	.011
95% Range	14.01	1.21	77.22	2.432	2.427
	16.67	3.69	91.26	2.464	2.471
Data Range	14.29	1.32	77.65	2.429	2.423
	16.52	3.54	90.8	2.464	2.461

TABLE-4

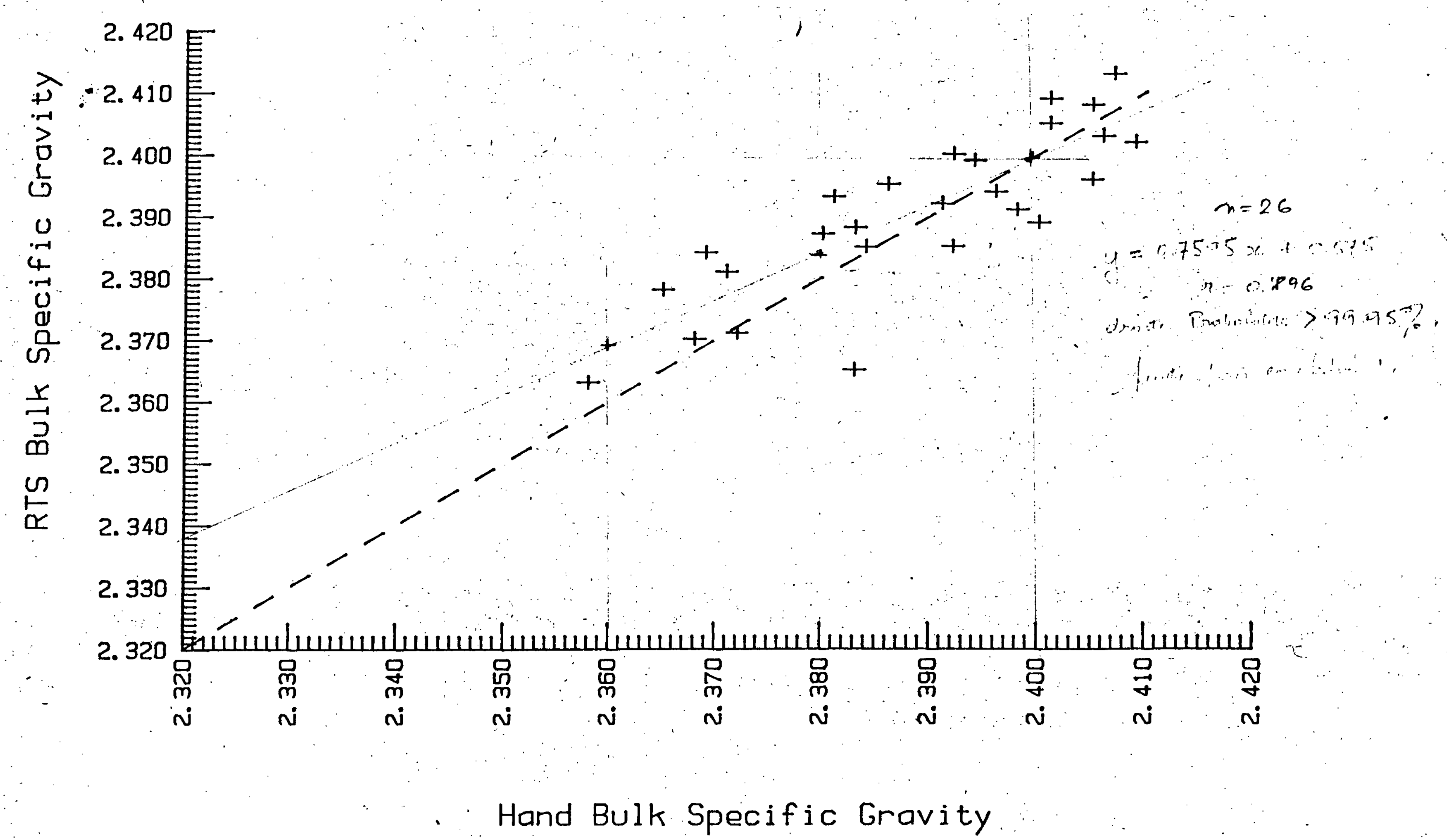
1986 CANADIAN ASPHALT MIX EXCHANGE

MECHANICAL COMPACTOR DATA

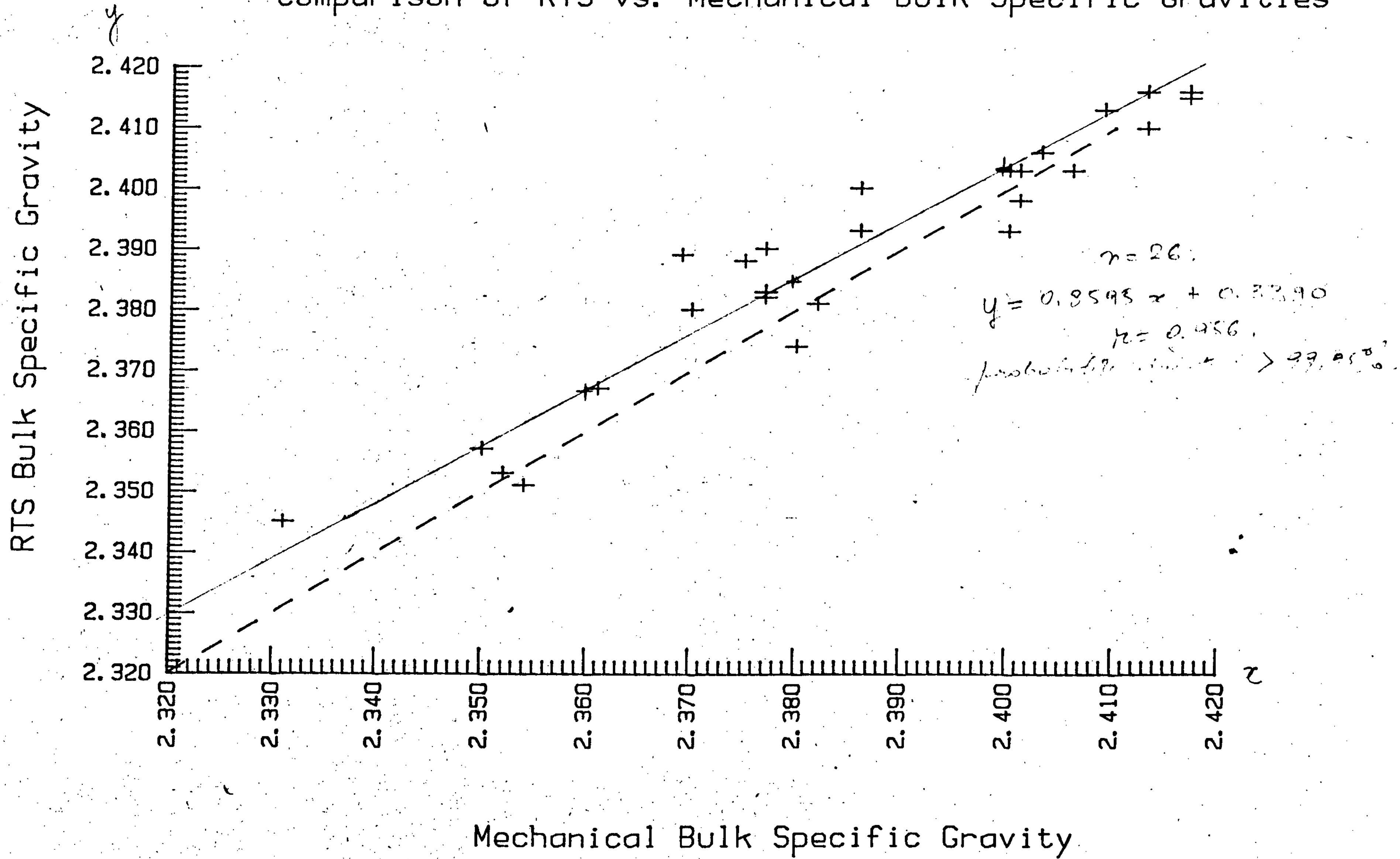
LAB NO.	MASS OF HAMMER(S)-kg	DROP OF HAMMER(S)-mm	THICKNESS OF COMPACTION FOOT-mm	TRADE NAME TYPE	MECH. BLOWS USED	MECH. DENSITY
1	4.67	445	7.0/13.0	P.K. COMPACTOR	75	2.361
2	4.54	457	10	RAINHART	75	2.377
3	4.54	457	11.25/14.39	HUMBOLDT/TRIPLE	60	2.413
4	4.54	454	6.25/12.5	PINE INSTRUMENTS	75	2.377
5	4.52	455	10.5/12.5	MARSHALL/DOUBLE	51	2.409
6	4.70	456	18/19	MARSHALL/DOUBLE	70	2.377
	4.69	456	18/19			
7	4.54	455	14.72/16.16	HUMBOLDT/DOUBLE	75	2.375
	4.54	455	14.30/15.88			
8	4.60	460	13	MARSHALL/DOUBLE	75	2.352
9	4.53	460	11.30/14.24	HUMBOLDT/DOUBLE	60	2.401
10	4.53	456	9.70/12.25	HUMBOLDT/double	60	2.369
11	4.50	457	13/15	MARSHALL/DOUBLE	60	2.403
12	4.56	460	12	SOILTEST/SINGLE	75	2.354
13	4.54	456	12.60/15.01	HUMBOLDT/DOUBLE	60	2.400
14	4.54	457	11.5/13.5	UNKNOWN	60	2.382
15	4.49	459	6/12	M&L	76	2.370
16	4.54	458	15	HUMBOLDT/TRIPLE	75	2.400
	4.53	458	15			
	4.54	457	15			
17	4.54	456	6.5/12.6	PINE INSTRUMENTS	75	2.386
	4.54	453	6.4/12.8			
18	4.54	457	16/19	MARSHALL/DOUBLE	65	2.417
19	4.70	457	11	HOMEMADE	75	2.331
20	4.68	457	12	SOILTEST	75	2.362
21	4.53	454	12	HOMEMADE/TRIPLE	100	2.380
	4.58	452	12	(SOILTEST		
	4.56	454	12	HAMMERS)		
22						
23	4.54	457	16	M&L/DOUBLE	75	2.413
24	4.54	460	10	RAINHART	75	2.401
25						
26	4.55	447	11/13	MARSHALL	65	2.417
27						
28	4.56	450	12	HUMBOLDT/SINGLE	75	2.350
29	4.55	450	13	HOMEMADE	75	2.406
30	4.54	457	12	SOILTEST	75	2.386

All Data	MASS OF HAMMER(S)-kg	DROP OF HAMMER(S)-mm
n	34	34
Mean	4.56	456
St. Dev.	0.06	3
Data Range (low)	4.49	445
(high)	4.70	460
ASTM	4.54	454

1986 CANADIAN ASPHALT MIX EXCHANGE
Comparison of RTS vs. Hand Bulk Specific Gravities

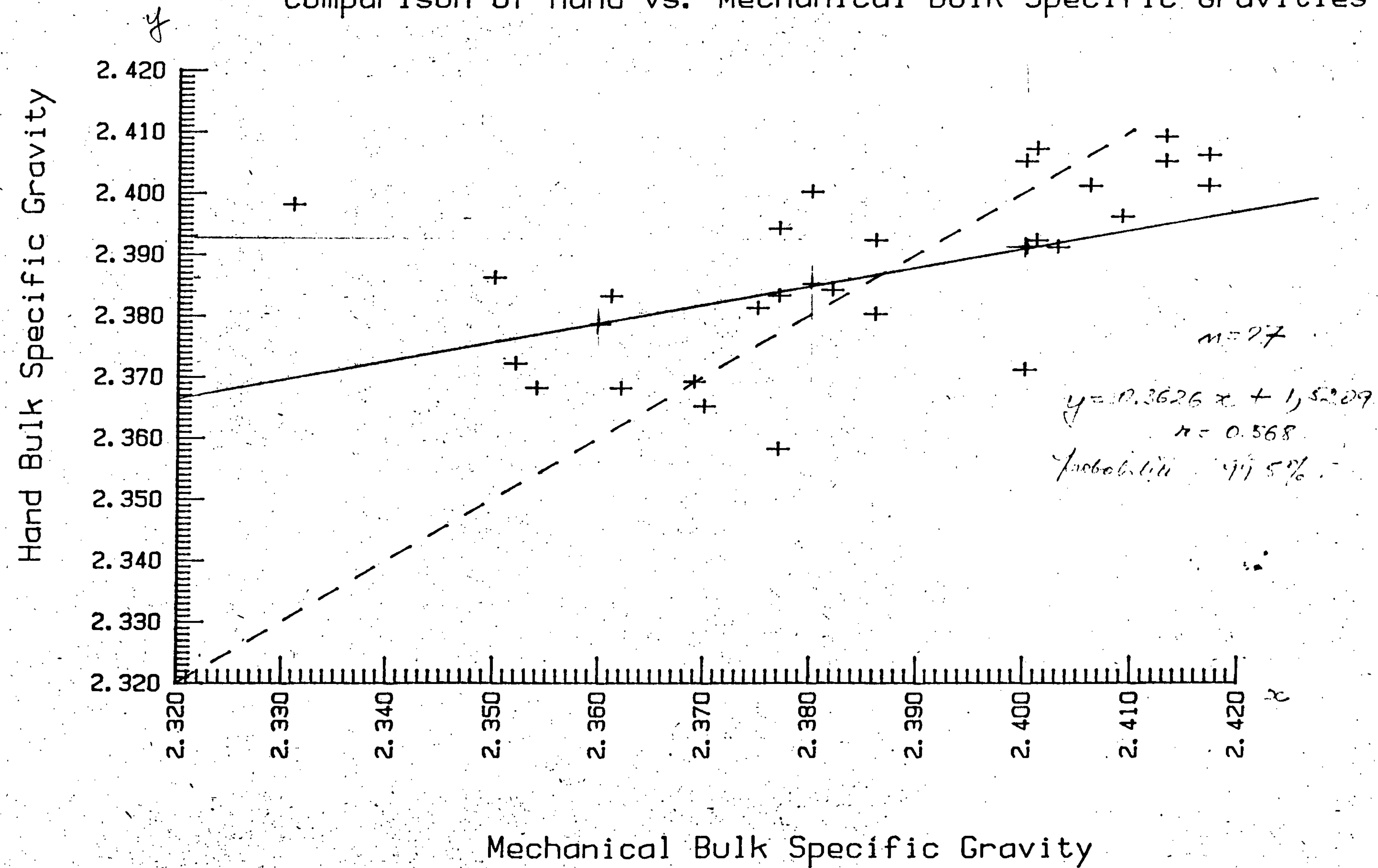


1986 CANADIAN ASPHALT MIX EXCHANGE
Comparison of RTS vs. Mechanical Bulk Specific Gravities

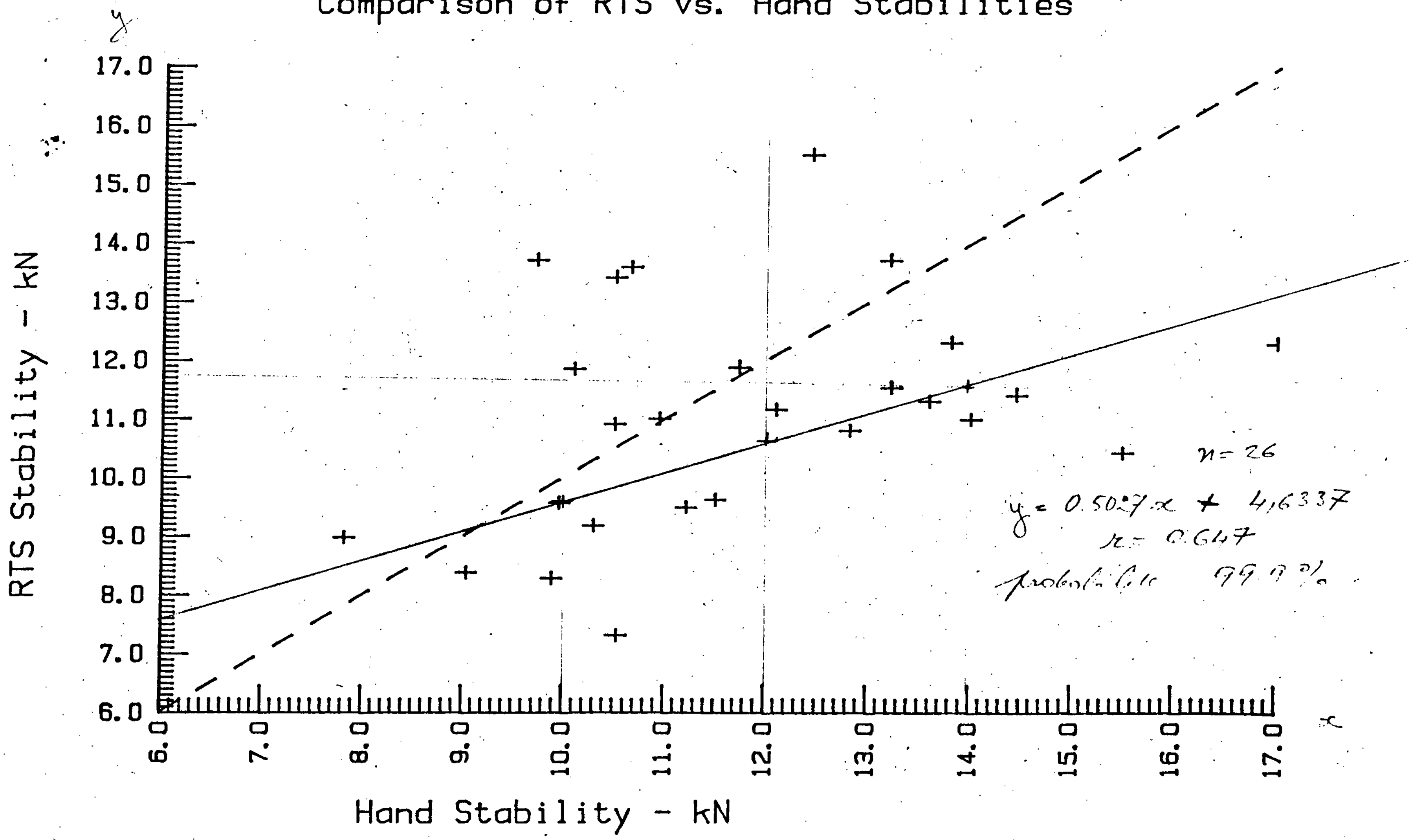


1986 CANADIAN ASPHALT MIX EXCHANGE

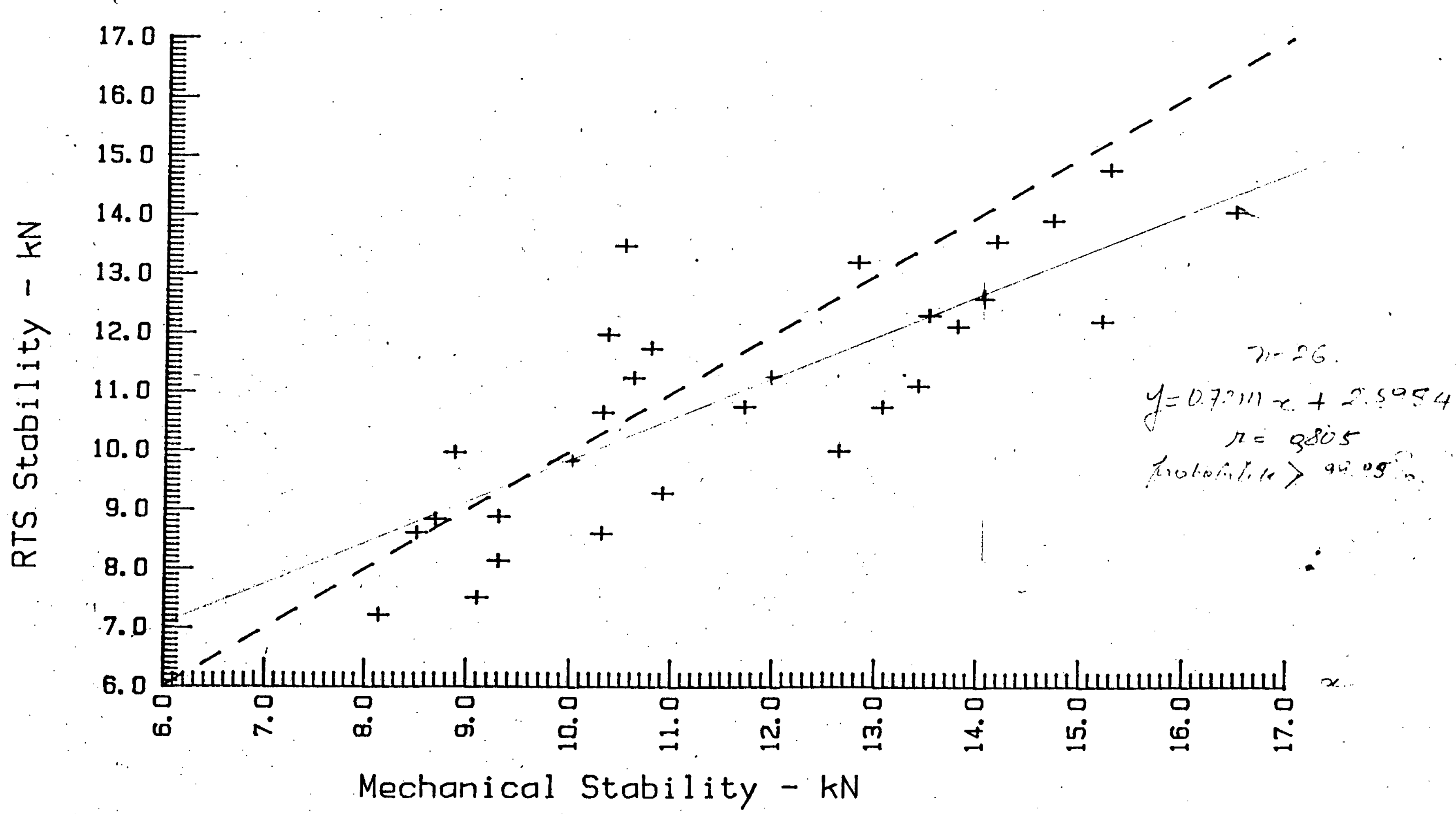
Comparison of Hand vs. Mechanical Bulk Specific Gravities



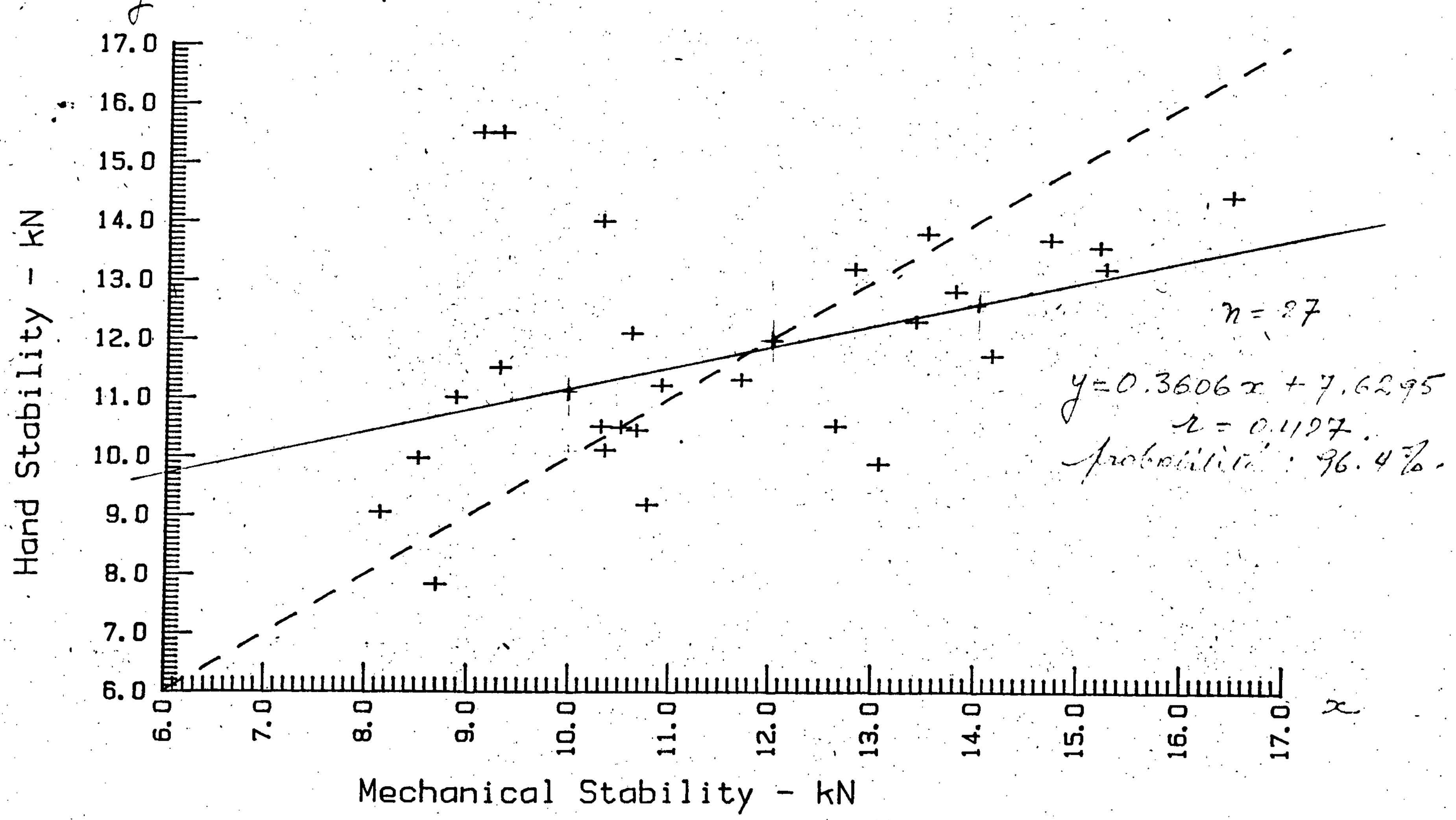
1986 CANADIAN ASPHALT MIX EXCHANGE
Comparison of RTS vs. Hand Stabilities



1986 CANADIAN ASPHALT MIX EXCHANGE
Comparison of RTS vs. Mechanical Stabilities



1986 CANADIAN ASPHALT MIX EXCHANGE
Comparison of Hand vs. Mechanical Stabilities



1986 CANADIAN ASPHALT MIX EXCHANGE
Comparison of Hand vs. Mechanical Flows