A Study on Hot Mix and Cold Mix

in Road Patching Application

by

Noor Aini Binti Yusof

Dissertation submitted in partial fulfilment of
the requirements for the
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CERTIFICATION OF APPROVAL

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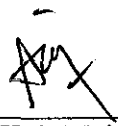
Approved by,



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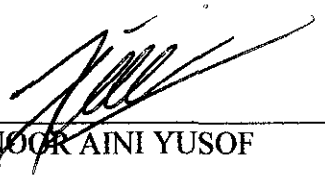
July 2007

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.



NOOR AINI YUSOF

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ABSTRACT

Pavement failures can lead to foaming of potholes on the road that not only can cause damage to vehicle but may also resulting motorist's losing control of vehicle and crashing. The need for pothole repair and the high cost of the repair worried the road maintenance department. Therefore this project is conducted to evaluate performance of different pothole patching materials, so that a better patching material can be suggested. Comparison between the performances of the cold mix asphalt and hot mix asphalt were performed in this study. The literature search was conducted in order to provide an overall view of information regarding patching, materials, repair procedures, and laboratory test. the project methodology consists of literature review, laboratory test, cost analysis and report of finding. Marshall Test, Creep Test and Wheel Tracking Test were performed to achieve better understanding on the properties of the patching material and their relationship to field performance. Eventually from all three tests, both materials meet the requirement for the pothole patching, but hot mix asphalt has higher stability which is 740 kg compared to cold mix asphalt that only 325 kg. The overall patching cost for hot mix is slightly higher than cold mix, but if repatching is needed for cold mix, the cost will increase twice as the analysis result. As a conclusion, hot mix patching most effectively and economically to use for the pothole with more than 1 m diameter size, heavy traffic road and urban area. Meanwhile cold mix patching is most suitable and economically to be used for the small pothole size and less traffic road. Cold mix is also the best solutions in all adverse climates including wet condition. Thus it can reduce vehicle damage because of pothole even during rains season.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Within this chapter, the author will discuss the background of the study. The problem occurs because of the appearance of pothole in the pavement road and the importance of selecting the correct material. The objective and scope of the study also will be discussed in this chapter. This section identifies various asphaltic concrete and surface treatment pavement failures, causes for those failures, and repair procedures. Cause identification is emphasizes on solving the root cause to achieve lasting road repairs.

1.1 BACKGROUND

Asphalt pavement is utilized in a variety of different applications because of its durability, cost-effectiveness, simplicity of construction, and strength. As asphalt pavements age and deteriorated, the needs for correct measurement to obtain safety and rideability increase. There are a few reasons asphalt pavement repair must be done. The failure on pavement such as pothole, crack, polished aggregate, raveling, grade depression and corrugation will happen if the design, construction and material for pavement were not done properly. Funding for rehabilitation and overlay of these pavements is not to keep up with the demand, but requiring more agencies to use the most cost-effective methods when patching the distressed areas.

Pothole is one of the asphalt pavement problems. Potholes are bowl-shaped holes of various sizes on the pavement surface. A pothole is normally only considered significant if the diameter of the hole is more than 150 mm and the depth more than 25 mm. Potholes are secondary forms of distress that develop from cracks. Potholes occur on asphalt-surfaced pavements subjected to a broad spectrum of traffic levels, from two-lane rural routes to multi-lane interstate highways.

In general, the pothole problem can be characterized as one of the most aggravating forms of asphalt pavement deterioration for the traveling public. Potholes are not just

a nuisance for drivers but they also constitute a dangerous safety hazard that can produce substantial damage to vehicles, force drivers to veer suddenly in traffic, or even cause the driver to lose control of a vehicle after contact that can cause crashing.

The remedy used for potholes is termed "patching". Patching can be described as the filling of deteriorated areas in a road surface to keep traffic moving safely or to prevent rapid deterioration of an area that could become unsafe.

Pothole patching is generally performed either as an emergency repair under harsh conditions, or as routine maintenance scheduled for warmer and drier periods. Pothole patching can be performed during any weather. Even though the moisture and traffic conditions may vary, the materials and methods for placing quality repairs are most likely similar.

1.2 PROBLEM STATEMENT

The problem of pothole formation can be very serious, especially in areas where adverse weather conditions contribute to accelerated pavement breakup. Pothole problem can be characterized as one of the most aggravating forms of asphalt pavement deterioration for the traveling traffic that can pose danger to the traveling public and damage to the vehicles. There is an immediate need for repair of potholes to secure safety and rideability.

Therefore the evaluation of the pothole patching materials in terms of longevity, serviceability and cost effectiveness of the repair could significantly help for traffic moving safely and prevent deterioration at the same area. As solution of the problem, two types of materials have been studied to determine the properties of the material.

1.3 OBJECTIVE

The objectives of this project are to compare the laboratory performance and perform cost analysis for hot mix and cold mix in pothole patching. The result of this report will determine the best material to be used for pothole patching in Malaysia.

1.4 SCOPE OF STUDY

A literature review was conducted to identify the pothole patching materials available in the market. This information was used to compare the characteristic and application of all type of pothole patching materials. The types of patching material to be compared are the conventional asphalt hot and cold mixes. Then laboratory tests were preformed to compare and demonstrate the effectiveness of the materials.

The cost analysis of the material also performed to in order to compare the overall criteria of the materials. The studied is ought to evaluated and compared the material used, so the best solution can obtain.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The literature search was conducted in order to provide an overall view of existing information regarding pothole patching materials, repair procedures, and laboratory tests for quality assurance.

Pothole repairs have not received a great deal of attention in the literature in the past years. However, as highway maintenance agencies are more concerned about the evaluation of the effectiveness of the materials and techniques which can lead to more economical and long lasting solutions, an increased emphasis has been given in pothole repair research.

Therefore the evaluation of the pothole patching material in terms of longevity and serviceability of the repair could significantly help to improve the cost effectiveness of the repairs. For this reason and since potholes that must be filled repeatedly are expensive to repair, many different agencies conducted studies to evaluate specific types of materials and techniques which can lead to the most economical and long-lasting solution

2.2 POTHOLE

Pothole is a bowl-shaped hole of various sizes localized distress in an asphalt-surfaced pavement. A pothole is normally only considered significant if the diameter of the hole is more than 150 mm and the depth more than 25 mm. (1). Potholes are secondary forms of distress that develop from the breakup of the asphalt surface and possibly the asphalt base course.(1)

The ingress of moisture into the pavement layers reduces the structural capacity of the layers and thereby accelerates the progression of the pothole. Pieces of asphalt pavement created by the action of climate and traffic on the weakened pavement are removed under the action of traffic, leaving a pothole. Poor drainage is a major contributor to pothole formation. Potholes will face moisture, freeze-thaw action, traffic, poor underlying support, or some combination of these factors. Water weakens pavement support and contributes to frost heaves and cracking.

Maintenance and improvement to drainage features reduce the amount of water on the road. Water-induced stripping of asphalt from aggregates in hot-mix asphalt pavements is also causing the pothole. The condition of patches must be recorded and repaired. Repair of the potholes entails patching which is the removal of the defective layers and the replacement with, normally, a bituminous mixture.

The University of New Hampshire Technology Transfer Centre says, the pothole form when water becomes trapped beneath the pavement surface, as vehicles run over the saturated base material, the unsupported surface layer collapses resulting in a hole. The hole expends as traffic hits the hole.

Pothole patching is the common repair of severe, localized distress in asphalt-surfaced pavements. This maintenance activity is generally done by the agency responsible for the roadway and is intended to be a temporary repair at best. Patches can be either partial or full-depth. Pothole patching is not intended to be a permanent repair, most of patches are done as emergency repairs in poor conditions (e.g., cold, rainy) and therefore are only considered temporary repairs. Full-depth reconstruction of the distressed areas is necessary for a permanent repair in most instances.

2.2.1 Pothole Formation in the Pavements

Pothole can be form to flexible pavement, rigid pavement or rigid base pavement. The formation of pothole for all types of pavement is slightly different. (2)

- **Flexible Pavement** – The formation of a pothole in a flexible pavement begins in a weakened area of the pavement. The heavy loads due to traffic lead to an

excessive bending of the pavement, which in turn causes cracks. Once the pavement section has cracked, water can easily enter the system and will gradually lead to the saturation of various layers of the material up to a point that the pavement cannot support heavy loads any more.

For the four season country, the effect of the water intrusion is even more pronounced during the winter because the pavement is subjected to freezing temperatures. As the water in the pavement layer freezes, it builds up forces due to expansion of the ice, which loosen the already weak pavement and in some cases, even cause lift off of the pieces of pavement. This lift-off worsens under the action of traffic and the cycles of alternating freezing and thawing, until the pothole is formed.

- **Rigid Pavement** – Potholes in rigid pavements usually occur at the contraction joint or in areas where concrete has deteriorated. As the concrete cures after construction, the slab shrinks and the concrete cracks at the location of the joint. Adverse temperature makes the slab expand and contract at the joint location. The joint must therefore be sealed and maintained to keep the water out of the pavement.

- **Rigid Base Pavement** –It is consists of an asphalt layer on top of a rigid pavement structure. If cracks exist in the rigid slab, the overlay begins to crack with any movement of the base. These are called reflective cracks, which gradually continue to enlarge. When reflective cracks are not sealed, water can enter the system. During winter and as the temperature is low, the water freezes, expands, and lifts the surface layer off the pavement. As this process continues the formation of potholes takes place

2.2.2 Pothole Patching Techniques

The construction technique is different for the type of materials used for patching the pothole. It is because the materials used have special properties that differ from each others.

2.2.2.1 Repair Procedures for Bituminous Mixture

Federal Highway Administration U.S. Department of Transportation in the report stated that there are different techniques exists used for pothole patching:

a) Throw and Roll

The difference between this method and the traditional throw and-go method is that some effort is needed to compact the patches. Compaction provides a tighter patch for traffic than simply leaving loose material. The extra time to compact the patches (generally 1 to 2 additional minutes per patch) will not significantly affect productivity. This is especially true if the areas to be patched are separated by long distances and most of the time is spent traveling between potholes.

b) Semi Permanent

The semi-permanent repair method is considered one of the best for repairing potholes, short or full-depth removal and replacement. The pothole must be cleaned up from the debris and water and the sides need to square up. This repair procedure provides a sound area for patches to be compacted against and results in very tightly compacted patches. However, it requires more workers and equipment.

c) Spray Injection

This procedure requires no compaction after the cover aggregate has been placed. There are two main types of spray-injection devices available. The first type is a trailer unit towed behind a truck carrying the aggregate. The second one is a unit with aggregate, heated binder tank, and delivery systems all contained in a single vehicle.

d) Edge-Seal

This procedure may require a second visit to the repaired section by the crew to allow water to dry before placing the tack. Although this does reduce the productivity of the procedure, the placement of the tack material prevents water from getting through the edge of the patch and can glue together pieces of the surrounding pavement, improving support for the patch.

Comparison between the "throw and roll" and semi-permanent method shows that in terms of longevity the semi-permanent method is superior as it increases the performance of patches by improving the surrounding support.

With the exemption of the spray injection method, the above procedures require cold mix patching materials. The only major equipment used for the "throw and roll" method is the truck that carries the material.

For the semi-permanent method, the necessary equipment varies. The most common equipment however is the following:

- Material trucks (with hand tools)
- Compaction device (vibratory plate and single-drum vibratory roller are generally the most inexpensive and the most maneuverable)
- Air compressor
- Edge straitening device (jack hammer, pavement saw, cold mining machine)

For the spray injection technique, a device that can place virgin aggregate and heated emulsion into a pothole simultaneously is required.

2.2.2.2 Repair procedures for Cement Concrete Mixture

For the following repair methods, begin the placement when the surface within the repair area is dry and thoroughly free of contaminants. (3)

Ensure that the finished surface including joints meets a surface tolerance of 1/8 in (3 mm) per 10 ft (3 m).

a) Repair Method 1: Twenty-four Hour Accelerated Strength Concrete

Completely coat the concrete surface areas within the repair area with a film of Type II epoxy approximately 10 to 20 mils (0.25 to 0.50 mm) thick. Mix the concrete on site in a portable mixer. Obtain approval for the mix design and mixing method from the laboratory. The material must meet a slump range of 1.0 in. (25mm) to 3.0 in. (75mm). Deposit the concrete in the repair area while the epoxy is still tacky. Vibrate it to form a dense, homogeneous mass of concrete that completely fills the patch

area. Screed the concrete to the proper grade and do not disturb it until the water sheen disappears from the surface. Cover the concrete with wet burlap or membrane curing compound. Allow the curing to continue for at least three hours. The Engineer may require longer curing to ensure sufficient concrete strength development before opening to traffic.

b) Repair Method 2: Rapid Setting Patching Material for PCC Pavement

In addition to the requirements outlined in Subsection 451.3.03.A, "Removing and Preparing the Repair Area," prepare the surfaces in the repair areas according to the manufacturer's written recommendations. Perform the patching material handling, mixing, placing, consolidating, screeding, and curing according to the manufacturer's written instructions as approved by the laboratory. Continue curing for at least one hour and until opening the section to traffic.

2.3 PATCHING MATERIALS FOR POTHOLE

Patching materials shall be a plant or pugmill mixed high performance pavement patching material capable of storage in an uncovered outdoor stockpile for minimum of 12 months. The permanent asphalt repair shall be uniform, remain flexible and cohesive to -15°F and be capable of retaining adhesive qualities in wet applications.

The patching materials shall be able to repair asphalt, concrete, surface treated roads and shall not required removal and replacement if ever the pavement is overlaid.

Bituminous patching mixtures are combinations of different binders and aggregates that have special characteristics needed for filling potholes in pavements. There are different types of patching mixtures and they can range widely in cost, stability, quality, and application. The patching mixtures can be generally placed in one of three groups, based on the type mixing and the temperature of the mixture at the time of placement.

The most important properties that a bituminous patching mixture should have are:

- Stability, to allow the patch to resist displacement by traffic. Stability can be related to most material characteristics of the patching mix. For example, the better graded a mixture, the more stable it is. Stability also increases when the aggregate used has a rough surface texture and they are angular. Material properties that influence the compatibility of the mixture also contribute to the stability of the mixture.

- Stickiness, so the patch will adhere to the sides of the pothole. Stickiness is important when the patching mixture must be feathered to thin edges. The property is influenced by the temperature of the mixture and the binder. Usually hot mixture materials have satisfactory adhesion when they are still hot, whereas cold- mixtures do not have adequate stickiness.
- Resistance to water action, to keep the binder from stripping off the aggregate. Patching mixtures lack water resistance when they are under-compacted. The property is also affected by the binder and the aggregate types.
- Durability, so that the patch has satisfactory resistance to disintegration. In terms of durability, hot-mix hot-placed materials are the ones that perform best. However, the durability of the cold-placed materials varies considerably. Cold-mixed cold-placed types, on the other hand, do not have high durability.
- Skid resistance, should be similar to the pavement in which the patch is placed.
- Workability, to enable the material to be easily shoveled and shaped. The most important factor that affects workability is temperature because it controls the hardness of the bituminous binders. Low viscosity binders can be used to improve the workability of the mixtures.
- Storage-ability, so the mixture can be stockpiled without hardening excessively or having the binder drain off the aggregate.

2.3.1 Cold Mix Asphalt

These mixtures are composed of liquid bituminous binders and aggregates, which have not been heated. Mixing is done either in a plant, where the materials are proportioned, or on the paved surface with few controls. The mixtures are stockpiled until needed used cold in any reason.

Cold mixed asphalt can be an economical alternative to traditionally hot mixed asphalt, especially in areas where there is a long distance to the nearest hot mix plant. The process can be used to produce mixtures suitable for base course or wearing course using continuously graded virgin aggregate mixtures normally containing between 5 and 10 % < 75 μm fines. Mixtures may be used shortly after manufacture or stockpiled for several days before use.

Cold mixes can normally be made in a standard hot mix plant (without any heating) or by a purpose-designed stationary or mobile cold mix plant. The resultant mix is either applied by using normal pavers or by grader or then compacted typically to an air void content of 5 to 10 %. Cold Mix emulsions are normally prepared using cationic slow-setting or medium setting emulsion with 60-65% bitumen contents, which may contain some solvent.

Cold mixes have a tendency to push, shove, and come out of pot holes very easily for pothole patching. Cold Mix is suitable for both asphalt and concrete surfaces and can be used immediately without adding any other materials. Besides undercoat preparation is no needed for the surface to be repaired. It also easy to be used and requires neither particular skills nor special tools. It can set in contact with air, and be crushed with such a simple tools as crushers or road roller, requiring no heat. Any traffic surface repair with cold mix becomes instantly operational.

simulate trafficking, and this recompaction could be done with either Marshall or static load. As laboratories in the USA move away from the Marshall compactor for hot mix design, there is a demand to use the Superpave gyratory compactor also to prepare cold mix specimens. The density that could or should be attained in the field with cold mixes is not defined in the traditional methods; most authors have taken the approach to reproduce typical field densities in the laboratory tests rather than to prescribe the densities based on expected traffic volumes.

In the Superpave approach, the optimum asphalt content is determined by the volumetrics of the mix. Depending on the expected traffic level and temperatures, the gyrations needed to produce a specimen representative of material at design or after long term trafficking are specified. Implicit is an assumption that 4% air voids for a dense graded mix is a target. At the same time the equipment gives information about the ease of compaction/workability. There is still some controversy in regards to the appropriate number of the gyrations for hot mix, and no guidance at all for cold mix. The 4% target voids is probably unreasonable for cold mixed materials.

In cold mix design, the compactor has been used both to make specimens for final structural testing and also to prepare specimens for determining optimum fluids for compaction. It has replaced the California Kneading compactor to prepare cold mixed specimens in some laboratories otherwise using the Hveem stabilometer method.

The key questions are what should be the number of gyrations to simulate the density of the mixture after lay down and compaction of the mixture and the number to simulate the maximum density after trafficking.

In work at the University of Rhode Island, an attempt was made to use also the methodology of the Superpave process to cold-in place recycled materials. The gyratory compactor was used to compact the mix to approximately 11% air voids expected to represent the road material after compaction. Between 25 and 57 gyrations were required with the materials tested.

In another approach the concept of locking point is applied. In the method described in the reference, samples with different asphalt contents are first compacted to 200 gyrations, representing maximum possible density after trafficking. The moulds are perforated to allow moisture to escape if necessary. Then the curve of height vs. gyrations is examined and the locking point determined. As the height of the specimen is decreased by each gyration, there comes a point where aggregate – aggregate contact prevents further consolidation and the height does not decrease rapidly. A locking point can be defined as the first 3 consecutive measurements at which there is no change in height followed by 3 more consecutive height measurements at the next lowest height. Typical values were between 40 and 75 gyrations for the materials studied. High values represent mixes which will require more compactive effort in the field. The target of was to achieve a density of 90 ± 1% of theoretical maximum at the locking point, which is meant to represent the density of the mix immediately after field compaction. The materials studied were reclaimed asphalt pavement, plus some virgin materials to correct the grading.

Workability and Compactability Tests

Once emulsion and aggregate have been mixed, there will be a tendency for the mix to gradually stiffen, either from the gradual breaking of the emulsion in solvent free mixes or from the loss of solvent and water from solvent containing mixes. This concept was not addressed in traditional methods. Eventually the mix will become too stiff to easily remove from a stockpile or to pave. Nynas developed a workability tester designed to measure the "workability window" between mixing and paving. The method involves placing the mixture in a box fitted with a ram. The force required to shear the materials at different times after storage is determined by the force required to push the ram through the mix. An improved version of the method has found use within the design laboratory of Koch Materials.

The Nynas method is designed to simulate the paver operation. A method designed to simulate the handling of cold patching stockpile materials resulted from the efforts of the ASTM sub-committee D04.27 *Cold Asphalt Mixtures*, and has recently been accepted by ASTM. The method uses the Marshall load frame or similar device to drive a blade through the mix. The force required is a measure of the workability.

The method is primarily designed for cold mixes based on cutbacks used for pothole patching but can be applied to similar fine grained materials based on emulsions.

Workability is related also to compactability. In the "locking point" concept the number of gyrations needed to reach this point is also considered a measure of the compactability of the mix. Other points on the compaction curve obtained from the Superpave compacter can be used for the same purpose. In some mix design methods the mixture is stored for a period before preparing compacted specimens. Some attempts have been made to develop an accelerated laboratory curing regime for uncompacted mixes, designed to simulate long term stockpile life. For example in a method developed by Koch Materials for RAP mixes, 24 hours at 60°C in a covered pan is used to represent 14-75 days stockpile, and 72 hours at 60°C for an extended stockpile life of up to 18 months. The compatibility of the stored materials is then determined using the density achieved in the Gyratory compactor (after 40 gyrations) as a measure.

Cohesion Tests

Once compacted, cold mixes may take time to develop sufficient cohesion to allow trafficking without ravelling. In the original Hveem design method a Hveem cohesiometer was used to determine the early cohesion of cold mixed materials after 24 hours curing at 25°C. In microsurfacing cohesion is addressed by the cohesion tester, but although this method has been adapted for use in cold mix, it is not used in the Americas. But another test from the slurry surfacing area has been adapted by Koch Materials as a cohesion test for cold mix. The test involves abrasion of partly (4 hours) cured, compacted cold mix specimens (150mm) with the Wet Track Abrasion Tester used in slurry testing. The test is run dry for 15 minutes and simulates raveling, which could occur from too early trafficking. According to the author a properly cured mix ready for traffic should exhibit less than 2% abrasion loss in the test.

Structural tests

In principle the same structural tests designed for hot mix can be used for cold mix. As alternative methods have been developed for hot mix materials these have been applied to cold mixes, both laboratory specimens and cores from the field. For

example, the Nottingham Asphalt tester has been used in Canada, the Asphalt Pavement Analyser (rutting equipment) has been used as well as the Indirect tensile Test.

There is no consensus on the curing regime for cold mixed specimens in the laboratory, which could simulate curing of compacted mix in the field. Most workers aim for complete cure (water loss) before structural testing.

2.5 A COMPARISON ON COLD MIXED AND HOT MIXED ASPHALT MIXTURES

Jack N Dybalski, Manager of Asphalt Technology, Akzo Chemicals Inc., McCook Illinois has prepared a report regarding the comparison of properties of laboratory prepared cold mixed emulsified and hot mixed asphalt mixtures. The purpose of this study was to compare properties of bituminous mixtures using paving -grade asphalt cement and emulsified asphalt binders to evaluate thickness requirements of paving materials using emulsified asphalt binders.

Asphalt emulsion cold mixes for construction of base and surface courses of bituminous pavements have been used in the United States since the 1930~s. These mixes were primarily used on lightly traveled roads with very little, if any, documentation of their physical properties either before or after construction.

Simply stated, in the field, asphalt emulsion layer equivalency to hot mix can be attained by:

- Having field paving crews learn the proper use and handling of water and solvent-free cationic asphalt emulsions.
- The use of an asphalt cement in the cold mix which is similar in viscosity or stiffness to the asphalt cement recovered from the hot mix, and
- Allowing the cold mix to cure to near its optimum stability, keeping all other variables equal.

The premise of this initial investigation was to emulsify asphalt cement that has viscosity (stiffness) properties similar to the asphalt extracted from a hot mix after

the hot mixing had been completed and to use the emulsion in the preparation of cold mixes for comparison to the original hot mix. This was done to determine whether a cold mix versus a hot mix, both containing asphalt cement of similar stiffness or viscosity, would indicate similar pavement thickness requirements.

The Marshall Method of lab specimen compaction and testing was used to obtain specimen density and stabilities. With the development of the density air voids data, it became evident that Marshall Compaction, as detailed in ASTM D-1559, is not the best tab method of compaction for these cold mix specimens. Densities and air voids equivalent to that of the hot mix was to obtain with the Marshall Compaction Hammer, particularly with the dense aggregate.

The major problem with specimen compaction for cold mixes using the Marshall Method is that it was designed for hot mix which contains only trace volatiles at compaction temperatures. The mold assembly is non-porous and the tamping foot of the compaction hammer is essentially the same diameter as the inside diameter of the mold. Although 50 to 75 blows of the Compaction Hammer are specified for each flat side of the specimen, the water containing cold mixes often attain maximum attainable density after only 20 blows with rapidly developing hydraulic pore pressure causing the hammer to bounce for the remaining blows and generating an accumulation of emulsified asphalt on the flat surfaces of the specimen.

Surprisingly the Resilient Modulus (Mr) (elastic Modulus) data is considerably higher for the emulsion mixes than for the hot mixes. Resilient Modulus (ElasticModuli) values have many meanings to design engineers; however, if only these numbers were used to determine pavement thickness design, they would imply that the hot mix should be placed thicker than the cold mix for equivalent load bearing.

Kneading compaction appears to produce specimens of higher density and lower voids than does the Marshall. However, both methods are inadequate, as written, to obtain the density and voids values which are comparable to the high density and low voids which are possible from a 3" to 4" mat of cold mix placed in the field.

2.6 PREVIOUS RESEARCH IN POTHOLE PATCHING

2.6.1 Asphalt Roofing Shingles in Cold Patch

The use of ground asphalt roofing shingles in cold patch materials was experimented. The product can be used to patch potholes, construct sidewalks, fill utility cuts, repair driveways and many more.

Roofing Shingles cold patch can be made with either manufacturing scrap or old tear-off roofing shingles. The patch is comprised of approximately 25 percent dry roofing material and 75 percent aggregate. If tear off are used, it is composed of approximately 25 percent dry roofing material, 3 percent solvents, and 72 percent aggregate.

The benefits of using recycle roofing shingle cold patch include the following:

- Improved pavement performance – the fiberglass and/or cellulose fibers in the shingles apparently add to the structural integrity of the patch.
- Possible economic saving – The overall cost lower due to longer life and decrease maintenance cost.
- Ease to use than traditional patches – It is lighter weight, no equipment needed and time flexibility.
- Landfill space saving
- Resource saving – The petroleum used to produced asphalt binders is a nonrenewable resource.

The shingles should be ground and screened to ¼ inches – minus, and mixed with the aggregates. If the shingles used are tear-off, then a solvent is added to rejuvenate the old, oxidized asphalt.

2.6.2 Pothole Repair, Baystate Roads Program

The study of Pothole Repair was done by ERES Consultant, Inc based on Report No FHWA RD 98 073, Long-Term Monitoring of Pavement Maintenance Materials test Sites. The objective of the experiment was to determine which combination of material and patching procedures provide the most cost-effective repair of potholes in asphalt concrete-surfaced pavement.

The cold mix patches were placed at 8 test sites across the US and Canada. Several of cold mixes were used in combination with different patching techniques. The patching techniques that been apply were throw and roll method, edge seal method, semi-permanent method and spray injection method.

Evaluations were made at 1, 3 and months after the installations were completed and semi-annual inspection were performed. To identify correlations between material properties and field performance, comparisons were made between laboratory test values and mean field performance values, such as survival rating and average distress rating.

The finding of this experiment showed that cold mix pothole patches are intended to be temporary repairs, but the success rate observed in this project indicated that materials are available that can remain in services in several years. Overall, 56% of all patches survived until the last round of performance monitoring, with 31% failure and 13% lost. For the patching procedure, the throw and roll technique proved as effective as semi-permanent using the similar materials. The throw and roll procedure is more cost effective in most situation, if quality of materials are used.

To achieve cost effective and long-lasting patches, high productivity operation is used in adverse weather. The best material available should be use to avoid patching the same potholes over and over because of poor quality patching materials. Lastly, testing should be performed to ensure compatibility of aggregate and binder.

2.7 COST ANALYSIS FOR POTHOLE PATCHING

Some of the major elements that influence the cost-effectiveness of a pothole patching operation are as follows:

- Labor rates
- Material purchase
- Productivity of the patching crew
- Total quantity of potholes to be repaired
- Equipment costs
- Performance of the repairs (either expected life or survival rating)

These elements are used to calculate cost-effectiveness for a specific time frame. The following section describes inputs needed to complete the calculation. (4)

a) Labor Rates

The cost of labor for a pothole-patching operation is usually determined by the experience and seniority of the crew members and the number of crew members actually involved. To calculate cost-effectiveness, the information on labor rates should be available on a per day basis. The value of labor rates should be given for the entire patching crew, including supervisors. The labor rate can then be multiplied by the number of days needed for patching to get a total cost for the patching operation over one year.

b) Material Costs

For each type of materials available to an agency, there will be an associated purchase cost that can be expressed in RM/ tonne. There will also be some cost associated with shipping the material from the plant where it is produced to an agency's yard. The total per ton cost associated with buying the materials and stockpiling it in the yard should be used to determine material costs.

c) Productivity of the Patching Operation

Each pothole-patching crew has a different value for the average productivity achieved. One way of estimating average productivity is to divide the total amount of materials placed by the total days spent patching. The value should be expressed in terms of tonne/ day of material placed.

d) Total Quantity of Potholes to Be Repaired

This value is one of the most difficult to calculate. It is intended to represent only the new potholes that develop during a given year and should not include "repeat" potholes-those that reappear as previously placed material loosens or degrades. For calculating total patching costs, this value should be in tonne of material. The volume of potholes is easier to estimate, a density of 125 lb/ft ^{3} (2,030 kg/m ^{3}) can be used to convert volume to mass.

e) Equipment Costs

Depending on the type of patching operation performed, different pieces of equipment are needed. Trucks, compressors, jackhammers, compaction devices, and spray-injection devices may be used, and each has costs associated with it. For calculating patching costs, the RM/ day rate for all necessary equipment should be used.

f) Performance of the Repairs

Obviously, a major factor in determining the cost-effectiveness of any pothole-patching operation is how the patches perform. Patches that last a long time and require very little re-patching greatly reduce the labor and equipment costs for the overall repair operation. Every patch placed may eventually fail. Because potholes are the result of the original pavement having failed, the chance of patches remaining permanent is unlikely.

2.8 SUMMARY

Pothole can be serious paving failure if not repair immediately since it poses danger the travelers on the road. There is various patching type available such as cold mix, hot mix and cement concrete mix that can be used. The patches type are used depend on the condition and the situation of the pothole and pavement.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Since there are patching materials are available and have been used nowadays, the study of those methods is necessary to enhance knowledge in this topic. After the evaluation and comparison between the materials were done, the most efficient and cost effective one can be suggested.

The two materials evaluated in this project are cold mix asphalt and hot mix asphalt. The sample preparations of these materials will be discussed in the following section.

3.2 PROCEDURE IDENTIFICATION

A planned methodology devised in order to ensure that the entire laboratory section of this project runs smoothly. Following are the stages of the methodology involved in conducting the three experiments.

3.2.1 Literature Review

The step included an in depth research on the various literature review topics, as well as a review on the methods for the tests to be conducted. This was then followed by thorough planning and execution of the laboratory needed.

3.2.2 Pre-Laboratory

Prelaboratory work were done to ensure the experiments to be conducted ran as smoothly as possible, a series of prelaboratory work was conducted. Prelaboratory works includes sieve analysis test and material preparation. The material was washed

and dried where needed. The properties of the hot mix and cold mix are available in the Tables A-1 and Table A-2 in the Appendix A.

3.2.3 Sample Preparation

At the first semester, there was a need to produce about six samples of cold mix and six samples of hot mix were prepared for the Marshall Test. This was done over a course of about two weeks, using 75 blows number of compaction for each sample.

For the second semester, another three samples of cold mix and three samples of hot mix were prepared for the Creep Testing. Additional two slab samples were produced for the Wheel Tracking Test. The slab samples were prepared with a hole in the middle to act as a pothole in the pavement, and then the hole was patched with cold mix or hot mix to stimulate the patching mechanism at the field. The Wheel Tracking Test was then conducted on the slab samples.

3.2.4 Laboratory Experiment

The laboratory tests were conducted for the determination of the properties of patching materials. The results are investigated along with the JKR specification, to allow for the characterization of the material properties that are the most critical for the desired field performance

There were three laboratories conducted. The three experiments are Marshall Test, Static Creep test and the Wheel Tracking Test. Further detail on each test will be elaborated in section 3.3, 3.4 and 3.5. More pictures during laboratories are available in Appendix B.

3.2.5 Data Collection and Analysis

Three laboratory tests were conducted and data obtained were analyzed. The results for each test were divided into different materials.

3.3 MARSHALL TEST

3.3.1 Introduction

Marshall Test was done to evaluate characteristic and performance of cold mixed and hot mixed asphalt. The materials were compared in term of stability and flow of the materials. The procedure for the Marshall were same for cold mixed and hot mixed, except for the cold mixed samples were not soak into the water bath. The preparation for hot mix and cold mix materials are available in the Appendix B.

3.3.2 Tools and Equipment

The tools that are required for the Marshall test are marshall hammer, thermometer, water bath, electronic balance, buoyancy balance, oven and marshall testing machine.

3.3.3 Sample preparation

Based on optimum asphalt binder content estimated from previous Marshall Test, samples are prepared at 5.7 percent by weight of mix increments. Figures 3.1 and 3.2 showed the hot mix and cold mix samples.

The cold mixed sample was done using the ready mix cold mix supply by Kemaman Bitumen Sdn Bhd.

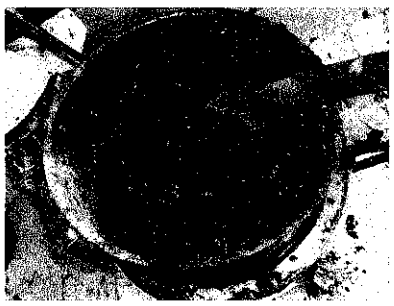

Figure 3.1: Hot Mix Preparation

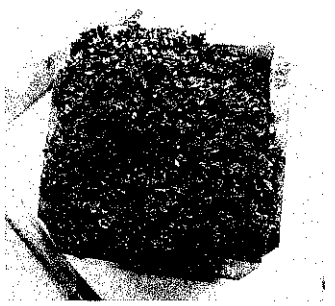

Figure 3.2: Cold Mix Asphalt

Each sample is then heated to the anticipated compaction temperature and compacted with a Marshall hammer, a device that applies pressure to a sample through a tamper foot (Refer Figures 3.3 and 3.4). Some hammers are automatic and some are hand operated. Key parameters of the compactor are:

- Sample size = 102 mm (4-inch) diameter cylinder 64 mm (2.5 inches) in height (corrections can be made for different sample heights)
- Tamper foot = Flat and circular with a diameter of 98.4 mm (3.875 inches) corresponding to an area of 76 cm^2 (11.8 in^2) at the standard height of the equipment.
- Weight of the sample = 1200g
- Compaction pressure = Specified as a 457.2 mm (18 inches) free fall drop distance of a hammer assembly with a 4536 g (10 lb.) sliding weight.
- Number of blows = 50 on each side
- Simulation method = The tamper foot strikes the sample on the top and covers almost the entire sample top area. After a specified number of blows, the sample is turned over and the procedure repeated

Figure 3.3: Hot Mix after Compaction

Figure 3.4: Cold Mix after Compaction

3.3.3 Procedure

The sample dimensions were measure and followed by weight of samples in the air and the water. The hot mixed samples then were soaked in the water bath for half an hour at 60°C to maintain the temperature. The samples then were tested using marshall testing machine. The Marshall Stability and flow test provides the performance prediction measure for the Marshall Mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute (2 inches/minute). Basically, the load is increased until it reaches a maximum then when the load begins to decrease, the loading is stopped and the maximum load is recorded.

During the loading, an attached dial gauge measures the specimen's plastic flow as a result of the loading. The flow value is recorded in 0.25 mm (0.01 inch) increments

at the same time the maximum load is recorded. Figures 3.5 and 3.6 depicted the samples after the Marshall Test.

Figure 3.5: Hot Mix after Stability and Flow Test

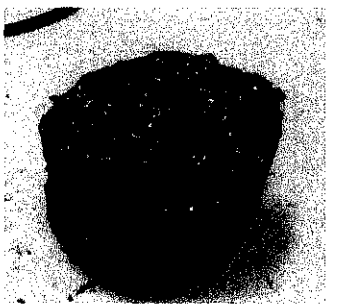

Figure 3.6: Cold Mix after Stability and Flow Test

3.4 CREEP TEST

3.4.1 Introduction

The uniaxial creep test is the simplest method of assessing the resistance to permanent deformation. This test used to determine the permanent deformation due to temperature and load similar to those experienced by the asphalt pavement. The measured parameters are the stiffness and permanent deformation of the samples. From the permanent deformation curve, the value of mix stiffness can be calculated and bitumen stiffness can be derived from a nomograph. The rut depth is calculated based on the stiffness linear relationship.

The Dynamic Creep Test is a test that applies a repeated pulsed uniaxial stress/load to an asphalt (or, other material) specimen and measures the resulting deformations in the same axis and/ or radial axis using Liner Variable Displacement Transformers (LVDTs). Test's can also be conducted under confined conditions using a standard triaxial pressure cell or the IPC Global developed Rapid Triaxial Tester (RaTT).

3.4.2 Tools and Equipment

The tools that are required for the dynamic creep test are the loading press, temperature control system with confined environment to carry out the test, static creep test jig with Linear Variable Differential Transducers (LVDT) and suitable software for the control of the equipment and recording of the data.

3.4.4 Sample Preparation

The samples for the creep test are same as the Marshall Test. The sample size is 102 mm in diameter and 64 mm in height.

3.4.3 Procedure

The stress/load applied to the specimen is feed back controlled allowing the operator to select a loading wave shape (havesine or square pulse), the pulse width duration, the rest period before the application of the next pulse, the deviator stress/load to be applied during each loading pulse and the contact stress/load to be applied so that the vertical loading shaft does not lift off the test specimen during the rest period. Prior to testing a preload stress/load can also be programmed into the testing sequence. For controlled temperature testing, the specimen's skin and core temperatures are estimated by transducers inserted in a dummy specimen and located near the specimen under test.

As the test proceeds, the operator can monitor and plot data, which includes the following items.

- Accumulated/Permanent and Resilient strains
- Accumulated strain slope
- Deviator and confining Stress
- Resilient modulus
- Creep stiffness
- Peak and Seating Load
- Permanent and Resilient deformations
- Temperature

The testing will continue until one of the following termination conditions is met.

- Maximum axial or radial strain limit.
- Maximum cycle count.
- Operator stops the test.

Standard test conditions and requirements for the Dynamic Creep test are:

Test stress	: 100kPa
Test duration	: 3600s
Test temperature	: 30 or 40 °C

3.5 WHEEL TRACKING TEST

3.5.1 Introduction

This is used to determine the susceptibility of particular patches on the pavement to a continuous dynamic load similar to that of the wheel of the vehicle on the road. The performances of the materials are assessed by measuring the resultant rut depth after a given fixed time frame and also the slope of the rut depth graph, which represent the rate of the rut depth based on the loading inflicted upon the sample. Work carry out by the TLR has shown that a good correlation exists between permanent deformation on open stretches of road and the performance in the laboratory scale wheel tracking test. All slabs are prepared with 150 mm x 150 mm x 30 mm hole at the middle of the slab as showed in Figure 3.7. The purpose of the hole is to act as a pothole at the road. The hole is then filled with cold mix and hot mix respectively as showed in Figure 3.8. The comparison of the rut depths for both materials was then analyzed.

Figure 3.7: Wheel tracking slab with a pothole

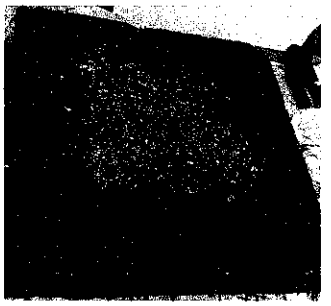

Figure 3.8: Patching the pothole using the cold mix

3.5.2 Tools and Equipment

The tools and equipment needed for the test is the wheel tracking device, rut depth measurement apparatus, temperature control system, and wheel pass counter specimen mounting system.

3.5.4 Sample Preparation

Preheat temperature bitumen to 162°C for four hours. The mould is preheated to compaction temperature which is 144°C.

Brown paper was place onto internal base of the mould. The slab mix material mass was spread evenly into the mould and tamp to ensure an even distribution until the partially compacted material is about 5 mm above the top of the mould.

The slab sample was gently rolled across the surface using a 30 kg roller with a 310 mm face width to bring the specimen to a true and flat face level width the top of the mould.

The specimen was removed from the sample after it is cool to the room temperature. The side faces of specimen was dressed and stored at the flat surface before testing.

3.5.3 Procedure

The wheel tracking test was conducted according to the specification mention in the relevant British Standard (BS), NCHRP and ASTM Standards.

The device applies a 710 N (160 lb) vertical force through 150 mm wide steel wheel with a 12.5 mm thick rubber contact surface for 45 minutes. The computer interface allows the user to plot rut depth versus time via displacement instrumentation on each loaded wheel. The samples are placed inside wooden sample holders and mounted on a reciprocating platform that translates a horizontal distance of 230 mm. The rate of loading is 26 cycles per minute, which corresponds to 52 wheel passes per minute.

CHAPTER 4

RESULT AND DISCUSSION

4.1 LABORATORY TESTING

4.1. 1 Marshall Test

The output reported from this test on the maximum load the material can stand before failure and the deformation at maximum load. The first parameter is known as the Marshall Stability and the second is regarded as the flow index. Stability is an indicator on the cohesion of the material and the flow index is related to the internal friction. A higher value of stability can therefore be synonymous to better cohesion and a mix that would uphold to heavier loads in the field. A higher flow index indicates that the material will have less internal friction and thus a higher rate of permanent deformation in a pavement.

The optimum binder content of the hot mix is obtained from previous test done by other student in the same lab. The results to find the optimum binder content are available in the Appendix B. Table 4.1 shows the calculation to determine the required mass or amount of course aggregate, fine aggregate, filter and binder content required for each proportion for hot mix. While the amount of ready mixed cold mix used is also 1200 g.

Table 4.1: Calculation of Hot mix for Marshall Test

Material	Percentage (%)	Mass (g)
Coarse aggregate	42	504
Fine aggregate	52	624
Filler	6	72
Binder content	5.7	72.5
Total mass		1200

Since there is no specification for the pothole patching, the results are compared using the wearing course specification for pavement design (Refer Table 4.2). The Marshall Stability test result showed that the stability of the material for hot mix is higher than cold mix. This is because the binder used for hot mix is stiffer than the binder for cold mix. For the pothole patching that shared the load transfer by the vehicle with existing pavement, both materials meet the requirement to be used as patches. The stability for cold mix can be increased with a stiffer binder seeing as stability is a function of the binder properties in asphalt concrete mixture or add new additive to increase the stability of the mixture .

The result showed that the flow index for cold mix is higher that hot mix with 1 mm different. Flow index is directly related to the aggregate composition of the mix. The flow value can be altered by changing the aggregate gradation of a mix. Some researchers theorize that a lower flow value indicates that the void content is too high (or asphalt content to low) and thus the mixture is less durable. (5)

Table 4.2: Specification Requirement from JKR and Laboratory Result

	JKR Specification	**Laboratory Result**	
Parameter	Wearing course	Hot mix	Cold mix
Stability (kg)	> 500	740	325
Flow (mm)	> 2.0	3	4
Stiffness (kg/mm)	>250	246.7	105.2
Air void in mix	3% - 5%	4.5%	6%

4.1.2 Creep Test

The simplest test to study the deformation behavior of asphalt is the creep test. For this test, six samples were tested, three hot mix samples and three cold mix samples. The mass used for the sample is same as in Marshall Test. Termination condition used for this test is a maximum cycle, which is 1800 cycles. The data that can be monitor from this test are many as discussed in chapter 3, but this report discussed

only creep stiffness and permanent deformation since they give a significant impact for the project.

Figure 4.1 and Figure 4.2 are the results for creep stiffness and permanent deformation for all hot mix samples. The average result is then plotted to represent the result for hot mix sample to be discuss later.

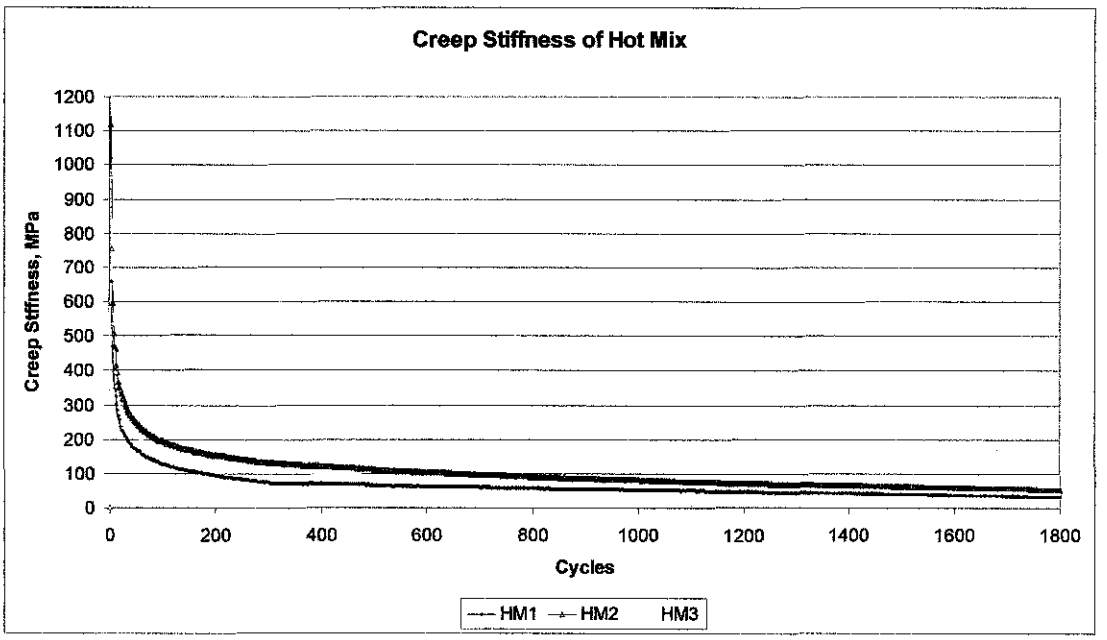

Figure 4.1: Creep stiffness for all hot mix samples

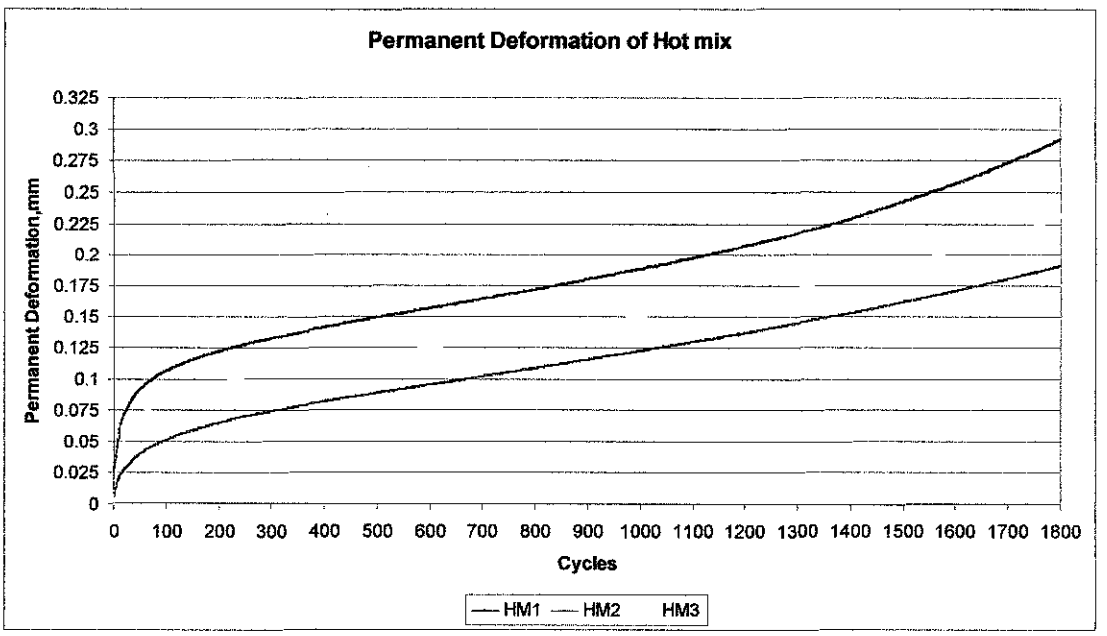

Figure 4.2: Permanent deformation for all hot mix samples

Figure 4.3 is an average result taken from all the samples of hot mix. All the hot mix samples manage to finish the test until 1800 cycles. It means that the hot mix samples can carry on until the end of it service life. At the beginning of the test, hot mix has high creep stiffness value, which is 1032 MPa and the stiffness decreased with the increasing loading. At the end of the test, the stiffness of the sample reduces to 42.46 MPa. Permanent deformation for the hot mix at the end of the testing is 0.238mm.

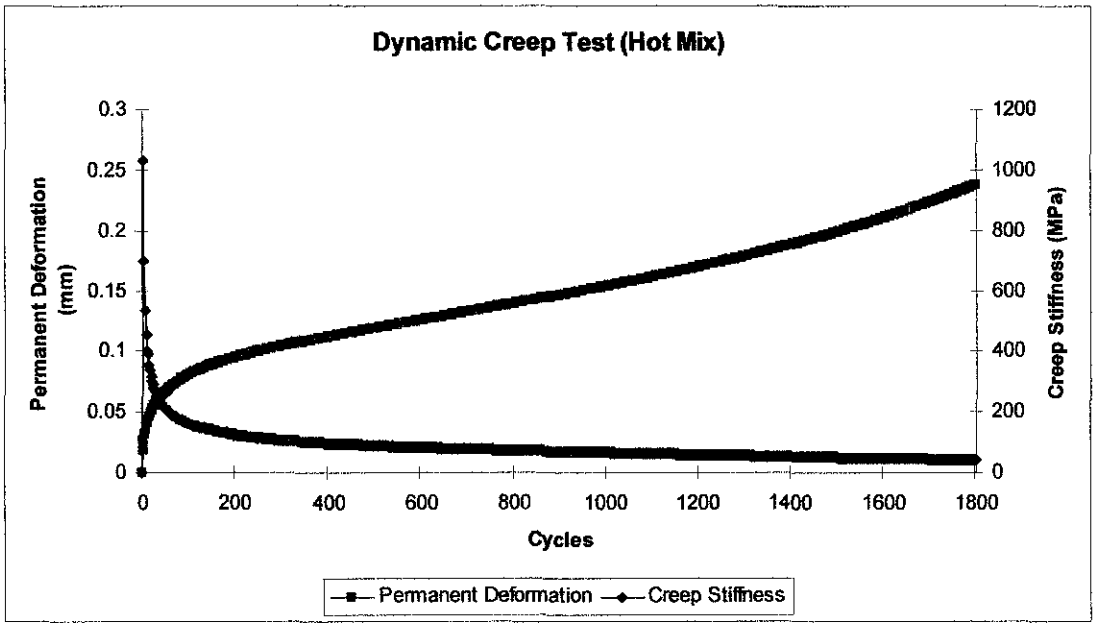

Figure 4.3: Average creep stiffness and permanent deformation for hot mix

Figure 4.4 and Figure 4.5 showed result for creep stiffness and permanent deformation for all cold mix samples. The average result is then plotted to represent the result for hot mix sample to be discuss later in Figure 4.6.

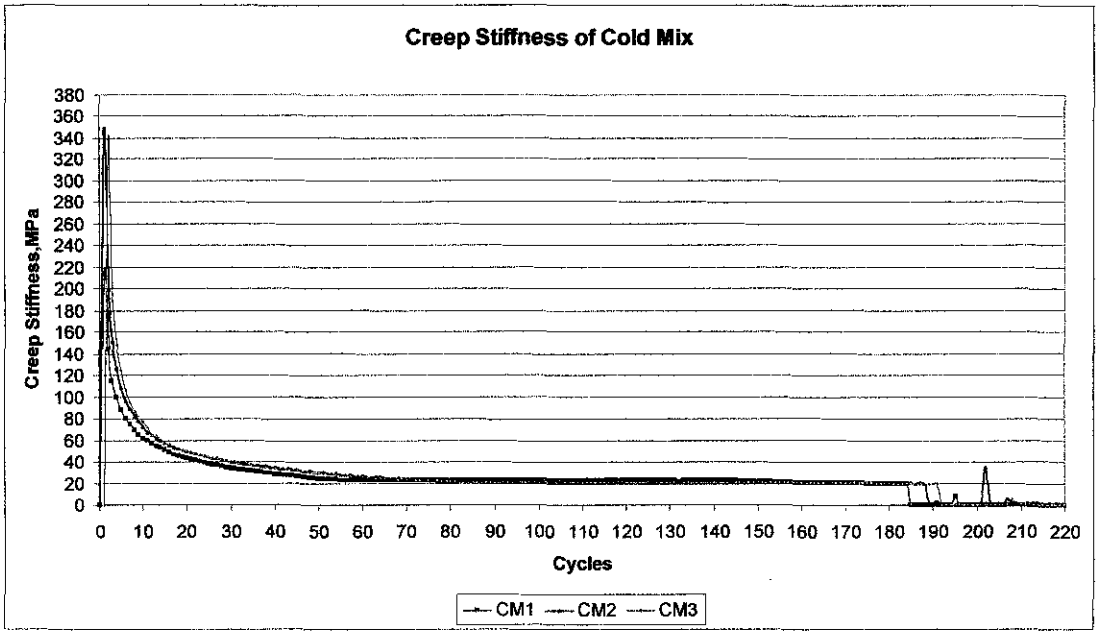

Figure 4.4: Creep stiffness for all cold mix samples

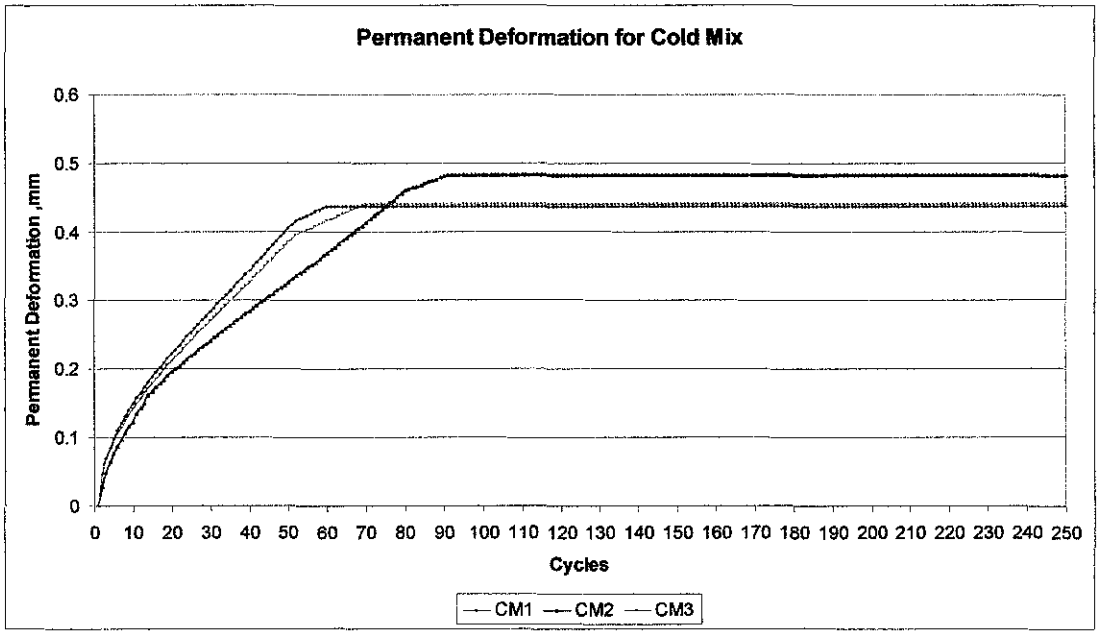

Figure 4.5: Permanent deformation for all cold mix samples

Figure 4.6 below is an average test result from the three cold mix samples. The graph showed that the cold mix sample failed to complete the 1800 cycles loading and only withstand 275 cycles. From this test, it proved that the cold mix samples have low stiffness compared to hot mix. The stiffness of the sample at the beginning of the test is 299.54 MPa and reduces to 0.28 MPa when the sample starts to collapse and failed. The permanent deformation of the sample when the sample fails is 0.439mm.

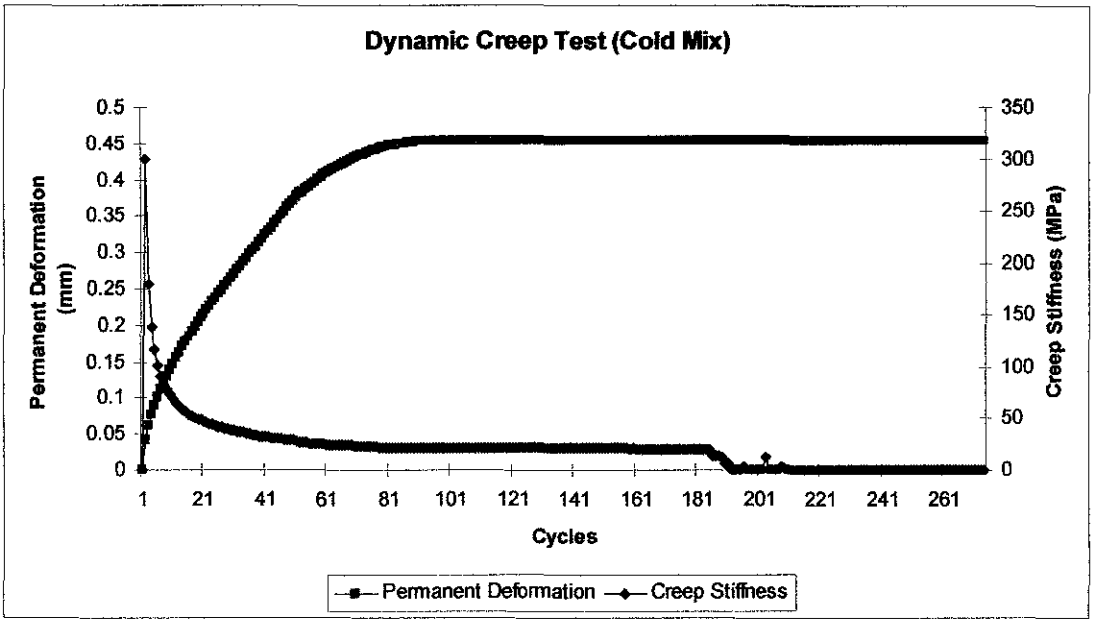

Figure 4.6: Average creep stiffness and permanent deformation for cold mi

Figures 4.7 and 4.8 below show the comparison of the permanent deformation and creep stiffness results between hot mix and cold mix. From the graph, cold mix sample collapsed before 200 cycles of the loading while hot mix sample can withstand until the end of the test. Cold mix sample continued to collapse and the test then stopped when it reach maximum radial strain. Hot mix sample is stopped after it reaches the maximum cycle count which is 1800 cycles. Cold mix mixture is not hardened, hence the sample is easy to break and collapse after stress is applied to them.

The stiffness of the cold mix sample is low compared to hot mix. Both materials have high stiffness at the beginning of the test, after several loading of stress on the sample; the stiffness is then dropping significantly. Cold mix collapse after 200 cycles, therefore the detector failed to read. Therefore reading turn out to be zero.

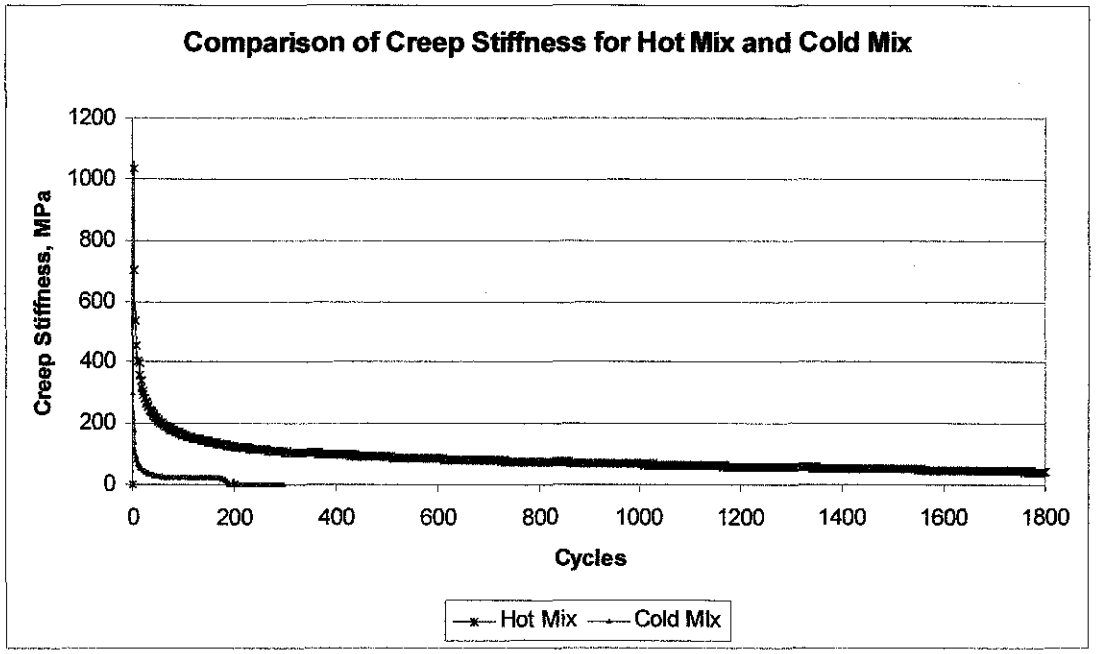

Figure 4.7: Comparison of creep stiffness between hot mix and cold mix

From the test, the permanent deformation of cold mix is about twice the permanent deformation of hot mix which is 0.439 mm and 0.238 mm, respectively. The deformation slope for cold mix curve is steep compared to hot mix since the sample start to break after 50 cycles and collapse before 200 cycles of stress loading. Permanent deformation for cold mix is at maximum after 200 cycles loading of stress. The hot mix sample has not reach the maximum deformation yet, and the minimal deformation showed that the hot mix is very strong and it can be used as permanent patching.

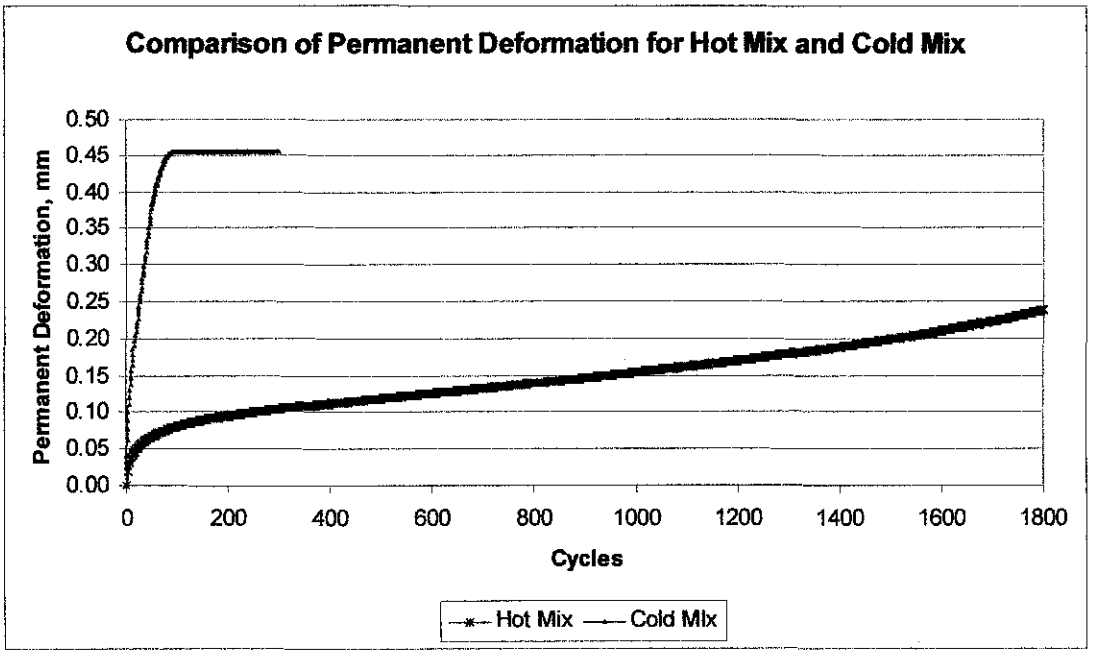

Figure 4.8: Comparison of permanent deformation between hot mix and cold mix

4.1.3 Wheel Tracking Test

Two samples for hot mix slabs with a patched hole are prepared and undergone Wheel Tracking Test to determine permanent deformation. While conducting the wheel tracking test, level of difficulty in patching also can be analyzed during patching the hole on the slab sample. The discussion on level of difficulty will be discussed in section 4.3. One sample was patched using cold mix and another one with hot mix. The amount of mixture need for patching is similar as Marshall Test which is 1200g.

Table 4.3 shows the calculation to determine the required mass or amount of course aggregate, fine aggregate, filter and binder content required for each proportion for hot mix.

Table 4.3: Hot mix for wheel tracking test slab

Material	Percentage (%)	Mass (g)
Coarse aggregate	42	4200
Fine aggregate	52	5200
Filler	6	600
Binder content	5.7	604.5
Total mass		10000

As result showed in Tables and Figure below, the rut depth after 45 minutes (approximately 2340 cycles) of test, under the same condition, the final rut depth for hot mix sample is 7.2 mm. Meanwhile for cold mix sample, the final rut depth is 9.5 mm. Based on the results, it found that the rut depth for hot mix sample is slightly lesser than cold mix sample, about 2.3 mm different from the cold mix sample. This result shows that both materials meet the requirement by JKR which is 12 mm and able to contribute almost same resistance to rut depth caused by cyclic loading.

Table 4.4: Wheel Tracking Test result data for hot mix

Time(min)	Temp(deg)	Depth(mm)	Time(min)	Temp(deg)	Depth(mm)
0	40	0	23	40.1	4
1	40	0.2	24	40.1	4
2	40	0.4	25	40.1	4.2
3	40	0.7	26	40.1	4.4
4	40	1	27	40.1	4.6
5	40	1.3	28	40.1	4.8
6	40	1.4	29	40.1	4.8
7	40	1.8	30	40.1	5
8	40	2	31	40.1	5.2
9	40	2	32	40.1	5.4
10	40	2.2	33	40.1	5.4
11	40	2.4	34	40.1	5.6
12	40	2.6	35	40.1	5.8
13	40.1	2.6	36	40.1	6
14	40.1	2.8	37	40.1	6.2
15	40.1	3	38	40.1	6.2
16	40.1	3	39	40.1	6.4
17	40.1	3.2	40	40.1	6.6
18	40.1	3.4	41	40.1	6.6
19	40.1	3.4	42	40.1	6.8
20	40.1	3.6	43	40.1	6.8
21	40.1	3.8	44	40.1	7
22	40.1	3.8	45	40.1	7.2

Table 4.5: Wheel Tracking Test result data for cold mix

Time(min)	Temp(deg)	Depth(mm)	Time(min)	Temp(deg)	Depth(mm)
0	40	0	23	40	5.6
1	40	0.2	24	40	5.8
2	40	0.5	25	40.1	6
3	40	1.1	26	40.1	6.2
4	40	1.3	27	40.1	6.3
5	40	1.5	28	40.1	6.6
6	40	1.7	29	40.1	6.8
7	40	2	30	40.1	7.1
8	40	2.2	31	40.1	7.2
9	40	2.5	32	40.1	7.5
10	40	2.8	33	40.1	7.6
11	40	3.2	34	40.1	7.9
12	40	3.6	35	40.1	8
13	40	3.8	36	40.1	8.2
14	40	4	37	40.1	8.3
15	40	4.2	38	40.1	8.4
16	40	4.5	39	40.1	8.6
17	40	4.6	40	40.1	8.8
18	40	4.7	41	40.1	9
19	40	4.9	42	40.1	9.1
20	40	5.1	43	40.1	9.3
21	40	5.2	44	40.2	9.4
22	40	5.4	45	40.2	9.5

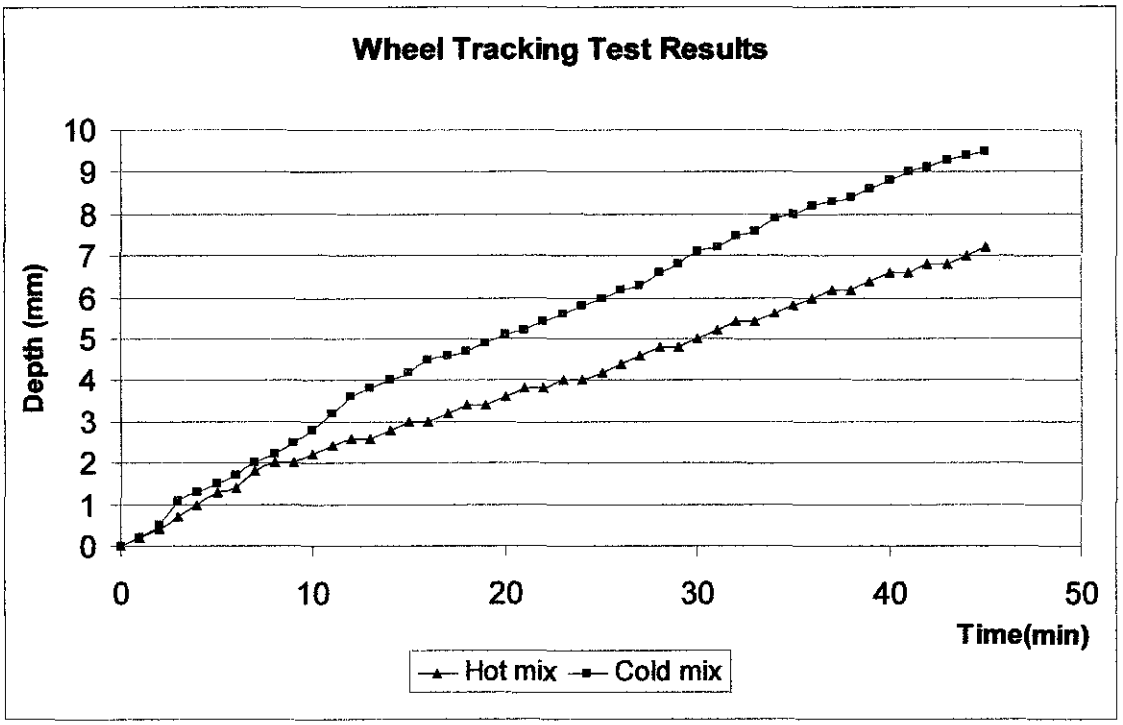

Figure 4.5: Comparison of WTT result between hot mix and cold mix patching

4.2 COST ANALYSIS

There are many factors to be considers for analysis of the cost analysis as discussed in Chapter 2. In this report, the cost analysis only covered the cost of material, labors and equipment. Since cold mix is easier to handle, the direct cost can be reduce because it does not required skillful labor to do the patching. The cost in this project is based on semi permanent technique, where the pothole must be trimmed at the edge, water and debris are removed and compacted after material is placed in the hole by roller or vibratory compactor.

The cost of the materials for hot mix and cold mix are RM 120 and RM 500 per tonne respectively (Refer to Table 4.6). The cost for the cold mix is higher because the cold mix can be stockpile and it was sold in packed. Cold mixes also add emulsion in their binder so that it can be prepared without heating the aggregate and binder. Based on patching process during wheel tracking test, 1 tonne or 1000 kg of hot mix and cold mix can patches around 3.5 m^2 x 5 cm potholes.

Table 4.6: Material Cost

Item	**Hot Mixed**	**Cold Mixed**
	Units	Units
Cost / tonne	RM 120	RM 500
Coverage / tonne	3.5 m^2	3.5 m^2
Depth	5 cm	5 cm

Table 4.7 below detailed the workmanship cost. From the table, the cost for the cold mix is lower than hot mix. It is because the cold mix is very easy to apply where no skilled personnel or special tool required for this material. The crew needed for both materials is operator to fill the pothole and compact the material and labor as a flagman to control the traffic on the road. Since the hot mix material required continues heating, it need mix truck to transport the materials from the factory to the site. As cold mix can be stockpile and do not required heating, it can be transport in small lorry or even a car (packed). Cold mix also do not required compactor to compact the materials, it just required lorry to roll on the patches a few times after filling the pothole.

Table 4.7: Workmanship

Factor	Cost / day	Hot Mixed		Cold Mixed	
		Quantity	Cost	Quantity	Cost
Crew					
- Operator	RM 80	2	RM 160	1	RM 80
- Labor	RM 40	2	RM 80	2	RM 80
Equipment					
- Mix Truck - Lorry	RM 300 RM 100	1	RM 300		 RM 100
- Plate compactor	RM 350	1	RM 350		-
Total Direct Cost			RM 890		RM 260

The overall cost patching the pothole using the hot mix and cold mix is discussed in Table 4.8 below. The cost to patching $1m^2$ pothole for hot mix is RM 288.57 and for cold mix is RM 217.14. To calculate the repair cost for the pothole, the cost of the patching must be multiply with the performance of the repair. Since cold mix is weaker than hot mix, assume that the service life of pothole using hot mix is 1 and cold mix is 0.5. So, if the patching using hot mix is 1 time per pothole the patching using the cold mix are 2 times per pothole. So the cost for hot mix is about RM 289 and for cold mix is RM 434.

Table 4.8: Total Patching Cost

Items	Hot Mixed	Cold Mixed	
Material Budget / tonne	RM 120	RM 500	Table 4.6
Workmanship	RM 890	RM 260	Table 4.7
Total Repair Cost	RM 1010	RM 760	
Cost / m^2	RM 288.57	RM 217.14	

4.3 SUMMARY

Marshall Test showed hot mix has higher value for marshall stability, and lower marshall flow compared to cold mix. Hot mix has better cohesion and is a mix that would uphold to heavier loads in the field.

For the Dynamic Creep Test, hot mix has high stiffness and lower permanent deformation compared to cold mix. From the test, it showed hot mix patches will remain pavement life cycle. While cold mix patches might need repatching after a few years.

Wheel Tracking Test results showed both materials meet the rutting depth requirement by JKR which is 12 mm.

From all three tests, both materials were considered meet the requirement for pothole patching. It is because the patches only covered small area in the pavement, so it will share the load transfer by the vehicle with the existing pavement. Thus, there is not necessary to use the most stable materials.

Cold mix is the best solutions in all adverse climates including wet condition. Thus it can reduce vehicle damage because of pothole even during rains season.

The cost analysis show that the cost for pothole patching using hot mix and cold mix are about RM 289 and RM 217 respectively per patching. Since the cold mix has lower stiffness compared to hot mix, the cost for cold mix may increase twice for re-patching the same pothole.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The laboratory tests performed showed that hot mix has higher value in stability and stiffness compared to cold mix, but both samples meet the specification for the pothole patching.

The cost analysis showed the cost for the cold mix is lower than hot mix. But if repatching is required, the cost for cold mix may increase twice from the analysis.

From the study, hot mix patching most effectively and economically to use for the pothole with more than 1 m diameter size, heavy traffic road and urban area. Meanwhile cold mix patching is most suitable and economically to be used for the small pothole size and less traffic road.

5.2 RECOMMENDATION

To complete the study, series of field tests can be performed in order to evaluate the rates of deterioration of the patches. The field inspections may take place 18 months after the completion of the patching.

The study of the properties of cold mix can be done to enhance the strength and stiffness of the materials, so that the cost for the re-patching can be reduced.

Further testing can be performed to ensure compatibility of aggregate and binder. When ever possible, the aggregate and binder to be used to produce a cold mix material should test on a smaller scale to determine if the two are compatible.

The laboratory test can be done to determine the optimum curing time for both materials, thus the delay time for the opening to the traffic after the patching can be determine.

Safety and user delay costs can be considered in calculating operation costs. Re-patching can be avoided by using a more expensive cold-mix and the safety conditions can also improved by allowing less crew time in traffic.

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APPENDICES

Appendix A: Materials Properties

Table A-1: JKR gradation standard for ACW 20 wearing course

Sieve size	Percentage passing by weight
28 mm	100
20 mm	76 – 100
14 mm	64 – 89
10 mm	56 – 80
5 mm	46 – 71
3.35 mm	32 – 58
1.18 mm	20 – 42
425 micron	12 – 28
150 micron	6 – 16
75 micron	4 – 8

Table A-2: Cold mix properties

Properties	Unit	Specification
Aggregate gradation : Total % by weight passing sieve		
Sieve size 12.5 mm	% wt	100
Sieve size 9.5 mm	% wt	85 – 100
Sieve size 4.75 mm	% wt	-
Sieve size 2.36 mm	% wt	0 – 10
Sieve size 300 micron	% wt	0 – 5
Sieve size 75 micron	% wt	0 – 2
Asphalt content by extraction	% wt	6 – 8
Coating ability*(by visual inspection)	%	>98

Appendix B: Laboratory Test

Sample Preparation

i) Hot Mixed Asphalt

All materials are batched and kept in oven at 150° C. The mixture is also heated to the same level of temperature; therefore great care should be exercised when handling the hot material and equipment.

The batched granular material (plus filter) should be placed in the mixer and mixed dry for about 1 minute, then the appropriate amount of bitumen should be added to the aggregate. Mixing should continue until all particles are coated with bitumen.

The material should also be compacted in 100 mm diameter steel moulds (which are also kept at 150° C - 160° C). After filling the mould with the appropriate amount of material, the operator should make sure that it is evenly distributed in the mould. This is done by temping the material (using steel rod) 15 mm times around the edges and 5 times in the centre. At this stage, the sample is ready for compaction using the Gyratory Testing Machine which is set to the following standard conditions:

Axial Load	= 0.7 MPa
Angle of Gyration	= 1°
No. of revolutions	= 30

When the specimen has cooled down to room temperature, they are extruded from the moulds. The weight of the specimen in air and water and its height should be taken (for density calculations).

Three specimens are to be prepared for each bitumen contents.

ii) Cold Mixed Asphalt

For purposes of this study, design residual asphalt content was selected to provide calculated asphalt film thicknesses the same as equivalent hot-mixed. Mixtures were

designed using The Asphalt Institute Pacific Coast Division Method (3) as a guide. More specifically, the method used for this study is outlined as follows:

a) Mixing water requirements were established by trial and error with a laboratory mixer and 1200 g. batches of aggregate. Mixing water was added and mixed. After incorporation of mixing water, emulsified asphalt was added in an amount to give six percent residual asphalt and mixed for one minute. Mixtures were subjectively evaluated for ease of mixing, complete coating, and excess water in the mixture. Two percent mixing water (based on dry weight of aggregate) was selected for study mixtures.

b) Two percent mixing water was added to 3600 g. of oven dried aggregate and mixed in a laboratory mixer for one minute.

c) The appropriate amount of emulsified asphalt was added to the moistened aggregate and mixed until complete coating was obtained.

Laboratory Test Pictures

Figure B-1: Marshall Drop Hammer

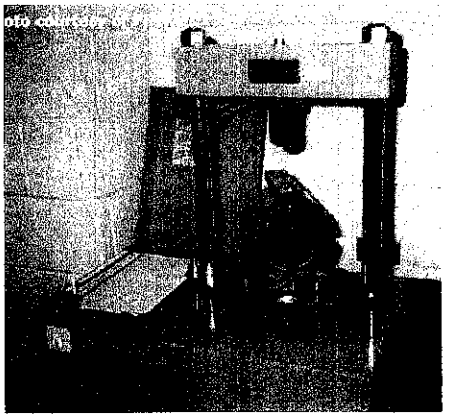

Figure B-2: Marshall Testing Apparatus

Figure B-3: Determination of sample height

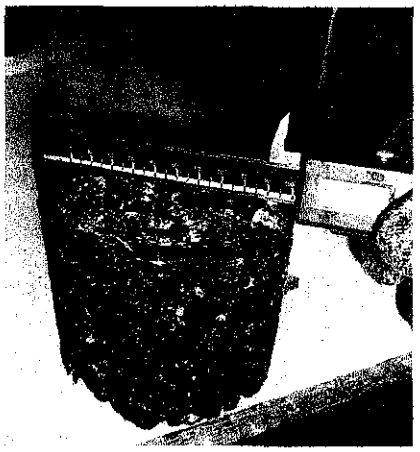

Figure B-4: Determination of sample diameter

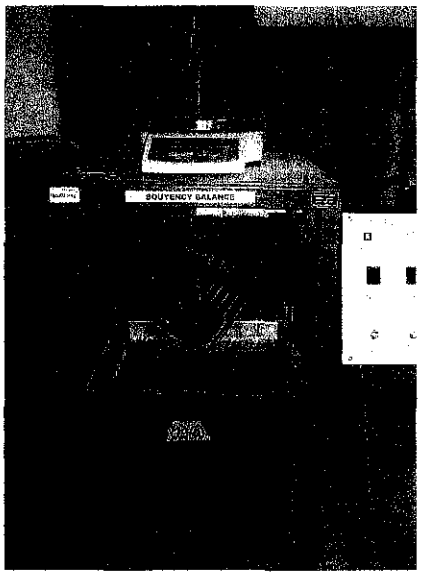

Figure B-5: Weight Sample in Air

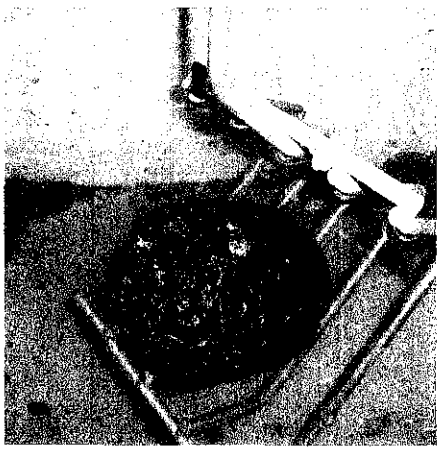

Figure B-6: Weight Sample in Water

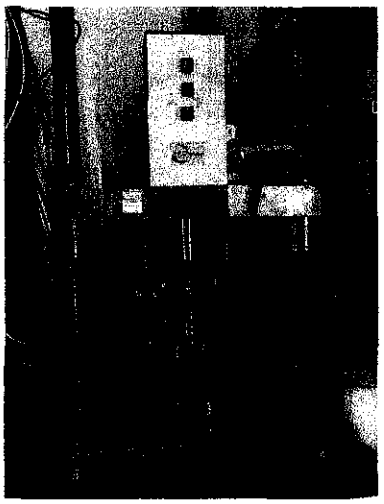

Figure B-7: Creep test

Figure B-8: The hole is build on the slab sample

Figure B-9: Compact the patches using hand compacter for WTT

Figure B-10: Wheel Tracking Test (WTT) equipment

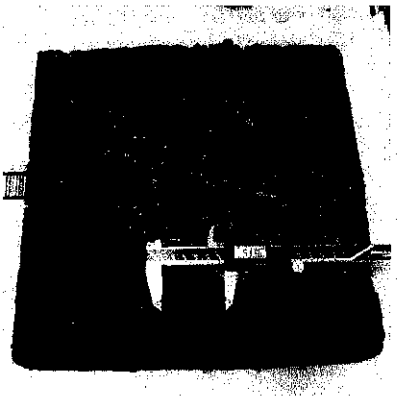

Figure B-11: Manual determination of rutting depth for hot mix from WTT

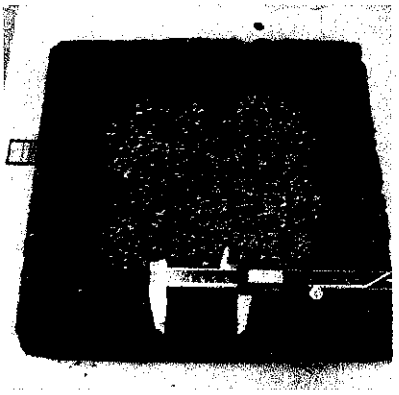

Figure B-12: Manual determination of rutting depth for cold mix from WTT

Table B-1: Marshall Test Result

Marshall Test (AC)

obc	Height			Average	Vol	Mass of Specimen		Pav	Flow	Stability (kN)		
(%)	1	2	3	(mm)	(mm^3)	Wa	Ww	(%)	(mm)	Measured	C.F.	Corrected
4.5	70.05	70.04	69.9	69.99667	549823.8	1244.5	704.8	8.037478	2.33	7.96	0.89	7.0844
4.5	71	71.02	70.83	70.95	557312.3	1248.9	704.2	12.22426	3.15	7.57	0.89	6.7373
4.5	71.74	72.19	71.94	71.95667	565219.6	1258.4	704.8	12.97844	2.65	6.64	0.86	5.7104
					557451.9	1250.6		11.08006	2.71			6.5107
5	69.76	70.06	69.74	69.85333	548697.9	1248.6	714.2	6.108019	3.35	7.64	0.89	6.7996
5	69.31	69.66	69.6	69.52333	546105.8	1251	713.5	10.17075	0	7.62	0.93	7.0866
5	68.72	69.08	68.81	68.87	540973.9	1243.2	712.2	9.638083	3.99	7.54	0.93	7.0122
					545259.2	1247.6		8.638949	2.446667			6.966133
5.5	70.41	70.48	70.53	70.47333	553568	1270.8	728.6	5.099694	3.72	6.73	0.89	5.9897
5.5	69.38	69.59	69.37	69.44667	545503.6	1257.5	722.5	8.546684	3.96	8.48	0.93	7.8864
5.5	69.01	69.27	69.04	69.10667	542832.9	1250.1	716.6	8.829239	2.74	7.04	0.93	6.5472
					547301.5	1259.467		7.491872	3.473333			6.807767
6	68.83	68.64	68.65	68.70667	539690.9	1257.7	726	3.502945	3.4	8.35	0.93	7.7655
6	69.59	69.83	69.58	69.66667	547231.7	1274.5	734.9	7.361557	3.28	9.66	0.89	8.5974
6	69.54	69.49	69.49	69.50667	545974.9	1267.7	731.1	7.340666	3.22	8.61	0.89	7.6629
					544299.1	1266.633		6.068389	3.3			8.0086
6.5	69.55	69.51	69.61	69.55667	546367.6	1273	735.9	2.589347	4.67	7.67	0.93	7.1331
6.5	70.81	70.58	70.89	70.76	555819.8	1281.9	735.6	7.232287	4.2	7.54	0.89	6.7106
6.5	69.7	69.88	69.83	69.80333	548305.2	1267.6	727.5	7.214107	4.32	7.67	0.89	6.8263
					550164.2	1274.167		5.67858	4.396667			6.89

Table B-2 : Aggregate Composition for Marshall Test

Aggregate type	% by weight of total paving mixture	bulk specific gravity
Coarse	42	2.69
Fine	52	2.65
Filler	6	3.15

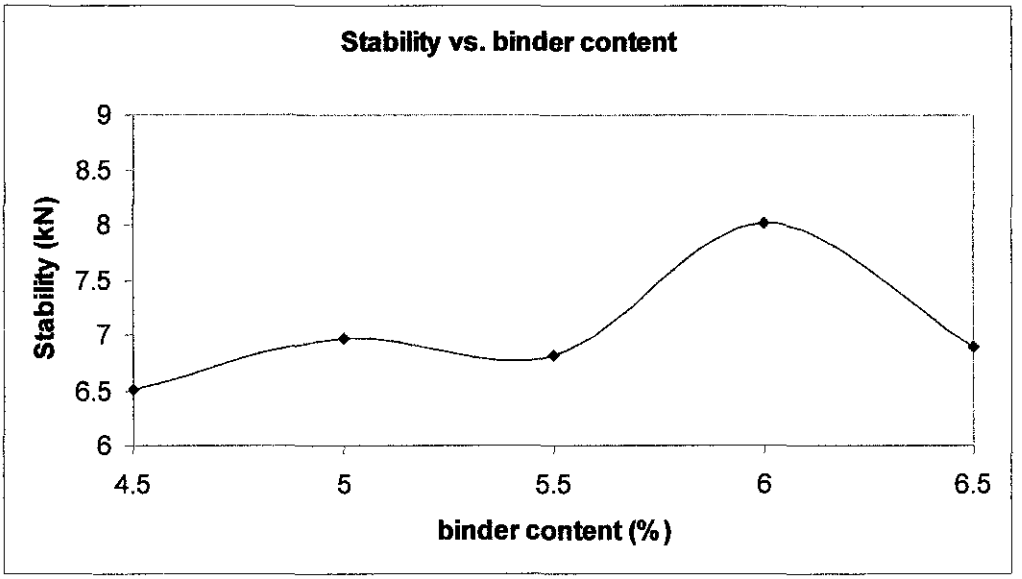

Figure B-13 : Stability Vs Binder Content

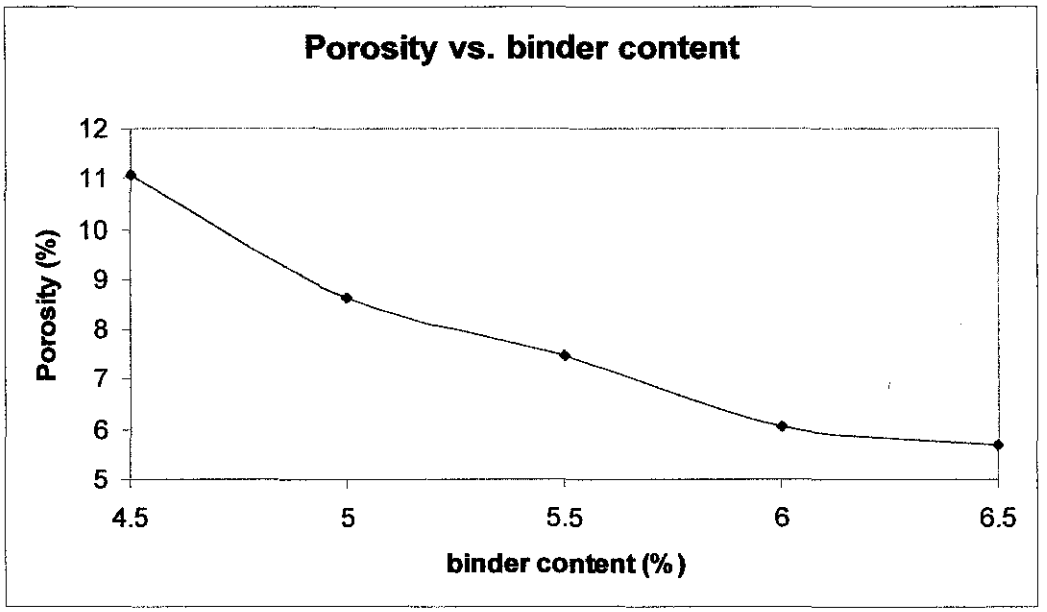

Figure B-14: Porosity Vs Binder Content Graph

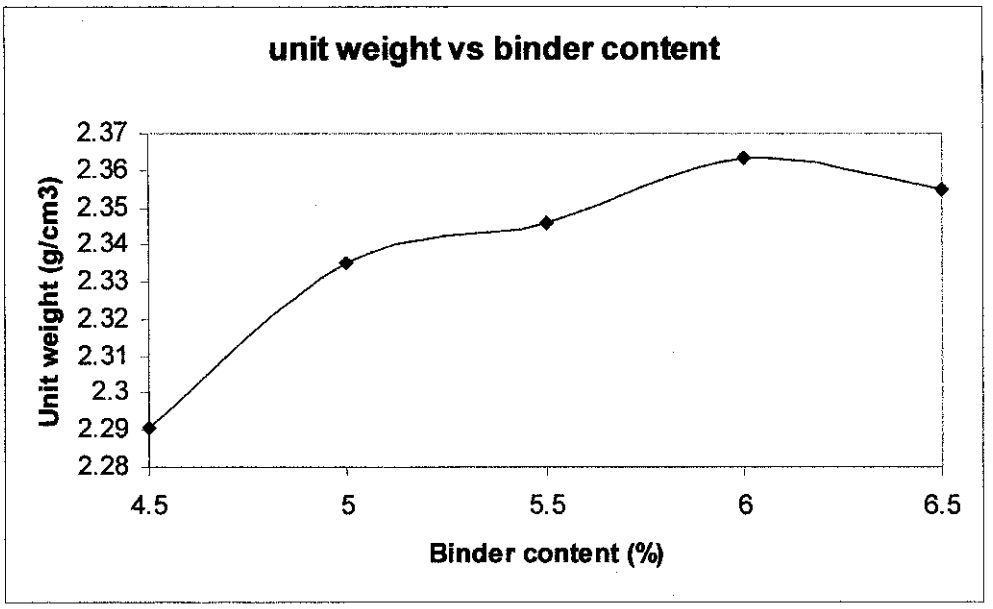

Figure B-15: Unit Weight Vs Binder Content

Table B-3: Permanent deformation and creep stiffness for hot mix

	Permanent Deformation (mm)				Creep stiffness (MPa)			
Cycles	Sample 1	Sample 2	Sample 3	Average	Sample 1	Sample 2	Sample 3	Average
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0269	0.0088	0.0196	0.0184	1019.6650	1119.0090	959.6280	1032.7673
4	0.0379	0.0123	0.0276	0.0259	659.6280	754.6680	679.2012	697.8324
6	0.0453	0.0158	0.0331	0.0314	468.3340	595.3570	535.8213	533.1708
8	0.0512	0.0181	0.0373	0.0355	396.3050	507.1770	456.4593	453.3138
10	0.0560	0.0199	0.0409	0.0390	348.9590	465.8380	395.9623	403.5864
12	0.0597	0.0211	0.0436	0.0415	325.5420	462.3640	393.0094	393.6385
14	0.0635	0.0230	0.0463	0.0443	301.8850	414.6830	352.4806	356.3495
16	0.0663	0.0242	0.0484	0.0463	283.6860	393.7390	334.6782	337.3677
18	0.0689	0.0258	0.0503	0.0483	268.4550	365.3600	310.5560	314.7903
20	0.0714	0.0271	0.0521	0.0502	257.3180	351.1730	298.4971	302.3294
22	0.0734	0.0280	0.0536	0.0516	237.3870	342.9690	291.5237	290.6266
24	0.0751	0.0291	0.0563	0.0535	226.9490	331.2180	281.5353	279.9008
26	0.0770	0.0300	0.0578	0.0550	223.1770	320.4460	272.3791	272.0007
28	0.0786	0.0309	0.0590	0.0562	216.5780	313.8710	266.7904	265.7465
30	0.0802	0.0317	0.0602	0.0574	209.0710	302.0770	256.7655	255.9712
32	0.0817	0.0327	0.0613	0.0586	205.7270	294.1410	250.0199	249.9626
34	0.0830	0.0335	0.0623	0.0596	199.9180	285.5850	242.7473	242.7501
36	0.0844	0.0344	0.0633	0.0607	195.0770	282.6210	240.2279	239.3086
38	0.0856	0.0353	0.0642	0.0617	191.1360	276.7790	235.2622	234.3924
40	0.0866	0.0360	0.0649	0.0625	188.2470	272.1320	231.3122	230.5637
42	0.0875	0.0366	0.0657	0.0633	183.9430	268.5620	227.4720	226.6590
44	0.0885	0.0374	0.0664	0.0641	179.6040	261.4020	221.4075	220.8045
46	0.0894	0.0380	0.0670	0.0648	176.4470	259.0630	219.4264	218.3121
48	0.0904	0.0387	0.0678	0.0656	175.1450	255.0740	216.0477	215.4222
50	0.0916	0.0394	0.0687	0.0666	170.8150	249.4390	211.2748	210.5096
52	0.0923	0.0400	0.0692	0.0672	169.4980	246.5200	208.8024	208.2735
54	0.0930	0.0405	0.0698	0.0678	166.1170	240.9310	204.0686	203.7055
56	0.0935	0.0410	0.0701	0.0682	163.2640	242.3750	205.2916	203.6435
58	0.0945	0.0418	0.0735	0.0699	163.2480	236.4280	200.2545	199.9768
60	0.0954	0.0422	0.0742	0.0706	159.2230	232.8570	197.2299	196.4366
62	0.0960	0.0427	0.0747	0.0711	157.6650	229.3680	194.2747	193.7692
64	0.0967	0.0433	0.0752	0.0718	153.8450	226.1380	191.5389	190.5073
66	0.0973	0.0437	0.0757	0.0722	153.7540	225.8620	191.3051	190.3070
68	0.0980	0.0441	0.0763	0.0728	152.2610	223.1820	189.0352	188.1594
70	0.0983	0.0446	0.0765	0.0731	148.4220	222.3240	188.3084	186.3515
72	0.0991	0.0453	0.0771	0.0739	148.3500	218.7290	185.2635	184.1142
74	0.0998	0.0457	0.0776	0.0743	146.2190	216.9740	183.7770	182.3233
76	0.1004	0.0463	0.0781	0.0749	145.1540	212.5820	180.0570	179.2643
78	0.1009	0.0465	0.0785	0.0753	142.8490	211.4660	179.1117	177.8089
80	0.1015	0.0469	0.0789	0.0758	141.0950	209.0600	177.0738	175.7429
82	0.1018	0.0473	0.0792	0.0761	140.1160	208.9370	176.9696	175.3409
84	0.1027	0.0476	0.0821	0.0775	139.6310	208.8160	176.8672	175.1047
86	0.1032	0.0484	0.0825	0.0780	138.4540	204.1880	172.9472	171.8631
88	0.1034	0.0487	0.0827	0.0783	136.3420	202.6530	171.6471	170.2140
90	0.1037	0.0490	0.0829	0.0785	134.9530	202.3650	171.4032	169.5737
92	0.1043	0.0495	0.0834	0.0790	133.3890	200.3660	169.7100	167.8217
94	0.1048	0.0501	0.0838	0.0795	132.2940	195.8020	165.8443	164.6468
96	0.1054	0.0504	0.0843	0.0800	131.6780	196.4850	166.4228	164.8619
98	0.1059	0.0503	0.0847	0.0803	129.7370	196.2580	166.2305	164.0752
100	0.1061	0.0509	0.0849	0.0806	128.4530	195.2950	165.4149	163.0543
102	0.1066	0.0512	0.0853	0.0810	127.8840	195.7460	165.7969	163.1423
104	0.1068	0.0515	0.0855	0.0813	125.9830	191.6080	162.2920	159.9610

106	0.1073	0.0519	0.0859	0.0817	125.2470	190.9370	161.7236	159.3025
108	0.1077	0.0521	0.0862	0.0820	124.6630	188.6850	158.4954	157.2811
110	0.1085	0.0529	0.0868	0.0828	123.5690	185.4020	155.7377	154.9029
112	0.1085	0.0530	0.0868	0.0828	122.6280	186.9780	157.0615	155.5558
114	0.1090	0.0531	0.0872	0.0831	122.9310	185.2150	155.5806	154.5755
116	0.1094	0.0536	0.0875	0.0835	121.3970	184.8480	155.2723	153.8391
118	0.1096	0.0538	0.0877	0.0837	120.4930	183.3530	152.1830	152.0097
120	0.1101	0.0542	0.0881	0.0842	118.8980	183.4190	152.2378	151.5183
122	0.1106	0.0545	0.0885	0.0845	118.7230	183.2470	152.0950	151.3550
124	0.1106	0.0547	0.0885	0.0846	117.2730	180.4880	149.8050	149.1887
126	0.1107	0.0554	0.0886	0.0849	116.1840	178.7410	151.9299	148.9516
128	0.1115	0.0553	0.0892	0.0853	115.5910	178.4960	151.7216	148.6029
130	0.1120	0.0558	0.0896	0.0858	114.7680	176.9330	150.3931	147.3647
132	0.1123	0.0563	0.0899	0.0862	114.8450	176.0270	149.6230	146.8317
134	0.1125	0.0560	0.0900	0.0862	114.1130	176.1620	149.7377	146.6709
136	0.1128	0.0568	0.0903	0.0866	112.6810	174.5120	148.3352	145.1761
138	0.1132	0.0568	0.0905	0.0868	113.0800	175.1360	148.8656	145.6939
140	0.1133	0.0571	0.0906	0.0870	111.7550	172.7750	146.8588	143.7963
142	0.1137	0.0575	0.0909	0.0874	110.5170	171.6740	145.9229	142.7046
144	0.1139	0.0578	0.0911	0.0876	110.5370	170.3350	144.7848	141.8856
146	0.1144	0.0582	0.0915	0.0881	109.4050	170.1220	144.6037	141.3769
148	0.1147	0.0584	0.0917	0.0882	108.9050	169.1600	143.7860	140.6170
150	0.1147	0.0585	0.0917	0.0883	107.7100	170.6220	145.0287	141.1202
152	0.1155	0.0586	0.0924	0.0888	107.3710	169.6630	144.2136	140.4159
154	0.1155	0.0590	0.0924	0.0890	107.0370	167.4090	142.2977	138.9146
156	0.1160	0.0591	0.0928	0.0893	105.3590	168.2610	143.0219	138.8806
158	0.1160	0.0596	0.0928	0.0895	106.0130	166.2880	141.3448	137.8819
160	0.1166	0.0596	0.0933	0.0898	105.0960	166.8810	141.8489	137.9420

162	0.1169	0.0602	0.0935	0.0902	105.1910	164.0130	139.4111	136.2050
164	0.1170	0.0607	0.0936	0.0904	104.2480	162.6930	138.2891	135.0767
166	0.1173	0.0606	0.0939	0.0906	103.9460	163.6050	139.0643	135.5384
168	0.1177	0.0609	0.0942	0.0909	102.2130	162.0410	137.7349	133.9963
170	0.1178	0.0613	0.0943	0.0911	101.8270	161.0730	136.9121	133.2707
172	0.1182	0.0614	0.0946	0.0914	102.0270	163.0570	138.5985	134.5608
174	0.1183	0.0615	0.0947	0.0915	101.1650	161.0090	136.8577	133.0106
176	0.1189	0.0619	0.0951	0.0920	99.5880	159.4840	135.5614	131.5445
178	0.1189	0.0621	0.0951	0.0921	100.3920	159.9960	133.5967	131.3282
180	0.1192	0.0623	0.0953	0.0923	99.3080	158.5460	132.3859	130.0800
182	0.1194	0.0624	0.0955	0.0924	99.5150	159.3700	133.0740	130.6530
184	0.1198	0.0628	0.0958	0.0928	99.2730	157.8760	131.8265	129.6585
186	0.1197	0.0629	0.0957	0.0928	98.3310	158.1320	132.0402	129.5011
188	0.1201	0.0634	0.0961	0.0932	98.3040	155.7970	130.0905	128.0638
190	0.1205	0.0635	0.0964	0.0935	97.1570	156.0540	127.9643	127.0584
192	0.1208	0.0640	0.0966	0.0938	97.0330	155.4160	127.4411	126.6300
194	0.1210	0.0642	0.0968	0.0940	96.1250	154.2740	126.5047	125.6346
196	0.1215	0.0641	0.0972	0.0943	95.4520	155.1200	127.1984	125.9235
198	0.1211	0.0643	0.0969	0.0941	94.4510	152.3320	124.9122	123.8984
200	0.1214	0.0646	0.0971	0.0944	93.6820	153.9470	126.2365	124.6218
202	0.1219	0.0648	0.0975	0.0947	93.9050	153.3670	125.7609	124.3443
204	0.1222	0.0651	0.0978	0.0950	93.7990	151.7040	124.3973	123.3001
206	0.1225	0.0650	0.0980	0.0951	92.7250	151.9900	124.6318	123.1156
208	0.1225	0.0657	0.0980	0.0954	92.4080	150.8330	123.6831	122.3080
210	0.1227	0.0657	0.0982	0.0955	92.1980	151.9110	124.5670	122.8920
212	0.1231	0.0659	0.0985	0.0958	90.6260	150.8110	123.6650	121.7007
214	0.1232	0.0661	0.0986	0.0959	91.1740	149.4610	122.5580	121.0643
216	0.1234	0.0662	0.0988	0.0961	90.7670	149.7200	122.7704	121.0858

218	0.1237	0.0663	0.0989	0.0963	89.9490	149.4440	122.5441	120.6457
220	0.1237	0.0667	0.0989	0.0964	89.4530	149.1540	122.3063	120.3044
222	0.1239	0.0667	0.0991	0.0966	89.2570	149.6850	122.7417	120.5612
224	0.1244	0.0672	0.0995	0.0970	89.2740	147.5420	120.9844	119.2668
226	0.1249	0.0673	0.0999	0.0974	88.1890	147.8010	121.1968	119.0623
228	0.1248	0.0673	0.0998	0.0973	87.8290	147.2750	120.7655	118.6232
230	0.1252	0.0674	0.1001	0.0976	87.8510	147.5330	120.9771	118.7870
232	0.1252	0.0680	0.1001	0.0978	87.4520	145.6880	119.4642	117.5347
234	0.1254	0.0681	0.1003	0.0979	86.1950	144.9080	118.8246	116.6425
236	0.1259	0.0684	0.1007	0.0983	85.7380	145.4250	119.2485	116.8038
238	0.1261	0.0686	0.1009	0.0986	85.6750	145.9390	119.6700	117.0947
240	0.1263	0.0686	0.1010	0.0986	85.4040	145.4230	119.2469	116.6913
242	0.1264	0.0690	0.1011	0.0988	84.8680	143.6250	117.7725	115.4218
244	0.1266	0.0690	0.1013	0.0990	84.6030	143.6250	117.7725	115.3335
246	0.1269	0.0694	0.1015	0.0992	84.2840	142.8670	117.1509	114.7673
248	0.1271	0.0694	0.1017	0.0994	84.1420	141.8460	116.3137	114.1006
250	0.1275	0.0700	0.1020	0.0998	83.8830	141.1140	115.7135	113.5702
252	0.1272	0.0698	0.1018	0.0996	83.0800	140.8540	119.7259	114.5533
254	0.1277	0.0700	0.1022	0.1000	83.0300	141.1140	119.9469	114.6970
256	0.1280	0.0702	0.1024	0.1002	82.0370	140.6230	119.5296	114.0632
258	0.1281	0.0703	0.1025	0.1003	82.1950	140.3790	119.3222	113.9654
260	0.1283	0.0706	0.1027	0.1005	81.5810	139.3920	118.4832	113.1521
262	0.1284	0.0707	0.1028	0.1006	80.8920	140.1530	119.1301	113.3917
264	0.1286	0.0711	0.1029	0.1008	80.9320	139.4300	118.5155	112.9592
266	0.1288	0.0712	0.1031	0.1010	80.2510	138.6940	117.8899	112.2783
268	0.1292	0.0712	0.1033	0.1012	79.4990	138.1970	117.4675	111.7212
270	0.1292	0.0716	0.1033	0.1014	78.6320	136.5000	116.0250	110.3857
272	0.1293	0.0716	0.1034	0.1014	78.2490	136.9950	116.4458	110.5633

274	0.1297	0.0718	0.1037	0.1017	78.2960	137.0220	116.4687	110.5956
276	0.1299	0.0718	0.1039	0.1019	78.4660	137.5140	116.8869	110.9556
278	0.1299	0.0723	0.1039	0.1020	78.0890	136.0960	115.6816	109.9555
280	0.1302	0.0723	0.1041	0.1022	77.5170	136.0960	115.6816	109.7649
282	0.1304	0.0727	0.1043	0.1025	76.9500	135.4100	115.0985	109.1528
284	0.1308	0.0725	0.1046	0.1026	76.2420	135.1500	114.8775	108.7565
286	0.1309	0.0729	0.1047	0.1028	75.7570	134.9560	114.7126	108.4752
288	0.1310	0.0728	0.1048	0.1029	75.7390	134.6960	114.4916	108.3089
290	0.1314	0.0733	0.1051	0.1032	75.3830	134.7640	114.5494	108.2321
292	0.1314	0.0734	0.1051	0.1033	74.9060	134.0580	113.9493	107.6378
294	0.1314	0.0733	0.1051	0.1032	74.4870	134.7640	114.5494	107.9335
296	0.1315	0.0734	0.1052	0.1034	74.7370	134.0580	113.9493	107.5814
298	0.1315	0.0740	0.1052	0.1036	74.3920	132.4730	112.6021	106.4890
300	0.1321	0.0740	0.1057	0.1039	73.8000	132.9520	113.0092	106.5871
302	0.1324	0.0740	0.1059	0.1041	74.1070	131.9950	112.1958	106.0993
304	0.1326	0.0742	0.1061	0.1043	73.5770	132.5140	112.6369	106.2426
306	0.1324	0.0744	0.1059	0.1042	73.5010	132.2970	112.4525	106.0835
308	0.1331	0.0746	0.1065	0.1047	73.1020	131.8640	112.0844	105.6835
310	0.1331	0.0746	0.1065	0.1047	72.2620	132.8120	112.8902	105.9881
312	0.1332	0.0747	0.1066	0.1048	72.2570	133.0690	113.1087	106.1449
314	0.1333	0.0750	0.1067	0.1050	72.9110	131.2190	111.5362	105.2221
316	0.1335	0.0751	0.1068	0.1051	72.8450	131.9480	112.1558	105.6496
318	0.1336	0.0755	0.1069	0.1053	72.5090	130.3700	110.8145	104.5645
320	0.1337	0.0755	0.1070	0.1054	72.2500	130.3700	110.8145	104.4782
322	0.1341	0.0755	0.1073	0.1056	71.7070	130.3700	110.8145	104.2972
324	0.1341	0.0758	0.1073	0.1057	72.2440	128.8070	109.4860	103.5123
326	0.1346	0.0759	0.1076	0.1060	71.9820	130.4640	110.8944	104.4468
328	0.1344	0.0761	0.1075	0.1060	72.8510	129.7890	110.3207	104.3202

330	0.1347	0.0761	0.1077	0.1062	72.4520	130.2540	110.7159	104.4740
332	0.1348	0.0766	0.1078	0.1064	72.1190	129.4230	110.0096	103.8505
334	0.1350	0.0764	0.1080	0.1065	72.2550	128.2410	109.0049	103.1670
336	0.1353	0.0767	0.1082	0.1067	71.8590	128.7560	109.4426	103.3525
338	0.1354	0.0769	0.1083	0.1069	71.5280	127.8870	108.7040	102.7063
340	0.1353	0.0772	0.1082	0.1069	71.8590	127.9410	108.7499	102.8500
342	0.1358	0.0773	0.1086	0.1072	71.8650	127.2810	108.1889	102.4450
344	0.1359	0.0777	0.1087	0.1074	71.8010	127.5920	108.4532	102.6154
346	0.1363	0.0775	0.1090	0.1076	70.8150	127.7930	108.6241	102.4107
348	0.1360	0.0777	0.1088	0.1075	71.2070	126.6800	107.6780	101.8550
350	0.1364	0.0777	0.1091	0.1077	71.5440	126.6800	107.6780	101.9673
352	0.1365	0.0778	0.1092	0.1078	71.4800	125.5720	106.7362	101.2627
354	0.1368	0.0783	0.1094	0.1081	70.8250	125.6920	106.8382	101.1184
356	0.1370	0.0784	0.1096	0.1083	70.4360	125.9480	107.0558	101.1466
358	0.1370	0.0785	0.1096	0.1084	70.6990	125.7520	106.8892	101.1134
360	0.1371	0.0788	0.1097	0.1085	71.4240	125.3620	106.5577	101.1146
362	0.1376	0.0789	0.1101	0.1089	71.1700	125.1680	106.3928	100.9103
364	0.1376	0.0789	0.1101	0.1089	71.1700	125.6170	106.7745	101.1872
366	0.1380	0.0789	0.1104	0.1091	70.1990	125.1680	106.3928	100.5866
368	0.1379	0.0790	0.1103	0.1090	71.0440	124.5270	105.8480	100.4730
370	0.1382	0.0792	0.1106	0.1093	70.8560	124.5890	105.9007	100.4486
372	0.1381	0.0795	0.1105	0.1094	70.6580	124.2070	105.5760	100.1470
374	0.1385	0.0799	0.1108	0.1097	70.2110	124.0800	105.4680	99.9197
376	0.1386	0.0799	0.1109	0.1098	70.4090	124.5230	105.8446	100.2589
378	0.1388	0.0801	0.1111	0.1100	70.2850	123.7020	105.1467	99.7112
380	0.1391	0.0800	0.1113	0.1101	70.6790	123.4480	104.9308	99.6859
382	0.1396	0.0805	0.1116	0.1106	69.9160	122.6990	104.2942	98.9697
384	0.1394	0.0803	0.1116	0.1104	70.7520	121.5640	103.3294	98.5485

386	0.1396	0.0805	0.1116	0.1106	70.1740	123.1390	104.6682	99.3271
388	0.1397	0.0808	0.1117	0.1108	70.1130	122.1430	101.3787	97.8782
390	0.1399	0.0808	0.1119	0.1109	69.9900	123.0180	102.1049	98.3710
392	0.1399	0.0807	0.1119	0.1109	69.7330	122.7660	101.8958	98.1316
394	0.1400	0.0812	0.1120	0.1111	69.9290	121.5920	100.9214	97.4808
396	0.1402	0.0812	0.1121	0.1112	69.8680	122.0280	101.2832	97.7264
398	0.1403	0.0812	0.1122	0.1112	70.0640	121.1560	100.5595	97.2598
400	0.1408	0.0816	0.1126	0.1117	70.3330	121.0460	100.4682	97.2824
402	0.1410	0.0818	0.1128	0.1119	69.7000	120.2520	99.8092	96.5871
404	0.1409	0.0823	0.1127	0.1120	70.0160	119.5380	99.2165	96.2568
406	0.1413	0.0819	0.1130	0.1121	69.5800	120.9360	100.3769	96.9643
408	0.1414	0.0822	0.1131	0.1122	69.7740	119.7160	99.3643	96.2848
410	0.1416	0.0824	0.1133	0.1125	69.1460	120.2200	99.7826	96.3829
412	0.1416	0.0827	0.1133	0.1125	69.6540	119.8650	99.4880	96.3357
414	0.1418	0.0828	0.1134	0.1126	69.0860	119.6880	99.3410	96.0383
416	0.1419	0.0828	0.1135	0.1127	69.2800	119.2600	98.9858	95.8419
418	0.1421	0.0825	0.1137	0.1128	69.4150	120.4710	99.9909	96.6256
420	0.1425	0.0833	0.1140	0.1133	69.2360	118.5610	98.4056	95.4009
422	0.1424	0.0830	0.1139	0.1131	69.0430	118.9100	98.6953	95.5494
424	0.1426	0.0834	0.1141	0.1134	68.9250	119.2360	98.9659	95.7090
426	0.1430	0.0834	0.1144	0.1136	68.7480	118.3870	98.2612	95.1321
428	0.1430	0.0834	0.1144	0.1136	69.0000	117.9630	97.9093	94.9574
430	0.1432	0.0835	0.1146	0.1138	69.1340	118.2140	98.1176	95.1552
432	0.1436	0.0839	0.1149	0.1141	68.4560	117.2760	97.3391	94.3570
434	0.1435	0.0839	0.1148	0.1140	68.5140	118.1200	98.0396	94.8912
436	0.1435	0.0841	0.1148	0.1141	68.7650	117.7770	97.7549	94.7656
438	0.1438	0.0842	0.1151	0.1144	69.0900	117.6060	97.6130	94.7697
440	0.1442	0.0842	0.1154	0.1146	68.4160	117.6060	97.6130	94.5450

442	0.1442	0.0844	0.1154	0.1146	67.9160	117.4360	97.4719	94.2746
444	0.1443	0.0849	0.1155	0.1149	68.1080	116.7600	96.9108	93.9263
446	0.1446	0.0846	0.1157	0.1149	67.9930	116.2610	96.4966	93.5835
448	0.1446	0.0849	0.1157	0.1150	68.4910	116.3430	96.5647	93.7996
450	0.1447	0.0851	0.1158	0.1152	68.6820	116.0090	96.2875	93.6595
452	0.1452	0.0852	0.1161	0.1155	68.2030	115.8430	96.1497	93.3986
454	0.1451	0.0853	0.1160	0.1155	68.2610	115.6770	96.0119	93.3166
456	0.1455	0.0855	0.1164	0.1158	67.2890	115.5120	95.8750	92.8920
458	0.1457	0.0855	0.1165	0.1159	67.7270	115.9260	96.2186	93.2905
460	0.1457	0.0856	0.1165	0.1159	67.7270	115.7610	96.0816	93.1899
462	0.1458	0.0858	0.1166	0.1161	67.6710	115.0190	95.4658	92.7186
464	0.1459	0.0861	0.1167	0.1162	67.3670	115.1040	95.5363	92.6691
466	0.1460	0.0862	0.1168	0.1164	67.3110	115.3510	95.7413	92.8011
468	0.1463	0.0863	0.1170	0.1165	67.4450	114.3680	94.9254	92.2461
470	0.1465	0.0866	0.1172	0.1168	67.5780	113.6370	94.3187	91.8446
472	0.1466	0.0867	0.1173	0.1169	67.0310	113.8850	94.5246	91.8135
474	0.1466	0.0866	0.1173	0.1168	67.5220	114.8630	95.3363	92.5738
476	0.1470	0.0869	0.1176	0.1172	67.3540	113.5650	94.2590	91.7260
478	0.1474	0.0869	0.1179	0.1174	67.1860	113.1580	93.9211	91.4217
480	0.1470	0.0869	0.1176	0.1172	67.5980	113.5650	94.2590	91.8073
482	0.1475	0.0874	0.1180	0.1176	67.1310	113.3360	94.0689	91.5120
484	0.1474	0.0874	0.1179	0.1176	66.9420	112.9310	93.7327	91.2019
486	0.1481	0.0874	0.1185	0.1180	66.8540	112.9310	93.7327	91.1726
488	0.1480	0.0877	0.1184	0.1180	66.9090	113.0200	93.8066	91.2452
490	0.1479	0.0882	0.1183	0.1181	67.2080	112.7950	93.6199	91.2076
492	0.1485	0.0882	0.1188	0.1185	66.4460	112.3940	93.2870	90.7090
494	0.1485	0.0883	0.1188	0.1185	66.2040	112.2380	93.1575	90.5332
496	0.1485	0.0880	0.1188	0.1184	65.7190	112.1480	93.0828	90.3166
498	0.1490	0.0884	0.1192	0.1188	65.5030	112.0830	93.0289	90.2050
500	0.1488	0.0885	0.1191	0.1188	65.5570	112.7280	93.5642	90.6164
502	0.1488	0.0889	0.1191	0.1189	65.3150	111.0690	92.1873	89.5238
504	0.1493	0.0885	0.1195	0.1191	65.8250	111.5290	92.5691	89.9744
506	0.1493	0.0889	0.1195	0.1192	65.5840	111.0690	92.1873	89.6134
508	0.1495	0.0893	0.1196	0.1194	65.7710	111.0100	92.1383	89.6398
510	0.1495	0.0890	0.1196	0.1193	66.0120	111.3150	92.3915	89.9062
512	0.1498	0.0895	0.1199	0.1197	64.6490	110.3120	91.5590	88.8400
514	0.1501	0.0897	0.1200	0.1200	64.7840	110.0120	91.3100	88.7020
516	0.1499	0.0896	0.1200	0.1198	64.8370	110.1610	91.4336	88.8105
518	0.1503	0.0897	0.1202	0.1201	64.6790	109.6170	90.9821	88.4260
520	0.1502	0.0899	0.1201	0.1201	65.4500	109.4680	90.8584	88.5921
522	0.1505	0.0902	0.1204	0.1204	64.3340	109.0240	90.4899	87.9493
524	0.1505	0.0902	0.1204	0.1204	65.0520	109.0240	90.4899	88.1886
526	0.1508	0.0904	0.1206	0.1206	64.2300	108.8770	90.3679	87.8250
528	0.1509	0.0906	0.1207	0.1207	64.4170	108.1930	89.8002	87.4701
530	0.1512	0.0901	0.1209	0.1207	64.3130	109.5640	90.9381	88.2717
532	0.1512	0.0907	0.1209	0.1209	64.3130	107.6570	89.3553	87.1084
534	0.1512	0.0908	0.1209	0.1210	64.0750	107.1230	88.9121	86.7034
536	0.1516	0.0911	0.1213	0.1214	63.3930	107.2240	88.9959	86.5376
538	0.1520	0.0910	0.1216	0.1215	63.2410	106.9790	88.7926	86.3375
540	0.1518	0.0908	0.1214	0.1213	64.0540	108.2910	89.8815	87.4088
542	0.1519	0.0912	0.1215	0.1215	64.2400	107.0800	88.8764	86.7321
544	0.1520	0.0915	0.1216	0.1217	64.1880	106.7940	88.6390	86.5403
546	0.1524	0.0917	0.1219	0.1220	64.0340	106.8960	88.7237	86.5512
548	0.1521	0.0921	0.1217	0.1220	63.9000	106.8550	88.6897	86.4816
550	0.1524	0.0919	0.1219	0.1221	63.7970	106.9970	88.8075	86.5338
552	0.1526	0.0921	0.1221	0.1223	63.6950	106.4710	88.3709	86.1790

554	0.1530	0.0921	0.1224	0.1225	63.7780	106.4710	88.3709	86.2066
556	0.1531	0.0922	0.1225	0.1226	63.2570	105.9460	87.9352	85.7127
558	0.1532	0.0922	0.1226	0.1227	64.1470	105.9460	87.9352	86.0094
560	0.1535	0.0923	0.1228	0.1229	63.8100	105.8060	87.8190	85.8117
562	0.1536	0.0927	0.1229	0.1231	63.2900	105.7690	87.7883	85.6158
564	0.1538	0.0929	0.1231	0.1233	63.6580	105.4910	87.5575	85.5688
566	0.1536	0.0928	0.1229	0.1231	63.2900	106.0110	87.9891	85.7634
568	0.1538	0.0932	0.1231	0.1234	63.6580	105.5950	87.6439	85.6323
570	0.1540	0.0930	0.1232	0.1234	63.6070	105.7330	87.7584	85.6995
572	0.1542	0.0932	0.1234	0.1236	63.0400	105.2150	87.3285	85.1945
574	0.1545	0.0934	0.1236	0.1238	63.1730	104.1820	86.4711	84.6087
576	0.1546	0.0935	0.1237	0.1239	63.3560	104.8030	86.9865	85.0485
578	0.1547	0.0938	0.1238	0.1241	63.0730	104.9070	87.0728	85.0176
580	0.1548	0.0939	0.1239	0.1242	63.2560	105.1480	87.2728	85.2256
582	0.1548	0.0937	0.1239	0.1241	63.4890	105.4220	87.5003	85.4704
584	0.1553	0.0943	0.1242	0.1246	63.5210	104.3640	86.6221	84.8357
586	0.1554	0.0941	0.1243	0.1246	63.0080	104.8750	87.0463	84.9764
588	0.1556	0.0943	0.1244	0.1248	62.7270	103.9880	86.3100	84.3417
590	0.1554	0.0943	0.1243	0.1247	62.5450	103.9880	86.3100	84.2810
592	0.1557	0.0945	0.1245	0.1249	62.4460	103.7190	86.0868	84.0839
594	0.1558	0.0948	0.1246	0.1251	63.0910	103.8260	86.1756	84.3642
596	0.1559	0.0950	0.1247	0.1252	62.5800	102.8140	85.3356	83.5765
598	0.1563	0.0950	0.1250	0.1254	62.4330	102.4410	85.0260	83.3000
600	0.1563	0.0952	0.1250	0.1255	62.4330	103.2930	85.7332	83.8197
602	0.1564	0.0954	0.1251	0.1256	63.0750	103.1610	85.6236	83.9532
604	0.1568	0.0954	0.1254	0.1259	62.6980	103.1610	85.6236	83.8275
606	0.1568	0.0957	0.1254	0.1260	62.4680	102.7660	85.2958	83.5099
608	0.1570	0.0956	0.1256	0.1261	62.3710	102.8970	85.4045	83.5575
610	0.1570	0.0961	0.1256	0.1262	62.8300	102.3740	84.9704	83.3915
612	0.1573	0.0957	0.1258	0.1263	62.7320	102.7660	85.2958	83.5979
614	0.1575	0.0961	0.1260	0.1265	62.1780	101.6380	84.3595	82.7252
616	0.1576	0.0961	0.1261	0.1266	62.3580	102.3740	84.9704	83.2341
618	0.1579	0.0965	0.1263	0.1269	62.2610	101.9860	84.6484	82.9651
620	0.1576	0.0966	0.1261	0.1268	62.3580	102.2230	84.8451	83.1420
622	0.1578	0.0968	0.1262	0.1269	62.3100	101.6000	84.3280	82.7460
624	0.1582	0.0967	0.1266	0.1272	62.1170	101.7280	84.4342	82.7597
626	0.1582	0.0971	0.1266	0.1273	62.3450	101.3440	84.1155	82.6015
628	0.1585	0.0969	0.1268	0.1274	62.7030	101.4720	84.2218	82.7989
630	0.1587	0.0969	0.1270	0.1276	62.1530	101.8370	84.5247	82.8382
632	0.1586	0.0971	0.1269	0.1275	61.7470	102.0730	84.7206	82.8469
634	0.1591	0.0974	0.1273	0.1279	61.7830	101.3260	84.1006	82.4032
636	0.1590	0.0976	0.1272	0.1279	61.3780	101.2000	83.9960	82.1913
638	0.1592	0.0977	0.1274	0.1281	61.5100	100.7110	83.5901	81.9370
640	0.1592	0.0979	0.1274	0.1282	61.2840	101.5440	84.2815	82.3698
642	0.1595	0.0977	0.1276	0.1282	61.8670	100.7110	83.5901	82.0560
644	0.1597	0.0979	0.1278	0.1285	61.5470	100.4600	83.3818	81.7963
646	0.1598	0.0979	0.1279	0.1285	61.5000	101.1820	83.9811	82.2210
648	0.1596	0.0983	0.1277	0.1285	61.8200	100.4450	83.3694	81.8781
650	0.1602	0.0987	0.1282	0.1290	61.5840	100.0720	83.0598	81.5719
652	0.1604	0.0987	0.1284	0.1291	61.4910	99.7140	82.7626	81.3225
654	0.1603	0.0988	0.1283	0.1291	61.3130	99.9490	82.9577	81.4066
656	0.1604	0.0989	0.1284	0.1292	61.4910	99.8250	82.8548	81.3903
658	0.1607	0.0983	0.1285	0.1292	60.9490	100.8050	83.6682	81.8074
660	0.1607	0.0994	0.1285	0.1295	60.7250	99.6910	82.7435	81.0532
662	0.1609	0.0995	0.1287	0.1297	60.8570	98.8570	82.0513	80.5884
664	0.1611	0.0994	0.1288	0.1298	61.0340	98.6230	81.8571	80.5047

666	0.1615	0.0995	0.1292	0.1301	61.0720	98.8570	82.0513	80.6601
668	0.1615	0.0996	0.1292	0.1301	61.0720	99.0910	82.2455	80.8028
670	0.1615	0.0999	0.1292	0.1302	61.2950	98.8490	82.0447	80.7296
672	0.1618	0.1001	0.1294	0.1304	61.4250	98.2540	81.5508	80.4099
674	0.1618	0.1001	0.1294	0.1304	60.9800	98.9610	82.1376	80.6929
676	0.1620	0.1001	0.1296	0.1306	61.1110	99.6680	82.7244	81.1678
678	0.1621	0.1002	0.1297	0.1307	60.3980	99.1940	82.3310	80.6410
680	0.1623	0.1004	0.1298	0.1308	60.5750	98.0150	81.3525	79.9808
682	0.1624	0.1006	0.1299	0.1310	60.3080	98.1290	81.4471	79.9614
684	0.1626	0.1009	0.1301	0.1312	60.6600	97.5410	80.9590	79.7200
686	0.1629	0.1009	0.1303	0.1313	60.7900	97.5410	80.9590	79.7633
688	0.1629	0.1010	0.1303	0.1314	60.5690	97.7730	81.1516	79.8312
690	0.1630	0.1011	0.1304	0.1315	60.3030	98.0050	81.3442	79.8841
692	0.1632	0.1013	0.1306	0.1317	60.4330	97.0710	80.5689	79.3576
694	0.1632	0.1017	0.1306	0.1319	60.2120	97.0690	80.5673	79.2828
696	0.1637	0.1015	0.1310	0.1321	60.4730	97.6510	81.0503	79.7248
698	0.1636	0.1017	0.1309	0.1321	60.0780	97.4170	80.8561	79.4504
700	0.1636	0.1018	0.1309	0.1321	60.7380	96.6050	80.1822	79.1751
702	0.1641	0.1020	0.1313	0.1324	59.8990	96.8370	80.3747	79.0369
704	0.1645	0.1022	0.1316	0.1327	59.7650	96.9510	80.4693	79.0618
706	0.1642	0.1024	0.1314	0.1327	60.2930	96.3750	79.9913	78.8864
708	0.1646	0.1023	0.1317	0.1329	60.1590	96.8360	80.3739	79.1230
710	0.1650	0.1024	0.1320	0.1331	60.2430	96.7200	80.2776	79.0802
712	0.1651	0.1027	0.1321	0.1333	59.9810	95.8010	79.5148	78.4323
714	0.1651	0.1027	0.1321	0.1333	60.4170	96.4900	80.0867	78.9979
716	0.1648	0.1029	0.1319	0.1332	60.0690	95.9180	79.6119	78.5330
718	0.1652	0.1032	0.1322	0.1335	59.9360	95.6910	79.4235	78.3502
720	0.1648	0.1034	0.1319	0.1334	60.0690	95.1220	78.9513	78.0474
722	0.1657	0.1034	0.1326	0.1339	59.5420	95.4650	79.2360	78.0810
724	0.1658	0.1035	0.1326	0.1340	59.7160	95.6940	79.4260	78.2787
726	0.1659	0.1037	0.1327	0.1341	59.6720	95.2400	79.0492	77.9871
728	0.1661	0.1040	0.1328	0.1343	59.4110	94.5640	78.4881	77.4877
730	0.1663	0.1038	0.1330	0.1344	59.1070	95.4690	79.2393	77.9384
732	0.1664	0.1040	0.1331	0.1345	59.0640	94.9040	78.7703	77.5794
734	0.1668	0.1042	0.1334	0.1348	59.1500	95.1330	78.9604	77.7478
736	0.1665	0.1044	0.1332	0.1347	59.4530	94.5710	78.4939	77.5060
738	0.1669	0.1042	0.1335	0.1349	58.8910	94.7930	78.6782	77.4541
740	0.1670	0.1046	0.1336	0.1351	58.8480	94.3510	78.3113	77.1701
742	0.1673	0.1045	0.1338	0.1352	58.5470	94.4610	78.4026	77.1369
744	0.1673	0.1049	0.1338	0.1353	58.5470	94.1310	78.1287	76.9356
746	0.1674	0.1049	0.1339	0.1354	58.7190	94.8060	78.6890	77.4047
748	0.1676	0.1051	0.1341	0.1356	57.9890	94.2490	78.2267	76.8216
750	0.1679	0.1049	0.1343	0.1357	58.3340	94.4680	78.4084	77.0701
752	0.1679	0.1053	0.1343	0.1358	57.9050	94.1400	78.1362	76.7271
754	0.1681	0.1055	0.1345	0.1360	58.2490	94.2570	78.2333	76.9131
756	0.1685	0.1056	0.1348	0.1363	58.1220	94.1480	78.1428	76.8043
758	0.1684	0.1055	0.1347	0.1362	57.9510	93.5860	77.6764	76.4045
760	0.1686	0.1059	0.1349	0.1365	58.0800	92.9280	77.1302	76.0461
762	0.1685	0.1059	0.1348	0.1364	57.9090	92.9280	77.1302	75.9891
764	0.1686	0.1060	0.1349	0.1365	58.0800	92.8210	77.0414	75.9808
766	0.1689	0.1061	0.1351	0.1367	57.5700	93.3810	77.5062	76.1524
768	0.1689	0.1065	0.1351	0.1368	57.5700	92.3950	76.6879	75.5510
770	0.1691	0.1066	0.1353	0.1370	57.9130	92.2890	76.5999	75.6006
772	0.1695	0.1067	0.1356	0.1373	57.5750	92.5150	76.7875	75.6258
774	0.1694	0.1068	0.1355	0.1372	57.1910	92.0780	76.4247	75.2312
776	0.1697	0.1070	0.1358	0.1375	57.7040	91.9730	76.3376	75.3382

778	0.1697	0.1072	0.1358	0.1376	57.7040	91.7640	76.1641	75.2107
780	0.1701	0.1073	0.1361	0.1378	57.3680	92.6490	76.8987	75.6386
782	0.1697	0.1073	0.1358	0.1376	57.2800	91.6590	76.0770	75.0053
784	0.1706	0.1078	0.1365	0.1383	57.2040	91.5720	76.0048	74.9269
786	0.1703	0.1074	0.1363	0.1380	57.0750	91.2260	75.7176	74.6729
788	0.1707	0.1077	0.1366	0.1383	56.9520	91.3480	75.8188	74.7063
790	0.1706	0.1079	0.1365	0.1383	57.4150	91.4690	75.9193	74.9344
792	0.1706	0.1079	0.1365	0.1383	57.4150	91.1410	75.6470	74.7343
794	0.1711	0.1078	0.1368	0.1386	57.4620	91.5720	76.0048	75.0129
796	0.1712	0.1083	0.1369	0.1388	57.2100	90.8330	75.3914	74.4781
798	0.1714	0.1082	0.1371	0.1389	57.3390	90.2810	74.9332	74.1844
800	0.1714	0.1084	0.1371	0.1390	56.9190	89.7510	74.4933	73.7211
802	0.1717	0.1087	0.1373	0.1392	57.0480	90.2010	74.8668	74.0386
804	0.1718	0.1088	0.1374	0.1393	57.2170	90.4250	75.0528	74.2316
806	0.1720	0.1090	0.1376	0.1396	56.9260	89.5730	74.3456	73.6149
808	0.1723	0.1092	0.1378	0.1398	56.8460	89.7970	74.5315	73.7248
810	0.1724	0.1094	0.1379	0.1399	56.5960	89.2730	74.0966	73.3219
812	0.1723	0.1094	0.1378	0.1398	56.6370	89.2730	74.0966	73.3355
814	0.1725	0.1095	0.1380	0.1400	56.5560	89.4970	74.2825	73.4452
816	0.1727	0.1093	0.1381	0.1400	56.7250	89.6970	74.4485	73.6235
818	0.1729	0.1096	0.1383	0.1403	56.6450	88.4290	73.3961	72.8234
820	0.1728	0.1099	0.1382	0.1403	56.8930	88.5550	73.5007	72.9829
822	0.1733	0.1099	0.1386	0.1406	56.5250	89.5210	74.3024	73.4495
824	0.1735	0.1103	0.1388	0.1409	56.0300	89.2230	74.0551	73.1027
826	0.1735	0.1103	0.1388	0.1409	57.0680	88.9020	73.7887	73.2529
828	0.1737	0.1103	0.1390	0.1410	56.5730	89.2230	74.0551	73.2837
830	0.1739	0.1105	0.1391	0.1412	56.9480	88.7060	73.6260	73.0933
832	0.1741	0.1106	0.1393	0.1413	56.4540	88.6080	73.5446	72.8689
834	0.1741	0.1109	0.1393	0.1414	56.4540	88.0940	73.1180	72.5553
836	0.1745	0.1107	0.1396	0.1416	55.9230	88.5100	73.4633	72.6321
838	0.1744	0.1111	0.1395	0.1417	56.1690	88.5370	73.4857	72.7306
840	0.1747	0.1112	0.1398	0.1419	56.2570	88.1220	73.1413	72.5068
842	0.1748	0.1112	0.1399	0.1420	56.2180	88.1220	73.1413	72.4938
844	0.1747	0.1114	0.1398	0.1420	56.2570	88.0250	73.0608	72.4476
846	0.1752	0.1115	0.1402	0.1423	56.1000	88.2460	73.2442	72.5301
848	0.1753	0.1118	0.1403	0.1425	55.6510	88.2730	73.2666	72.3969
850	0.1758	0.1118	0.1407	0.1428	56.1100	87.6410	72.7420	72.1643
852	0.1758	0.1121	0.1407	0.1429	55.9050	87.1340	72.3212	71.7867
854	0.1757	0.1122	0.1406	0.1428	55.7390	87.3550	72.5047	71.8662
856	0.1761	0.1122	0.1409	0.1430	56.2370	87.3550	72.5047	72.0322
858	0.1762	0.1125	0.1410	0.1432	55.7890	88.1090	73.1305	72.3428
860	0.1762	0.1125	0.1410	0.1432	55.3810	88.1090	73.1305	72.2068
862	0.1764	0.1127	0.1411	0.1434	55.7120	86.9760	72.1901	71.6260
864	0.1766	0.1128	0.1412	0.1435	56.0810	86.8820	72.1121	71.6917
866	0.1768	0.1131	0.1414	0.1438	55.5970	86.3810	71.6962	71.2247
868	0.1769	0.1132	0.1415	0.1439	55.1510	86.6010	71.8788	71.2103
870	0.1772	0.1133	0.1417	0.1441	55.8880	86.1950	71.5419	71.2083
872	0.1773	0.1132	0.1418	0.1441	55.4430	86.2880	71.6190	71.1167
874	0.1774	0.1137	0.1419	0.1443	55.4050	86.5400	71.8282	71.2577
876	0.1775	0.1136	0.1420	0.1444	55.3670	86.9450	72.1644	71.4921
878	0.1778	0.1139	0.1422	0.1446	55.6960	86.3540	71.6738	71.2413
880	0.1778	0.1139	0.1422	0.1446	55.4940	86.6650	71.9320	71.3637
882	0.1781	0.1140	0.1425	0.1449	55.1770	85.9520	71.3402	70.8231
884	0.1783	0.1143	0.1426	0.1451	55.3420	86.3870	71.7012	71.1434
886	0.1785	0.1145	0.1428	0.1453	55.4680	85.5850	71.0356	70.6962
888	0.1788	0.1144	0.1430	0.1454	54.9890	85.9860	71.3684	70.7811

890	0.1788	0.1144	0.1430	0.1454	54.9890	85.6760	71.1111	70.5920
892	0.1791	0.1149	0.1433	0.1458	54.8770	85.6200	71.0646	70.5205
894	0.1790	0.1150	0.1432	0.1457	55.3160	86.1450	71.5004	70.9871
896	0.1792	0.1149	0.1434	0.1458	55.0400	85.9280	71.3202	70.7627
898	0.1794	0.1148	0.1435	0.1459	54.8020	84.4780	70.1167	69.7989
900	0.1796	0.1153	0.1437	0.1462	54.7270	85.0410	70.5840	70.1173
902	0.1799	0.1151	0.1439	0.1463	54.6530	85.4390	70.9144	70.3355
904	0.1801	0.1156	0.1441	0.1466	54.5790	85.3840	70.8687	70.2772
906	0.1802	0.1158	0.1442	0.1467	54.7420	84.9880	70.5400	70.0900
908	0.1801	0.1160	0.1441	0.1467	54.9790	85.1140	70.6446	70.2459
910	0.1803	0.1159	0.1443	0.1468	54.7050	85.2040	70.7193	70.2094
912	0.1805	0.1161	0.1444	0.1470	55.0670	84.4150	70.0645	69.8488
914	0.1806	0.1164	0.1445	0.1471	54.2320	84.2380	69.9175	69.4625
916	0.1808	0.1164	0.1447	0.1473	54.7560	84.2380	69.9175	69.6372
918	0.1810	0.1166	0.1448	0.1474	54.7190	84.3650	70.0230	69.7023
920	0.1813	0.1167	0.1451	0.1477	54.8070	84.5800	70.2014	69.8628
922	0.1814	0.1169	0.1452	0.1478	54.5720	83.8860	69.6254	69.3611
924	0.1817	0.1166	0.1453	0.1479	53.9040	84.9720	70.5268	69.8009
926	0.1819	0.1171	0.1455	0.1482	54.4250	83.7110	69.4801	69.2054
928	0.1821	0.1172	0.1456	0.1483	53.9930	83.9260	69.6586	69.1925
930	0.1823	0.1173	0.1458	0.1485	54.1180	83.8380	69.5855	69.1805
932	0.1824	0.1175	0.1459	0.1486	54.0820	83.7510	69.5133	69.1154
934	0.1825	0.1175	0.1460	0.1487	54.2430	83.7510	69.5133	69.1691
936	0.1827	0.1177	0.1461	0.1488	54.2070	83.5770	69.3689	69.0510
938	0.1828	0.1181	0.1462	0.1490	53.7770	83.0180	68.9049	68.5666
940	0.1830	0.1179	0.1464	0.1491	53.9020	83.7040	69.4743	69.0268
942	0.1832	0.1182	0.1465	0.1493	53.8660	83.2320	69.0826	68.7269
944	0.1834	0.1187	0.1467	0.1496	53.5980	82.8900	68.7987	68.4289
946	0.1835	0.1189	0.1468	0.1498	53.5620	83.0170	68.9041	68.4944
948	0.1835	0.1186	0.1468	0.1496	53.9550	82.6760	68.6211	68.4174
950	0.1838	0.1189	0.1470	0.1499	53.6870	83.0170	68.9041	68.5360
952	0.1839	0.1190	0.1471	0.1500	53.8470	83.2290	69.0801	68.7187
954	0.1842	0.1189	0.1474	0.1502	53.5450	83.0170	68.9041	68.4887
956	0.1845	0.1194	0.1476	0.1505	53.4740	82.9740	68.8684	68.4388
958	0.1846	0.1192	0.1477	0.1505	53.2430	82.8470	68.7630	68.2843
960	0.1847	0.1195	0.1478	0.1507	53.5980	82.0010	68.0608	67.8866
962	0.1850	0.1197	0.1480	0.1509	53.3330	82.2130	68.2368	67.9276
964	0.1849	0.1199	0.1479	0.1509	53.3680	82.3410	68.3430	68.0173
966	0.1849	0.1199	0.1479	0.1509	52.9780	82.3410	68.3430	67.8873
968	0.1851	0.1199	0.1481	0.1510	53.2970	82.0450	68.0974	67.8131
970	0.1855	0.1203	0.1484	0.1514	53.1920	82.3840	68.3787	67.9849
972	0.1860	0.1205	0.1488	0.1517	53.0520	81.6300	67.7529	67.4783
974	0.1858	0.1204	0.1487	0.1516	52.7000	82.0070	68.0658	67.5909
976	0.1861	0.1206	0.1489	0.1519	53.0180	81.5470	67.6840	67.4163
978	0.1861	0.1208	0.1489	0.1519	53.0180	81.1720	67.3728	67.1876
980	0.1863	0.1205	0.1491	0.1520	52.7550	81.6300	67.7529	67.3793
982	0.1866	0.1210	0.1493	0.1523	52.6860	81.5930	67.7222	67.3337
984	0.1867	0.1211	0.1494	0.1524	52.6510	81.2180	67.4109	67.0933
986	0.1867	0.1214	0.1494	0.1525	52.2660	80.7630	67.0333	66.6874
988	0.1868	0.1211	0.1495	0.1525	52.0390	81.2180	67.4109	66.8893
990	0.1872	0.1215	0.1497	0.1528	52.1290	81.2650	67.4500	66.9480
992	0.1873	0.1215	0.1498	0.1529	51.9030	80.9740	67.2084	66.6951
994	0.1875	0.1219	0.1500	0.1531	51.8350	81.0210	67.2474	66.7011
996	0.1877	0.1221	0.1501	0.1533	51.8020	80.5690	66.8723	66.4144
998	0.1878	0.1220	0.1502	0.1533	51.5760	81.2300	67.4209	66.7423
1000	0.1879	0.1223	0.1503	0.1535	51.9260	80.6970	66.9785	66.5338

1002	0.1879	0.1226	0.1503	0.1536	52.1180	80.5360	66.8449	66.4996
1004	0.1882	0.1226	0.1505	0.1538	51.6670	80.2480	66.6058	66.1736
1006	0.1884	0.1225	0.1507	0.1539	52.3650	80.3280	66.6722	66.4551
1008	0.1886	0.1227	0.1509	0.1541	51.5330	80.1680	66.5394	66.0801
1010	0.1890	0.1228	0.1512	0.1544	51.8150	79.8000	66.2340	65.9497
1012	0.1890	0.1232	0.1512	0.1545	51.8150	80.1370	66.5137	66.1552
1014	0.1894	0.1233	0.1515	0.1547	51.1440	79.7710	66.2099	65.7083
1016	0.1894	0.1234	0.1515	0.1548	51.9050	80.5520	66.8582	66.4384
1018	0.1894	0.1236	0.1515	0.1548	51.3340	79.6130	66.0788	65.6753
1020	0.1897	0.1237	0.1518	0.1551	51.6150	79.5350	66.0141	65.7214
1022	0.1897	0.1238	0.1518	0.1551	51.9940	79.4560	65.9485	65.7995
1024	0.1900	0.1241	0.1520	0.1553	51.5480	80.1560	66.5295	66.0778
1026	0.1900	0.1239	0.1520	0.1553	51.5480	79.9490	66.3577	65.9516
1028	0.1906	0.1242	0.1525	0.1558	51.7610	78.6520	65.2812	65.2314
1030	0.1902	0.1244	0.1522	0.1556	51.4820	79.3510	65.8613	65.5648
1032	0.1907	0.1245	0.1526	0.1559	51.1610	79.2730	65.7966	65.4102
1034	0.1908	0.1244	0.1527	0.1560	51.3170	79.3510	65.8613	65.5098
1036	0.1910	0.1248	0.1528	0.1562	51.2850	79.1180	65.6679	65.3570
1038	0.1912	0.1250	0.1530	0.1564	51.0310	78.6800	65.3044	65.0051
1040	0.1915	0.1253	0.1532	0.1566	50.9660	78.5270	65.1774	64.8901
1042	0.1915	0.1253	0.1532	0.1566	51.1540	78.5270	65.1774	64.9528
1044	0.1917	0.1255	0.1534	0.1569	51.0890	78.3740	65.0504	64.8378
1046	0.1919	0.1256	0.1536	0.1570	51.0240	78.2980	64.9873	64.7698
1048	0.1921	0.1256	0.1537	0.1571	51.1790	78.5800	65.2214	64.9935
1050	0.1921	0.1255	0.1537	0.1571	50.9910	78.6560	65.2845	64.9772
1052	0.1924	0.1264	0.1539	0.1576	50.8940	77.5640	64.3781	64.2787
1054	0.1926	0.1261	0.1540	0.1576	50.6750	77.7140	64.5026	64.2972
1056	0.1928	0.1264	0.1542	0.1578	50.6110	77.2840	64.1457	64.0136

1058	0.1930	0.1264	0.1544	0.1579	50.9200	78.1240	64.8429	64.6290
1060	0.1934	0.1265	0.1547	0.1582	50.6370	77.7690	64.5483	64.3181
1062	0.1933	0.1269	0.1546	0.1583	50.4830	76.9870	63.8992	63.7897
1064	0.1935	0.1269	0.1548	0.1584	50.6050	76.4290	63.4361	63.4900
1066	0.1935	0.1267	0.1548	0.1584	50.9770	77.3400	64.1922	64.1697
1068	0.1937	0.1271	0.1549	0.1586	50.7590	77.3950	64.2379	64.1306
1070	0.1940	0.1272	0.1552	0.1588	50.8490	77.0430	63.9457	63.9459
1072	0.1941	0.1274	0.1553	0.1589	50.4460	76.9690	63.8843	63.7664
1074	0.1944	0.1277	0.1555	0.1592	50.7530	76.7480	63.7008	63.7339
1076	0.1946	0.1276	0.1557	0.1593	50.6890	76.5450	63.5324	63.5888
1078	0.1950	0.1278	0.1560	0.1596	50.0400	76.1220	63.1813	63.1144
1080	0.1950	0.1280	0.1560	0.1597	49.6710	76.8790	63.8096	63.4532
1082	0.1951	0.1281	0.1561	0.1598	50.3780	76.8050	62.9801	63.3877
1084	0.1954	0.1281	0.1563	0.1599	50.3150	76.8050	62.9801	63.3667
1086	0.1954	0.1283	0.1563	0.1600	50.1310	75.8320	62.1822	62.7151
1088	0.1957	0.1283	0.1566	0.1602	50.4050	75.2800	61.7296	62.4715
1090	0.1957	0.1286	0.1566	0.1603	50.4050	76.2380	62.5152	63.0527
1092	0.1961	0.1287	0.1569	0.1606	50.3110	75.6160	62.0051	62.6440
1094	0.1962	0.1291	0.1570	0.1607	50.6460	75.9500	62.2790	62.9583
1096	0.1965	0.1294	0.1572	0.1610	50.2170	75.7350	62.1027	62.6849
1098	0.1966	0.1293	0.1573	0.1610	50.3690	76.0800	62.3856	62.9449
1100	0.1968	0.1292	0.1575	0.1612	50.1230	75.6040	61.9953	62.5741
1102	0.1969	0.1295	0.1576	0.1614	50.0920	75.6630	62.0437	62.5996
1104	0.1971	0.1297	0.1577	0.1615	49.8780	75.3190	61.7616	62.3195
1106	0.1973	0.1298	0.1579	0.1617	49.9990	75.5210	61.9272	62.4824
1108	0.1976	0.1302	0.1580	0.1619	49.7550	74.7650	61.3073	61.9424
1110	0.1978	0.1299	0.1582	0.1620	49.6940	75.4500	61.8690	62.3377
1112	0.1982	0.1302	0.1585	0.1623	49.6020	75.3090	61.7534	62.2215

1114	0.1980	0.1302	0.1584	0.1622	49.8140	75.0370	61.5303	62.1271
1116	0.1984	0.1304	0.1587	0.1625	49.3590	75.4390	61.8600	62.2193
1118	0.1985	0.1306	0.1588	0.1627	49.8730	75.2980	61.7444	62.3051
1120	0.1987	0.1308	0.1589	0.1628	49.8420	74.6860	61.2425	61.9235
1122	0.1990	0.1309	0.1592	0.1630	49.9320	74.8870	61.4073	62.0754
1124	0.1991	0.1313	0.1593	0.1632	49.7200	74.6780	61.2360	61.8780
1126	0.1993	0.1311	0.1594	0.1633	49.5090	74.7480	61.2934	61.8501
1128	0.1996	0.1314	0.1597	0.1636	49.2380	74.6090	61.1794	61.6755
1130	0.1995	0.1316	0.1596	0.1636	49.2680	74.7390	61.2860	61.7643
1132	0.1996	0.1317	0.1597	0.1637	49.5990	74.9380	61.4492	61.9954
1134	0.1999	0.1317	0.1599	0.1638	49.1780	74.4010	61.0088	61.5293
1136	0.2002	0.1317	0.1602	0.1641	49.2680	74.1330	60.7891	61.3967
1138	0.2005	0.1316	0.1604	0.1642	49.2080	73.9320	60.6242	61.2547
1140	0.2006	0.1322	0.1605	0.1644	49.5370	74.3940	61.0031	61.6447
1142	0.2007	0.1325	0.1606	0.1646	49.1480	73.9900	60.6718	61.2699
1144	0.2011	0.1324	0.1609	0.1648	49.2370	74.0580	60.7276	61.3409
1146	0.2013	0.1322	0.1611	0.1649	48.9990	74.6620	60.4762	61.3791
1148	0.2015	0.1328	0.1612	0.1652	49.3260	74.0520	59.9821	61.1200
1150	0.2017	0.1330	0.1614	0.1653	49.0880	73.7180	59.7116	60.8392
1152	0.2017	0.1328	0.1614	0.1653	48.7310	73.7860	59.7667	60.7612
1154	0.2020	0.1335	0.1616	0.1657	48.8510	73.1830	59.2782	60.4374
1156	0.2021	0.1336	0.1617	0.1658	48.6430	73.9110	59.8679	60.8073
1158	0.2024	0.1336	0.1620	0.1660	48.9110	73.6460	59.6533	60.7368
1160	0.2024	0.1338	0.1620	0.1661	48.9110	73.2470	59.3301	60.4960
1162	0.2028	0.1339	0.1622	0.1663	48.6450	73.1800	59.2758	60.3669
1164	0.2031	0.1339	0.1624	0.1665	48.7630	73.7090	59.7043	60.7254
1166	0.2029	0.1341	0.1623	0.1664	48.4380	73.1140	59.2223	60.2581
1168	0.2034	0.1343	0.1627	0.1668	48.6760	73.2440	59.3276	60.4159

1170	0.2035	0.1348	0.1628	0.1671	48.4700	72.9790	59.1130	60.1873
1172	0.2035	0.1347	0.1628	0.1670	48.8230	72.7820	58.9534	60.1861
1174	0.2040	0.1347	0.1632	0.1673	48.3540	72.7820	58.9534	60.0298
1176	0.2042	0.1348	0.1633	0.1674	48.1480	72.7160	58.9000	59.9213
1178	0.2044	0.1352	0.1635	0.1677	48.0910	73.0430	59.1648	60.0996
1180	0.2048	0.1352	0.1638	0.1679	48.3560	72.5190	58.7404	59.8718
1182	0.2048	0.1352	0.1638	0.1679	48.1810	72.7810	58.9526	59.9715
1184	0.2050	0.1354	0.1640	0.1681	48.2990	72.6500	58.8465	59.9318
1186	0.2050	0.1358	0.1640	0.1683	48.4740	72.4540	58.6877	59.8719
1188	0.2053	0.1355	0.1642	0.1683	48.0660	72.3230	58.5816	59.6569
1190	0.2056	0.1364	0.1645	0.1688	48.3300	71.6110	58.0049	59.3153
1192	0.2057	0.1361	0.1646	0.1688	47.9520	72.2590	58.5298	59.5803
1194	0.2061	0.1361	0.1649	0.1690	47.8670	72.5190	58.7404	59.7088
1196	0.2063	0.1363	0.1651	0.1692	47.8100	71.9340	58.2665	59.3368
1198	0.2062	0.1365	0.1650	0.1692	47.6640	72.0650	58.3727	59.3672
1200	0.2062	0.1369	0.1650	0.1694	47.6640	71.8720	58.2163	59.2508
1202	0.2067	0.1366	0.1654	0.1696	47.8990	72.2600	58.5306	59.5632
1204	0.2071	0.1369	0.1657	0.1699	47.9890	72.3890	58.6351	59.6710
1206	0.2073	0.1372	0.1659	0.1701	47.4110	71.9380	58.2698	59.2063
1208	0.2070	0.1372	0.1656	0.1699	47.3210	71.4220	57.8518	58.8649
1210	0.2074	0.1376	0.1660	0.1703	47.2100	72.0040	57.6032	58.9391
1212	0.2078	0.1375	0.1663	0.1705	47.6460	71.5530	57.2424	58.8138
1214	0.2077	0.1377	0.1662	0.1705	47.5010	71.4260	57.1408	58.6893
1216	0.2082	0.1381	0.1665	0.1709	47.3890	71.2370	56.9896	58.5385
1218	0.2085	0.1381	0.1668	0.1712	46.6150	71.2370	56.9896	58.2805
1220	0.2085	0.1382	0.1668	0.1712	46.9610	71.6860	57.3488	58.6653
1222	0.2088	0.1383	0.1670	0.1714	46.7330	71.1110	56.8888	58.2443
1224	0.2094	0.1386	0.1675	0.1718	46.5970	70.9860	56.7888	58.1239

1226	0.2095	0.1385	0.1676	0.1719	46.5700	71.3040	57.0432	58.3057
1228	0.2093	0.1388	0.1674	0.1718	46.4520	70.6060	56.4848	57.8476
1230	0.2094	0.1391	0.1675	0.1720	46.4250	70.9910	56.7928	58.0696
1232	0.2098	0.1391	0.1678	0.1722	46.5160	70.7360	56.5888	57.9469
1234	0.2096	0.1394	0.1677	0.1723	46.5430	70.2970	56.2376	57.6925
1236	0.2104	0.1397	0.1683	0.1728	46.7230	70.9340	56.7472	58.1347
1238	0.2105	0.1398	0.1684	0.1729	46.1830	70.3660	56.2928	57.6139
1240	0.2105	0.1398	0.1684	0.1729	46.5250	70.6190	56.4952	57.8797
1242	0.2106	0.1398	0.1685	0.1730	46.3270	70.6190	56.4952	57.8137
1244	0.2110	0.1402	0.1688	0.1733	46.4170	70.9390	56.7512	58.0357
1246	0.2110	0.1403	0.1688	0.1734	46.2470	70.6250	56.5000	57.7907
1248	0.2115	0.1403	0.1692	0.1737	46.1400	70.1210	56.0968	57.4526
1250	0.2115	0.1404	0.1692	0.1737	45.7990	70.0600	56.0480	57.3023
1252	0.2118	0.1405	0.1695	0.1740	46.2300	70.5020	56.4016	57.7112
1254	0.2121	0.1407	0.1697	0.1741	46.0070	70.4410	56.3528	57.6003
1256	0.2122	0.1410	0.1698	0.1743	46.3200	70.0070	56.0056	57.4442
1258	0.2125	0.1413	0.1700	0.1746	46.4360	69.8860	55.9088	57.4103
1260	0.2125	0.1414	0.1700	0.1746	46.0970	69.3250	55.4600	56.9607
1262	0.2128	0.1414	0.1703	0.1748	46.0180	70.0760	56.0608	57.3849
1264	0.2133	0.1415	0.1706	0.1752	45.9120	69.5160	55.6128	57.0136
1266	0.2133	0.1418	0.1706	0.1752	45.5750	69.1460	55.3168	56.6793
1268	0.2134	0.1418	0.1707	0.1753	46.0550	69.3960	55.5168	56.9893
1270	0.2136	0.1420	0.1708	0.1755	45.6910	69.7750	55.8200	57.0953
1272	0.2138	0.1422	0.1710	0.1757	45.8080	69.4060	55.5248	56.9129
1274	0.2143	0.1424	0.1714	0.1760	45.1990	69.3470	55.4776	56.6745
1276	0.2143	0.1425	0.1714	0.1761	45.5350	68.7910	55.0328	56.4529
1278	0.2144	0.1430	0.1715	0.1763	45.5090	68.5560	54.8448	56.3033
1280	0.2147	0.1429	0.1717	0.1764	45.4570	68.6140	54.8912	56.3207

1282	0.2150	0.1432	0.1720	0.1768	45.7150	68.6860	54.9488	56.4499
1284	0.2150	0.1431	0.1720	0.1767	46.0500	68.4970	54.7976	56.4482
1286	0.2153	0.1432	0.1722	0.1769	45.9980	68.6860	54.9488	56.5443
1288	0.2154	0.1435	0.1723	0.1771	45.8040	68.5690	54.8552	56.4094
1290	0.2161	0.1436	0.1729	0.1775	45.4820	69.2500	55.4000	56.7107
1292	0.2159	0.1441	0.1727	0.1775	45.5340	68.7700	55.0160	56.4400
1294	0.2161	0.1440	0.1729	0.1777	45.1490	68.3360	54.6688	56.0513
1296	0.2169	0.1441	0.1735	0.1781	45.1630	68.5240	54.8192	56.1687
1298	0.2165	0.1443	0.1732	0.1780	45.2390	67.9180	54.3344	55.8305
1300	0.2167	0.1442	0.1734	0.1781	45.3540	68.4660	54.7728	56.1976
1302	0.2172	0.1448	0.1738	0.1786	45.4180	68.4220	54.7376	56.1925
1304	0.2172	0.1447	0.1738	0.1786	45.4180	68.4800	54.7840	56.2273
1306	0.2175	0.1449	0.1740	0.1788	45.5330	68.3640	54.6912	56.1961
1308	0.2176	0.1451	0.1741	0.1789	45.1760	68.0630	54.4504	55.8965
1310	0.2181	0.1449	0.1745	0.1792	45.2400	67.6320	54.1056	55.6592
1312	0.2183	0.1454	0.1747	0.1795	45.1890	67.6480	54.1184	55.6518
1314	0.2183	0.1455	0.1747	0.1795	44.5300	67.5910	54.0728	55.3979
1316	0.2187	0.1457	0.1749	0.1798	45.1140	67.5350	54.0280	55.5590
1318	0.2188	0.1455	0.1750	0.1798	45.2530	67.3480	53.8784	55.4931
1320	0.2192	0.1462	0.1753	0.1802	44.5200	67.0670	53.6536	55.0802
1322	0.2193	0.1463	0.1754	0.1803	44.8240	66.7690	53.4152	55.0027
1324	0.2194	0.1465	0.1755	0.1805	44.6350	67.1410	53.7128	55.1629
1326	0.2199	0.1466	0.1759	0.1808	45.0270	66.6020	53.2816	54.9702
1328	0.2201	0.1469	0.1761	0.1811	44.6500	67.2140	53.7712	55.2117
1330	0.2204	0.1469	0.1763	0.1812	44.7640	67.2140	53.7712	55.2497
1332	0.2205	0.1470	0.1764	0.1813	45.2290	66.9180	53.5344	55.2271
1334	0.2206	0.1470	0.1765	0.1814	44.8780	66.4360	53.1488	54.8209
1336	0.2210	0.1474	0.1768	0.1817	44.8030	66.0310	52.8248	54.5529

1338	0.2212	0.1474	0.1770	0.1819	44.7540	66.5110	53.2088	54.8246
1340	0.2215	0.1476	0.1772	0.1821	44.3790	66.4010	53.1208	54.6336
1342	0.2216	0.1479	0.1773	0.1823	44.1920	66.2910	53.0328	54.5053
1344	0.2217	0.1482	0.1774	0.1825	44.3300	65.8890	52.7112	54.3101
1346	0.2221	0.1480	0.1777	0.1826	44.4190	66.4760	53.1808	54.6919
1348	0.2222	0.1484	0.1778	0.1828	44.3950	66.3120	53.0496	54.5855
1350	0.2223	0.1482	0.1779	0.1828	44.0470	65.8890	52.7112	54.2157
1352	0.2228	0.1485	0.1783	0.1832	44.4350	65.7800	52.6240	54.2797
1354	0.2232	0.1482	0.1786	0.1833	44.2010	66.1280	52.9024	54.4105
1356	0.2233	0.1492	0.1787	0.1837	44.0150	65.6950	52.5560	54.0887
1358	0.2234	0.1491	0.1788	0.1838	44.1520	65.7480	52.5984	54.1661
1360	0.2238	0.1493	0.1790	0.1841	44.4020	65.4040	52.3232	54.0431
1362	0.2242	0.1490	0.1793	0.1842	43.8470	66.0400	52.8320	54.2397
1364	0.2244	0.1496	0.1795	0.1845	43.8000	66.0070	52.8056	54.2042
1366	0.2245	0.1503	0.1796	0.1848	43.7760	65.2140	52.1712	53.7204
1368	0.2247	0.1498	0.1797	0.1847	44.0730	65.4270	52.3416	53.9472
1370	0.2250	0.1499	0.1800	0.1850	43.8410	65.1380	52.1104	53.6965
1372	0.2253	0.1503	0.1802	0.1853	43.7930	64.7430	51.7944	53.4435
1374	0.2253	0.1503	0.1802	0.1853	43.6340	65.6850	52.5480	53.9557
1376	0.2255	0.1504	0.1804	0.1855	43.7460	65.3970	52.3176	53.8202
1378	0.2260	0.1507	0.1808	0.1858	43.8110	65.0560	52.0448	53.6373
1380	0.2264	0.1507	0.1811	0.1860	43.5810	65.0560	52.0448	53.5606
1382	0.2264	0.1508	0.1811	0.1861	43.7400	64.5340	51.6272	53.3004
1384	0.2265	0.1514	0.1812	0.1864	43.3980	64.5070	51.6056	53.1702
1386	0.2270	0.1512	0.1816	0.1866	43.4640	64.6120	51.6896	53.2552
1388	0.2272	0.1512	0.1818	0.1867	43.4170	64.1430	51.3144	52.9581
1390	0.2276	0.1515	0.1821	0.1871	43.5050	64.6890	51.7512	53.3151
1392	0.2277	0.1518	0.1822	0.1872	43.3240	64.8180	51.8544	53.3321

1394	0.2280	0.1519	0.1824	0.1874	43.2770	64.7660	51.8128	53.2853
1396	0.2280	0.1523	0.1824	0.1875	43.2770	64.6100	51.6880	53.1917
1398	0.2286	0.1525	0.1829	0.1880	43.1620	64.2750	51.4200	52.9523
1400	0.2286	0.1525	0.1829	0.1880	43.1620	64.2750	51.4200	52.9523
1402	0.2288	0.1526	0.1831	0.1882	43.1160	64.6870	51.7496	53.1842
1404	0.2293	0.1529	0.1834	0.1885	43.0240	64.3520	51.4816	52.9525
1406	0.2298	0.1529	0.1838	0.1888	42.9320	64.3520	51.4816	52.9219
1408	0.2299	0.1532	0.1839	0.1890	42.9100	63.7360	50.9888	52.5449
1410	0.2300	0.1532	0.1840	0.1891	42.7300	63.9670	51.1736	52.6235
1412	0.2302	0.1536	0.1841	0.1893	42.8640	64.0450	51.2360	52.7150
1414	0.2303	0.1535	0.1842	0.1893	42.8410	64.3270	51.4616	52.8765
1416	0.2309	0.1540	0.1847	0.1899	42.8840	63.6630	50.9304	52.4925
1418	0.2309	0.1538	0.1847	0.1898	42.7280	63.9430	51.1544	52.6085
1420	0.2314	0.1541	0.1851	0.1902	42.9490	64.5310	51.6248	53.0349
1422	0.2316	0.1542	0.1853	0.1904	42.5930	63.7920	51.0336	52.4729
1424	0.2317	0.1546	0.1854	0.1906	42.5700	63.6400	50.9120	52.3740
1426	0.2320	0.1548	0.1856	0.1908	42.6810	63.9970	51.1976	52.6252
1428	0.2324	0.1551	0.1859	0.1911	42.4590	63.2120	50.5696	52.0802
1430	0.2326	0.1549	0.1861	0.1912	42.4140	63.2620	50.6096	52.0952
1432	0.2330	0.1552	0.1864	0.1915	42.0380	63.6180	50.8944	52.1835
1434	0.2332	0.1554	0.1866	0.1917	42.1490	63.0630	50.4504	51.8875
1436	0.2335	0.1556	0.1868	0.1919	42.2590	63.2410	50.5928	52.0309
1438	0.2338	0.1557	0.1871	0.1922	42.3470	63.1910	50.5528	52.0303
1440	0.2337	0.1562	0.1870	0.1923	42.2150	63.2200	50.5760	52.0037
1442	0.2343	0.1559	0.1874	0.1926	42.2580	62.8650	50.2920	51.8050
1444	0.2344	0.1563	0.1875	0.1928	42.2360	63.1710	50.5368	51.9813
1446	0.2346	0.1565	0.1876	0.1929	41.7540	62.6200	50.0960	51.4900
1448	0.2353	0.1567	0.1882	0.1934	41.7770	62.7970	50.2376	51.6039

1450	0.2352	0.1567	0.1881	0.1933	41.6450	63.0230	50.4184	51.6955
1452	0.2357	0.1568	0.1885	0.1937	41.8650	62.7480	50.1984	51.6038
1454	0.2358	0.1570	0.1886	0.1938	41.6900	63.1010	50.4808	51.7573
1456	0.2360	0.1575	0.1876	0.1937	40.8840	63.1300	50.5040	51.5060
1458	0.2363	0.1574	0.1878	0.1938	41.4520	62.5050	50.0040	51.3203
1460	0.2365	0.1576	0.1880	0.1941	41.2570	62.1830	49.7464	51.0621
1462	0.2366	0.1576	0.1881	0.1941	41.6920	62.6320	50.1056	51.4765
1464	0.2372	0.1579	0.1886	0.1946	41.2810	62.5360	50.0288	51.2819
1466	0.2372	0.1582	0.1886	0.1947	41.2810	62.3910	49.9128	51.1949
1468	0.2375	0.1581	0.1888	0.1948	40.9350	61.9910	49.5928	50.8396
1470	0.2379	0.1585	0.1891	0.1951	40.7210	62.0710	49.6568	50.8163
1472	0.2381	0.1586	0.1893	0.1953	41.1330	62.2470	49.7976	51.0592
1474	0.2383	0.1587	0.1895	0.1955	40.7890	62.1990	49.7592	50.9157
1476	0.2390	0.1590	0.1900	0.1960	40.9860	62.3260	49.8608	51.0576
1478	0.2391	0.1590	0.1901	0.1960	40.8140	61.4360	49.1488	50.4663
1480	0.2392	0.1593	0.1902	0.1962	40.7930	61.7380	49.3904	50.6405
1482	0.2396	0.1596	0.1905	0.1965	40.8810	61.8660	49.4928	50.7466
1484	0.2399	0.1596	0.1907	0.1968	40.9690	61.8660	49.4928	50.7759
1486	0.2400	0.1601	0.1908	0.1970	40.6480	61.4560	49.1648	50.4229
1488	0.2403	0.1600	0.1910	0.1971	40.7570	61.7240	49.3792	50.6201
1490	0.2408	0.1601	0.1914	0.1974	40.6740	62.1190	49.6952	50.8294
1492	0.2410	0.1604	0.1916	0.1977	40.6330	61.5360	49.2288	50.4659
1494	0.2413	0.1607	0.1918	0.1979	40.5920	61.4430	49.1544	50.3965
1496	0.2414	0.1608	0.1919	0.1980	40.5710	61.6160	49.2928	50.4933
1498	0.2420	0.1611	0.1924	0.1985	40.3200	61.3030	49.0424	50.2218
1500	0.2420	0.1612	0.1924	0.1985	40.4690	61.2560	49.0048	50.2433
1502	0.2422	0.1615	0.1926	0.1988	40.2790	60.8980	48.7184	49.9651
1504	0.2429	0.1617	0.1931	0.1992	40.1780	61.2900	49.0320	50.1667

1506	0.2431	0.1617	0.1933	0.1993	39.9900	60.8520	48.6816	49.8412
1508	0.2433	0.1623	0.1935	0.1997	40.0970	60.8420	48.6736	49.8709
1510	0.2435	0.1621	0.1936	0.1997	39.7820	60.8870	48.7096	49.7929
1512	0.2436	0.1623	0.1937	0.1998	40.2050	60.8420	48.6736	49.9069
1514	0.2440	0.1621	0.1939	0.2000	39.9970	60.6690	48.5352	49.7337
1516	0.2443	0.1626	0.1942	0.2004	39.9370	60.7050	48.5640	49.7353
1518	0.2447	0.1630	0.1945	0.2007	40.1720	60.5680	48.4544	49.7315
1520	0.2446	0.1630	0.1944	0.2007	40.1920	60.3510	48.2808	49.6079
1522	0.2452	0.1632	0.1949	0.2011	39.9450	60.4780	48.3824	49.6018
1524	0.2459	0.1632	0.1955	0.2016	40.1190	60.4780	48.3824	49.6598
1526	0.2458	0.1636	0.1954	0.2016	39.6990	60.3420	48.2736	49.4382
1528	0.2459	0.1637	0.1955	0.2017	40.1190	59.8650	47.8920	49.2920
1530	0.2462	0.1637	0.1957	0.2019	39.9320	60.5130	48.4104	49.6185
1532	0.2465	0.1642	0.1960	0.2022	39.7270	59.9020	47.9216	49.1835
1534	0.2464	0.1641	0.1959	0.2021	40.0390	60.1630	48.1304	49.4441
1536	0.2471	0.1645	0.1965	0.2027	39.6290	60.2440	48.1952	49.3561
1538	0.2474	0.1646	0.1967	0.2029	39.8810	59.3390	47.4712	48.8971
1540	0.2476	0.1646	0.1969	0.2030	39.5510	60.1990	48.1592	49.3031
1542	0.2479	0.1648	0.1971	0.2032	39.5120	59.6810	47.7448	48.9793
1544	0.2481	0.1650	0.1972	0.2034	39.4730	59.8510	47.8808	49.0683
1546	0.2486	0.1653	0.1976	0.2039	39.5400	59.9320	47.9456	49.1392
1548	0.2488	0.1656	0.1978	0.2041	39.6460	59.4160	47.5328	48.8649
1550	0.2493	0.1657	0.1982	0.2044	39.1350	59.5860	47.6688	48.7966
1552	0.2496	0.1659	0.1984	0.2046	39.3850	59.4990	47.5992	48.8277
1554	0.2496	0.1662	0.1984	0.2047	39.2410	59.1980	47.3584	48.5991
1556	0.2499	0.1663	0.1987	0.2050	39.4720	59.5800	47.6640	48.9053
1558	0.2502	0.1664	0.1989	0.2052	39.2890	58.8990	47.1192	48.4357
1560	0.2507	0.1665	0.1993	0.2055	39.0690	59.4930	47.5944	48.7188

1562	0.2508	0.1670	0.1994	0.2057	39.3370	59.1070	47.2856	48.5765
1564	0.2512	0.1672	0.1997	0.2060	39.2800	59.2760	47.4208	48.6589
1566	0.2515	0.1673	0.2000	0.2063	39.0800	58.8090	47.0472	48.3121
1568	0.2514	0.1675	0.1999	0.2063	39.2420	58.9350	47.1480	48.4417
1570	0.2521	0.1676	0.2004	0.2067	38.8420	58.6810	46.9448	48.1559
1572	0.2521	0.1679	0.2004	0.2068	38.8420	58.8060	47.0448	48.2309
1574	0.2529	0.1680	0.2010	0.2073	38.8720	58.9740	47.1792	48.3417
1576	0.2529	0.1680	0.2010	0.2073	38.7300	58.9740	47.1792	48.2944
1578	0.2531	0.1685	0.2012	0.2076	39.1190	58.1730	46.5384	47.9435
1580	0.2535	0.1684	0.2015	0.2078	38.6360	58.6360	46.9088	48.0603
1582	0.2535	0.1685	0.2015	0.2078	38.7780	58.8030	47.0424	48.2078
1584	0.2542	0.1689	0.2021	0.2084	38.6670	58.0470	46.4376	47.7172
1586	0.2543	0.1691	0.2022	0.2085	38.7900	58.1720	46.5376	47.8332
1588	0.2546	0.1691	0.2024	0.2087	38.6110	57.5450	46.0360	47.3973
1590	0.2551	0.1695	0.2028	0.2091	38.5370	58.0470	46.4376	47.6739
1592	0.2553	0.1698	0.2030	0.2094	38.6410	57.9210	46.3368	47.6329
1594	0.2556	0.1700	0.2032	0.2096	38.6040	58.0880	46.4704	47.7208
1596	0.2558	0.1701	0.2034	0.2097	38.4270	57.6300	46.1040	47.3870
1598	0.2560	0.1702	0.2036	0.2099	38.3900	57.1730	45.7384	47.1005
1600	0.2564	0.1705	0.2038	0.2102	38.3350	57.7140	46.1712	47.4067
1602	0.2568	0.1706	0.2041	0.2105	38.4210	58.0880	46.4704	47.6598
1604	0.2571	0.1707	0.2044	0.2108	38.2260	57.2170	45.7736	47.0722
1606	0.2571	0.1711	0.2044	0.2109	38.2260	57.0940	45.6752	46.9984
1608	0.2578	0.1711	0.2049	0.2112	38.2750	57.0940	45.6752	47.0147
1610	0.2579	0.1714	0.2050	0.2114	37.9780	57.3850	45.9080	47.0903
1612	0.2582	0.1714	0.2053	0.2117	38.2030	56.9720	45.5776	46.9175
1614	0.2585	0.1718	0.2055	0.2119	38.0270	57.0570	45.6456	46.9099
1616	0.2589	0.1720	0.2058	0.2122	38.1130	56.9760	45.5808	46.8899

1618	0.2592	0.1720	0.2061	0.2124	37.9200	57.1810	45.7448	46.9486
1620	0.2596	0.1724	0.2064	0.2128	37.7280	56.8550	45.4840	46.6890
1622	0.2601	0.1724	0.2068	0.2131	37.7950	56.8550	45.4840	46.7113
1624	0.2601	0.1729	0.2068	0.2132	37.7950	56.6940	45.3552	46.6147
1626	0.2603	0.1729	0.2070	0.2134	38.0360	57.1030	45.6824	46.9405
1628	0.2608	0.1730	0.2073	0.2137	37.6890	56.8590	45.4872	46.6784
1630	0.2611	0.1731	0.2075	0.2139	37.7920	57.0230	45.6184	46.8111
1632	0.2614	0.1739	0.2078	0.2144	37.7390	56.3760	45.1008	46.4053
1634	0.2617	0.1736	0.2080	0.2144	37.7040	56.6590	45.3272	46.5634
1636	0.2620	0.1737	0.2083	0.2147	37.5130	56.8230	45.4584	46.5981
1638	0.2628	0.1741	0.2089	0.2153	37.5460	56.0930	44.8744	46.1711
1640	0.2628	0.1737	0.2089	0.2151	37.4090	56.4150	45.1320	46.3187
1642	0.2629	0.1744	0.2090	0.2154	37.5280	56.4210	45.1368	46.3619
1644	0.2634	0.1742	0.2094	0.2157	37.4590	56.2570	45.0056	46.2405
1646	0.2634	0.1747	0.2094	0.2158	37.4590	56.3020	45.0416	46.2675
1648	0.2641	0.1751	0.2100	0.2164	37.4910	55.9820	44.7856	46.0862
1650	0.2643	0.1752	0.2102	0.2166	37.4570	55.9430	44.7544	46.0515
1652	0.2647	0.1755	0.2104	0.2169	37.4050	55.8660	44.6928	45.9879
1654	0.2650	0.1757	0.2106	0.2171	37.0990	55.5870	44.4696	45.7185
1656	0.2653	0.1759	0.2109	0.2174	37.3190	55.9120	44.7296	45.9869
1658	0.2658	0.1759	0.2113	0.2177	36.9790	55.7110	44.5688	45.7529
1660	0.2659	0.1767	0.2114	0.2180	37.0980	55.8800	44.7040	45.8940
1662	0.2662	0.1767	0.2116	0.2182	37.0640	55.4800	44.3840	45.6427
1664	0.2668	0.1764	0.2121	0.2184	36.8440	55.3560	44.2848	45.4949
1666	0.2672	0.1767	0.2124	0.2187	36.7930	55.8800	44.7040	45.7923
1668	0.2676	0.1769	0.2128	0.2191	36.7260	55.6030	44.4824	45.6038
1670	0.2678	0.1772	0.2129	0.2193	36.8440	55.5260	44.4208	45.5969
1672	0.2679	0.1775	0.2130	0.2195	36.9620	55.2120	44.1696	45.4479

1674	0.2684	0.1780	0.2134	0.2199	36.8940	55.2600	44.2080	45.4540
1676	0.2689	0.1781	0.2137	0.2203	36.8270	55.4200	44.3360	45.5277
1678	0.2694	0.1780	0.2141	0.2205	36.7610	55.2600	44.2080	45.4097
1680	0.2695	0.1781	0.2142	0.2206	36.6100	55.6190	44.4952	45.5747
1682	0.2696	0.1785	0.2143	0.2208	36.3270	54.9100	43.9280	45.0550
1684	0.2701	0.1788	0.2147	0.2212	36.3940	55.0330	44.0264	45.1511
1686	0.2703	0.1785	0.2149	0.2213	36.2280	55.1090	44.0872	45.1414
1688	0.2708	0.1789	0.2153	0.2217	36.2960	55.1940	44.1552	45.2151
1690	0.2711	0.1791	0.2155	0.2219	36.1300	55.3160	44.2528	45.2329
1692	0.2714	0.1795	0.2158	0.2222	35.9490	55.2030	44.1624	45.1048
1694	0.2719	0.1797	0.2162	0.2226	36.0170	54.9310	43.9448	44.9643
1696	0.2723	0.1797	0.2165	0.2228	35.9680	54.7340	43.7872	44.8297
1698	0.2725	0.1800	0.2167	0.2231	35.9360	54.6600	43.7280	44.7747
1700	0.2724	0.1803	0.2166	0.2231	35.8200	54.7450	43.7960	44.7870
1702	0.2730	0.1805	0.2170	0.2235	36.0040	54.5120	43.6096	44.7085
1704	0.2735	0.1802	0.2174	0.2237	35.5440	54.5860	43.6688	44.5996
1706	0.2739	0.1810	0.2177	0.2242	35.7600	54.1690	43.3352	44.4214
1708	0.2740	0.1810	0.2178	0.2243	35.8750	54.7560	43.8048	44.8119
1710	0.2746	0.1811	0.2183	0.2247	35.2710	54.5240	43.6192	44.4714
1712	0.2750	0.1814	0.2186	0.2250	35.3550	54.2180	43.3744	44.3158
1714	0.2752	0.1817	0.2188	0.2252	35.4540	54.1460	43.3168	44.3056
1716	0.2756	0.1818	0.2191	0.2255	35.1460	54.3040	43.4432	44.2977
1718	0.2759	0.1822	0.2194	0.2258	35.3600	54.0000	43.2000	44.1867
1720	0.2763	0.1822	0.2197	0.2261	35.0530	54.3890	43.5112	44.3177
1722	0.2766	0.1825	0.2199	0.2263	35.1520	54.2800	43.4240	44.2853
1724	0.2769	0.1827	0.2202	0.2266	35.3660	54.0500	43.2400	44.2187
1726	0.2774	0.1833	0.2205	0.2271	35.1730	53.2910	42.6328	43.6989
1728	0.2775	0.1830	0.2206	0.2271	35.2880	54.1350	43.3080	44.2437
1730	0.2775	0.1830	0.2206	0.2271	35.4170	54.1350	43.3080	44.2867
1732	0.2784	0.1834	0.2213	0.2277	35.0500	53.6410	42.9128	43.8679
1734	0.2789	0.1836	0.2217	0.2281	35.1180	53.7620	43.0096	43.9632
1736	0.2790	0.1839	0.2218	0.2282	34.7150	54.0760	43.2608	44.0173
1738	0.2796	0.1840	0.2223	0.2286	35.0260	53.2710	42.6168	43.6379
1740	0.2801	0.1846	0.2227	0.2291	34.7080	53.4780	42.7824	43.6561
1742	0.2805	0.1846	0.2230	0.2293	34.7910	53.4780	42.7824	43.6838
1744	0.2806	0.1849	0.2231	0.2295	35.0320	53.2160	42.5728	43.6069
1746	0.2808	0.1849	0.2233	0.2296	34.6170	53.2160	42.5728	43.4686
1748	0.2813	0.1851	0.2236	0.2300	34.9410	53.1460	42.5168	43.5346
1750	0.2818	0.1856	0.2240	0.2305	34.8800	53.1960	42.5568	43.5443
1752	0.2819	0.1857	0.2241	0.2306	34.6100	52.7800	42.2240	43.2047
1754	0.2824	0.1856	0.2245	0.2308	34.9320	53.1960	42.5568	43.5616
1756	0.2828	0.1861	0.2248	0.2312	34.3780	53.0570	42.4456	43.2935
1758	0.2833	0.1864	0.2252	0.2316	34.1920	52.7630	42.2104	43.0551
1760	0.2836	0.1864	0.2255	0.2319	34.5280	53.1420	42.5136	43.3945
1762	0.2840	0.1866	0.2258	0.2321	34.3570	52.9180	42.3344	43.2031
1764	0.2842	0.1868	0.2260	0.2323	34.4540	52.6590	42.1272	43.0801
1766	0.2845	0.1871	0.2262	0.2326	34.2980	52.7800	42.2240	43.1007
1768	0.2855	0.1871	0.2269	0.2332	34.0540	52.7800	42.2240	43.0193
1770	0.2855	0.1871	0.2269	0.2332	34.3070	52.7800	42.2240	43.1037
1772	0.2858	0.1877	0.2272	0.2336	34.3890	52.7970	42.2376	43.1412
1774	0.2862	0.1880	0.2275	0.2339	34.2190	52.3170	41.8536	42.7965
1776	0.2868	0.1880	0.2280	0.2343	34.0200	52.5060	42.0048	42.8436
1778	0.2868	0.1883	0.2280	0.2344	34.3970	52.0620	41.6496	42.7029
1780	0.2874	0.1886	0.2285	0.2349	34.1990	51.9600	41.5680	42.5757
1782	0.2878	0.1888	0.2288	0.2351	33.9050	52.1140	41.6912	42.5701
1784	0.2882	0.1888	0.2291	0.2353	34.2370	52.3020	41.8416	42.7935

1786	0.2886	0.1894	0.2295	0.2358	33.8050	51.9460	41.5568	42.4359
1788	0.2890	0.1895	0.2298	0.2361	34.0110	51.9130	41.5304	42.4848
1790	0.2896	0.1896	0.2302	0.2365	33.9390	52.0660	41.6528	42.5526
1792	0.2899	0.1899	0.2304	0.2367	33.9110	52.3720	41.8976	42.7269
1794	0.2902	0.1902	0.2307	0.2371	34.2400	51.8990	41.5192	42.5527
1796	0.2907	0.1902	0.2311	0.2374	33.6870	52.0850	41.6680	42.4800
1798	0.2910	0.1905	0.2313	0.2376	33.6590	51.2750	41.0200	41.9847
1800	0.2918	0.1906	0.2320	0.2381	33.8070	51.9850	41.5880	42.4600

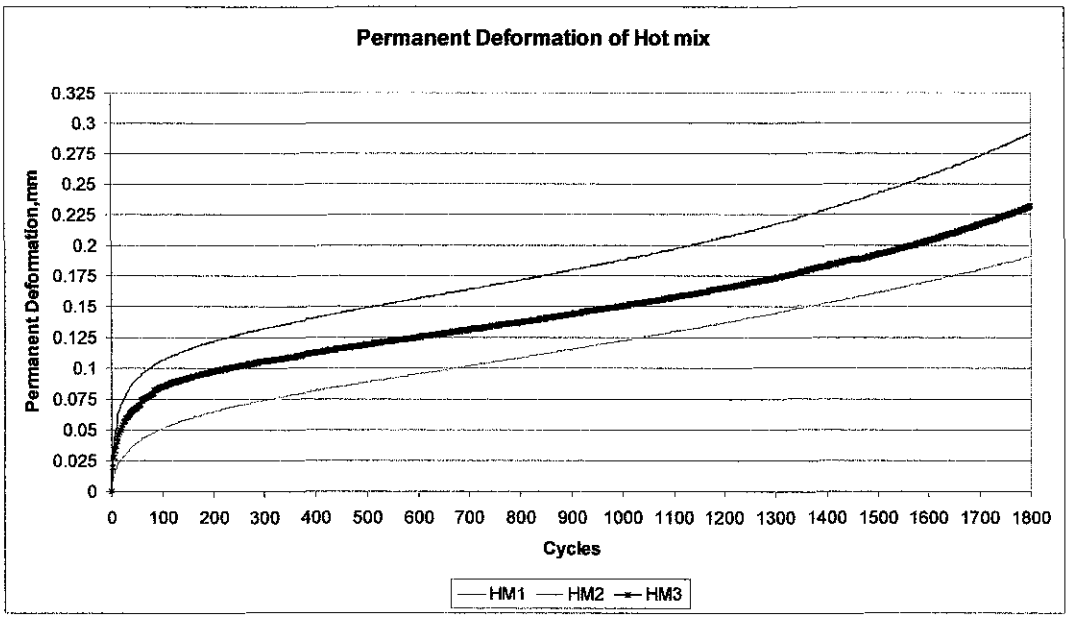

Figure B-16: Permanent deformation for hot mix samples

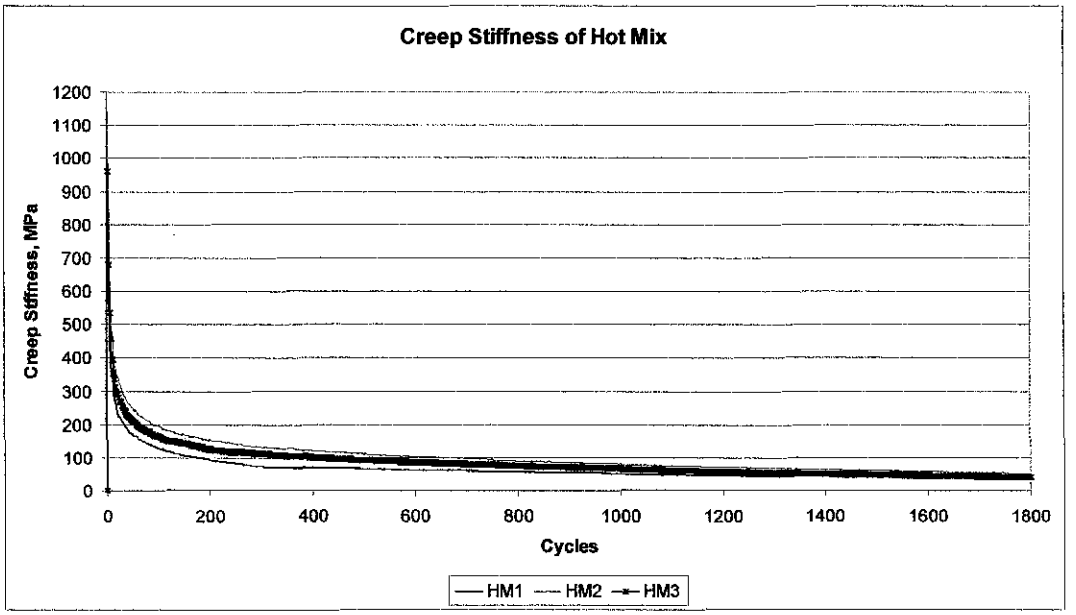

Figure B-17: Creep stiffness for hot mix samples

Table B-4: Permanent deformation and creep stiffness of cold mix

	Permanent deformation (mm)					Creep stiffness (MPa)			
Cycles	Sample 1	Sample 2	Sample 3	Average		Sample 1	Sample 2	Sample 3	Average
0	0.0000	0.0000	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000
1	0.0482	0.0294	0.0458	0.0412		214.2040	345.6650	338.7517	299.5402
2	0.0695	0.0498	0.0660	0.0618		144.1020	199.1470	195.1641	179.4710
3	0.0855	0.0643	0.0812	0.0770		114.6420	151.3950	148.3671	138.1347
4	0.0984	0.0758	0.0935	0.0892		99.2040	126.5890	124.0572	116.6167
5	0.1103	0.0873	0.1047	0.1008		88.2260	108.7160	106.5417	101.1612
6	0.1208	0.0973	0.1147	0.1109		80.2600	96.0580	94.1368	90.1516
7	0.1306	0.1063	0.1241	0.1204		74.1840	88.5710	86.7996	83.1849
8	0.1397	0.1154	0.1327	0.1293		69.6400	82.5660	80.9147	77.7069
9	0.1488	0.1232	0.1414	0.1378		65.1170	78.2010	76.6370	73.3183
10	0.1573	0.1341	0.1494	0.1469		62.0800	72.6640	71.2107	68.6516
11	0.1654	0.1432	0.1572	0.1553		59.2250	66.7680	65.4326	63.8085
12	0.1733	0.1495	0.1646	0.1624		56.3490	64.7050	63.4109	61.4883
13	0.1803	0.1608	0.1713	0.1708		54.5300	61.4720	60.2426	58.7482
14	0.1879	0.1674	0.1785	0.1779		52.5220	59.0510	57.8700	56.4810
15	0.1950	0.1735	0.1852	0.1846		50.4320	56.9730	55.8335	54.4128
16	0.2022	0.1790	0.1921	0.1911		48.6350	55.2240	54.1195	52.6595
17	0.2089	0.1844	0.1985	0.1973		47.0720	53.2260	52.1615	50.8198
18	0.2158	0.1899	0.2050	0.2035		45.4160	52.0630	51.0217	49.5002
19	0.2222	0.1950	0.2111	0.2094		44.4130	50.8780	49.8604	48.3838
20	0.2286	0.1999	0.2171	0.2152		43.3340	49.4550	48.4659	47.0850
21	0.2352	0.2045	0.2234	0.2210		42.2700	48.5090	47.5388	46.1059
22	0.2415	0.2094	0.2294	0.2268		40.8650	47.2060	46.2619	44.7776
23	0.2475	0.2142	0.2351	0.2323		40.0210	46.3240	45.3975	43.9142
24	0.2537	0.2189	0.2410	0.2379		39.0380	45.3160	44.4097	42.9212
25	0.2597	0.2232	0.2467	0.2432		38.0020	44.6090	43.7168	42.1093
26	0.2659	0.2281	0.2526	0.2489		36.9790	43.6540	42.7809	41.1380
27	0.2714	0.2327	0.2579	0.2540		36.4920	42.7830	41.9273	40.4008
28	0.2778	0.2370	0.2639	0.2596		35.4020	42.0120	41.1718	39.5286
29	0.2838	0.2416	0.2696	0.2650		34.6560	40.9090	40.0908	38.5519
30	0.2897	0.2458	0.2753	0.2703		34.0630	40.5090	39.6988	38.0903
31	0.2961	0.2503	0.2813	0.2759		33.4520	39.6350	38.8423	37.3098
32	0.3020	0.2546	0.2869	0.2811		32.8030	39.2510	38.4660	36.8400
33	0.3082	0.2591	0.2928	0.2867		32.3700	38.4280	37.6594	36.1525
34	0.3142	0.2631	0.2985	0.2919		31.4150	37.7040	36.9499	35.3563
35	0.3201	0.2674	0.3041	0.2972		30.9390	37.1010	36.3590	34.7997
36	0.3261	0.2718	0.3098	0.3026		30.1540	36.3700	35.6426	34.0555
37	0.3320	0.2753	0.3154	0.3076		29.9420	35.7720	35.0566	33.5902

38	0.3380	0.2796	0.3211	0.3129		29.2020	35.2250	34.5205	32.9825
39	0.3438	0.2841	0.3266	0.3182		28.8070	34.6650	33.9717	32.4812
40	0.3501	0.2882	0.3326	0.3236		28.3960	34.1800	33.4964	32.0241
41	0.3560	0.2926	0.3382	0.3289		27.8190	33.9110	33.2328	31.6543
42	0.3619	0.2967	0.3438	0.3341		27.4670	33.5580	32.8868	31.3039
43	0.3679	0.3006	0.3495	0.3393		27.1170	33.2410	32.5762	30.9781
44	0.3740	0.3051	0.3553	0.3448		26.7690	32.7490	32.0940	30.5373
45	0.3801	0.3094	0.3611	0.3502		26.3390	32.1800	31.5364	30.0185
46	0.3861	0.3137	0.3668	0.3555		25.6550	31.8560	31.2189	29.5766
47	0.3922	0.3178	0.3726	0.3609		25.5270	31.2150	30.5907	29.1109
48	0.3982	0.3220	0.3783	0.3661		24.8760	31.1460	30.5231	28.8484
49	0.4044	0.3264	0.3842	0.3716		24.4050	30.7260	30.1115	28.4142
50	0.4101	0.3308	0.3896	0.3768		24.1510	30.2100	29.6058	27.9889
51	0.4150	0.3350	0.3943	0.3814		23.9520	30.0380	29.4372	27.8091
52	0.4179	0.3393	0.3971	0.3848		23.6140	29.7660	29.1707	27.5169
53	0.4208	0.3436	0.3997	0.3880		23.6250	29.1870	28.6033	27.1384
54	0.4237	0.3476	0.4025	0.3913		23.4620	28.7460	28.1711	26.7930
55	0.4266	0.3524	0.4050	0.3947		23.2170	28.2550	27.6899	26.3873
56	0.4294	0.3560	0.4078	0.3978		22.9830	27.9650	27.4057	26.1179
57	0.4324	0.3606	0.4105	0.4012		22.9090	27.7140	27.1597	25.9276
58	0.4355	0.3648	0.4133	0.4046		22.7420	27.3890	26.8412	25.6574
59	0.4371	0.3694	0.4164	0.4076		22.6600	26.9570	26.4179	25.3450
60	0.4371	0.3737	0.4179	0.4096		22.6600	26.5440	26.0131	25.0724
61	0.4371	0.3779	0.4199	0.4116		22.6600	26.2530	25.7279	24.8803
62	0.4371	0.3822	0.4229	0.4141		22.6600	25.9590	25.4398	24.6863
63	0.4371	0.3867	0.4260	0.4166		22.8220	25.7480	25.2330	24.6010
64	0.4371	0.3911	0.4289	0.4190		22.9030	25.5510	25.0400	24.4980
65	0.4371	0.3952	0.4309	0.4211		22.8220	25.3730	24.8655	24.3535
66	0.4371	0.4000	0.4339	0.4237		22.7410	25.1600	24.6568	24.1859
67	0.4371	0.4045	0.4359	0.4258		22.7410	24.7910	24.2952	23.9424
68	0.4371	0.4085	0.4380	0.4279		22.8220	24.5460	24.0551	23.8077
69	0.4371	0.4138	0.4399	0.4303		22.8220	24.2350	23.7503	23.6024
70	0.4371	0.4182	0.4409	0.4321		22.9850	23.9800	23.5004	23.4885
71	0.4371	0.4227	0.4409	0.4336		22.9030	23.6390	23.1662	23.2361
72	0.4371	0.4270	0.4409	0.4350		22.8220	23.4860	23.0163	23.1081
73	0.4371	0.4319	0.4409	0.4366		22.7410	23.3040	22.8379	22.9610
74	0.4371	0.4364	0.4409	0.4381		22.9850	22.9800	22.5204	22.8285
75	0.4371	0.4411	0.4409	0.4397		22.6600	22.8950	22.4371	22.6640
76	0.4371	0.4460	0.4409	0.4413		22.6600	22.7240	22.2695	22.5512
77	0.4371	0.4507	0.4409	0.4429		22.7410	22.1720	21.7286	22.2139
78	0.4371	0.4554	0.4409	0.4445		22.6600	22.0980	21.6560	22.1380
79	0.4371	0.4598	0.4409	0.4459		22.4970	21.8090	21.3728	21.8929

80	0.4371	0.4621	0.4409	0.4467		22.6600	21.6990	21.2650	21.8747
81	0.4371	0.4641	0.4409	0.4474		22.6600	21.4540	21.0249	21.7130
82	0.4371	0.4662	0.4409	0.4481		22.5780	21.3580	20.9308	21.6223
83	0.4371	0.4681	0.4409	0.4487		22.6600	21.2690	20.8436	21.5909
84	0.4371	0.4702	0.4409	0.4494		22.7410	21.3270	20.9005	21.6562
85	0.4371	0.4723	0.4409	0.4501		22.7410	21.1580	20.7348	21.5446
86	0.4371	0.4742	0.4409	0.4507		22.6600	21.1460	20.7231	21.5097
87	0.4371	0.4764	0.4409	0.4515		22.7410	21.1990	20.7750	21.5717
88	0.4371	0.4786	0.4409	0.4522		22.7410	20.9520	20.5330	21.4087
89	0.4371	0.4808	0.4409	0.4529		22.7410	21.0050	20.5849	21.4436
90	0.4371	0.4819	0.4409	0.4533		22.7410	20.8090	20.3928	21.3143
91	0.4371	0.4819	0.4409	0.4533		22.7410	20.8090	20.3928	21.3143
92	0.4371	0.4819	0.4409	0.4533		22.7410	20.8830	20.4653	21.3631
93	0.4371	0.4819	0.4409	0.4533		22.8220	20.9570	20.5379	21.4390
94	0.4371	0.4819	0.4409	0.4533		22.9850	20.7340	20.3193	21.3461
95	0.4371	0.4819	0.4409	0.4533		22.7410	20.7340	20.3193	21.2648
96	0.4371	0.4819	0.4409	0.4533		22.8220	20.6600	20.2468	21.2429
97	0.4371	0.4819	0.4409	0.4533		22.8220	20.6600	20.2468	21.2429
98	0.4371	0.4819	0.4409	0.4533		22.8220	20.7340	20.3193	21.2918
99	0.4371	0.4819	0.4409	0.4533		22.6600	20.7340	20.3193	21.2378
100	0.4371	0.4819	0.4409	0.4533		22.5780	20.7340	20.3193	21.2104
101	0.4371	0.4819	0.4409	0.4533		22.6600	20.7340	20.3193	21.2378
102	0.4371	0.4819	0.4409	0.4533		22.6600	20.7340	20.3193	21.2378
103	0.4371	0.4819	0.4409	0.4533		22.6600	20.7340	20.3193	21.2378
104	0.4371	0.4819	0.4409	0.4533		22.6600	20.7340	20.3193	21.2378
105	0.4371	0.4819	0.4409	0.4533		22.5780	20.8090	20.3928	21.2599
106	0.4371	0.4819	0.4409	0.4533		22.5780	21.0320	20.6114	21.4071
107	0.4371	0.4819	0.4409	0.4533		22.5780	21.0320	20.6114	21.4071
108	0.4371	0.4819	0.4409	0.4533		22.5780	20.9570	20.5379	21.3576
109	0.4371	0.4819	0.4409	0.4533		22.4160	20.9570	20.5379	21.3036
110	0.4371	0.4819	0.4409	0.4533		22.5780	21.0320	20.6114	21.4071
111	0.4371	0.4819	0.4409	0.4533		22.6600	20.8830	20.4653	21.3361
112	0.4371	0.4819	0.4409	0.4533		22.7410	20.8830	20.4653	21.3631
113	0.4371	0.4819	0.4409	0.4533		22.8220	20.9570	20.5379	21.4390
114	0.4371	0.4819	0.4409	0.4533		22.7410	20.9570	20.5379	21.4120
115	0.4371	0.4819	0.4409	0.4533		22.8220	21.0320	20.6114	21.4885
116	0.4371	0.4819	0.4409	0.4533		22.7410	20.9570	20.5379	21.4120
117	0.4371	0.4819	0.4409	0.4533		22.8220	20.8830	20.4653	21.3901
118	0.4371	0.4819	0.4409	0.4533		22.9030	20.8830	20.4653	21.4171
119	0.4371	0.4819	0.4409	0.4533		22.8220	20.8830	20.4653	21.3901
120	0.4371	0.4819	0.4409	0.4533		22.7410	20.8090	20.3928	21.3143
121	0.4371	0.4819	0.4409	0.4533		22.7410	20.7340	20.3193	21.2648

122	0.4371	0.4819	0.4409	0.4533		22.6600	20.8090	20.3928	21.2873
123	0.4371	0.4819	0.4409	0.4533		22.5780	20.8090	20.3928	21.2599
124	0.4371	0.4819	0.4409	0.4533		22.6600	20.8830	20.4653	21.3361
125	0.4371	0.4819	0.4409	0.4533		22.5780	20.8830	20.4653	21.3088
126	0.4371	0.4819	0.4409	0.4533		22.6600	20.8090	20.3928	21.2873
127	0.4371	0.4819	0.4409	0.4533		22.6600	20.9570	20.5379	21.3850
128	0.4371	0.4819	0.4409	0.4533		22.6600	20.9570	20.5379	21.3850
129	0.4371	0.4819	0.4409	0.4533		22.4970	20.9570	20.5379	21.3306
130	0.4371	0.4819	0.4409	0.4533		22.5780	20.8830	20.4653	21.3088
131	0.4371	0.4819	0.4409	0.4533		22.3350	21.1060	20.6839	21.3750
132	0.4371	0.4819	0.4409	0.4533		22.1720	20.8830	20.4653	21.1734
133	0.4371	0.4819	0.4409	0.4533		22.2540	20.9570	20.5379	21.2496
134	0.4371	0.4819	0.4409	0.4533		22.4160	20.8830	20.4653	21.2548
135	0.4371	0.4819	0.4409	0.4533		22.3350	20.8830	20.4653	21.2278
136	0.4371	0.4819	0.4409	0.4533		22.3350	20.8090	20.3928	21.1789
137	0.4371	0.4819	0.4409	0.4533		22.3350	20.7340	20.3193	21.1294
138	0.4371	0.4819	0.4409	0.4533		22.3350	20.7340	20.3193	21.1294
139	0.4371	0.4819	0.4409	0.4533		22.3350	20.7340	20.3193	21.1294
140	0.4371	0.4819	0.4409	0.4533		22.2540	20.7340	20.3193	21.1024
141	0.4371	0.4819	0.4409	0.4533		22.4160	20.8090	20.3928	21.2059
142	0.4371	0.4819	0.4409	0.4533		22.3350	20.8090	20.3928	21.1789
143	0.4371	0.4819	0.4409	0.4533		22.2540	20.8830	20.4653	21.2008
144	0.4371	0.4819	0.4409	0.4533		22.2540	20.9570	20.5379	21.2496
145	0.4371	0.4819	0.4409	0.4533		22.2540	20.9570	20.5379	21.2496
146	0.4371	0.4819	0.4409	0.4533		22.1720	20.8090	20.3928	21.1246
147	0.4371	0.4819	0.4409	0.4533		22.0100	20.8090	20.3928	21.0706
148	0.4371	0.4819	0.4409	0.4533		21.8470	20.7340	20.3193	20.9668
149	0.4371	0.4819	0.4409	0.4533		21.7660	20.8090	20.3928	20.9893
150	0.4371	0.4819	0.4409	0.4533		21.6040	20.8830	20.4653	20.9841
151	0.4371	0.4819	0.4409	0.4533		21.2790	20.8090	20.3928	20.8269
152	0.4371	0.4819	0.4409	0.4533		21.2790	20.8830	20.4653	20.8758
153	0.4371	0.4819	0.4409	0.4533		21.1980	21.0320	20.6114	20.9471
154	0.4371	0.4819	0.4409	0.4533		20.9540	20.9570	20.5379	20.8163
155	0.4371	0.4819	0.4409	0.4533		20.8730	21.0320	20.6114	20.8388
156	0.4371	0.4819	0.4409	0.4533		20.8720	21.0320	20.6114	20.8385
157	0.4371	0.4819	0.4409	0.4533		20.8720	20.8830	20.4653	20.7401
158	0.4371	0.4819	0.4409	0.4533		20.7830	20.8830	20.4653	20.7104
159	0.4371	0.4819	0.4409	0.4533		20.7520	21.0320	20.6114	20.7985
160	0.4371	0.4819	0.4409	0.4533		20.5650	20.8830	20.4653	20.6378
161	0.4371	0.4819	0.4409	0.4533		20.5650	20.8830	20.4653	20.6378
162	0.4371	0.4819	0.4409	0.4533		20.5210	20.8830	20.4653	20.6231
163	0.4371	0.4819	0.4409	0.4533		20.4230	21.0320	20.6114	20.6888

164	0.4371	0.4819	0.4409	0.4533		20.4230	20.6600	20.2468	20.4433
165	0.4371	0.4819	0.4409	0.4533		20.4230	20.8090	20.3928	20.5416
166	0.4371	0.4819	0.4409	0.4533		20.4010	20.6600	20.2468	20.4359
167	0.4371	0.4819	0.4409	0.4533		20.4010	20.7340	20.3193	20.4848
168	0.4371	0.4819	0.4409	0.4533		20.4010	20.7340	20.3193	20.4848
169	0.4371	0.4819	0.4409	0.4533		20.3450	20.7340	20.3193	20.4661
170	0.4371	0.4819	0.4409	0.4533		20.3440	20.6600	20.2468	20.4169
171	0.4371	0.4819	0.4409	0.4533		20.3390	20.7340	20.3193	20.4641
172	0.4371	0.4819	0.4409	0.4533		20.2990	20.6600	20.2468	20.4019
173	0.4371	0.4819	0.4409	0.4533		20.2990	20.5860	20.1743	20.3531
174	0.4371	0.4819	0.4409	0.4533		20.2550	20.6600	20.2468	20.3873
175	0.4371	0.4819	0.4409	0.4533		20.0050	20.5110	20.1008	20.2056
176	0.4371	0.4819	0.4409	0.4533		19.4920	20.3630	19.9557	19.9369
177	0.4371	0.4819	0.4409	0.4533		19.4910	20.3630	19.9557	19.9366
178	0.4371	0.4819	0.4409	0.4533		19.4920	20.4370	20.0283	19.9858
179	0.4371	0.4819	0.4409	0.4533		19.4920	20.3630	19.9557	19.9369
180	0.4371	0.4819	0.4409	0.4533		19.4920	20.2880	19.8822	19.8874
181	0.4371	0.4819	0.4409	0.4533		19.2090	20.4370	20.0283	19.8914
182	0.4371	0.4819	0.4409	0.4533		19.2090	20.2880	19.8822	19.7931
183	0.4371	0.4819	0.4409	0.4533		19.2100	20.3630	19.9557	19.8429
184	0.4371	0.4819	0.4409	0.4533		19.2090	20.0660	19.6647	19.6466
185	0.4371	0.4819	0.4409	0.4533		0.3250	20.0660	19.6647	13.3519
186	0.4371	0.4819	0.4409	0.4533		0.3250	19.9170	19.5187	13.2536
187	0.4371	0.4819	0.4409	0.4533		0.4060	20.0660	19.6647	13.3789
188	0.4371	0.4819	0.4409	0.4533		0.2440	19.6200	19.2276	13.0305
189	0.4371	0.4819	0.4409	0.4533		0.2760	0.2230	19.2070	6.5687
190	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	18.9890	6.5370
191	0.4371	0.4819	0.4409	0.4533		0.5680	0.2230	0.2185	0.3365
192	0.4371	0.4819	0.4409	0.4533		0.3250	0.1490	0.1460	0.2067
193	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
194	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
195	0.4371	0.4819	0.4409	0.4533		7.3250	0.2230	0.2185	2.5888
196	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
197	0.4371	0.4819	0.4409	0.4533		0.2440	0.3720	0.3646	0.3269
198	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
199	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
200	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
201	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2311	0.2574
202	0.4371	0.4819	0.4409	0.4533		0.1620	34.4330	0.2191	11.6047
203	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
204	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2611	0.2674
205	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2711	0.2977

206	0.4371	0.4819	0.4409	0.4533		0.4060	0.2230	0.2185	0.2825
207	0.4371	0.4819	0.4409	0.4533		0.3250	5.3510	5.2440	3.6400
208	0.4371	0.4819	0.4409	0.4533		0.1620	1.6350	1.6023	1.1331
209	0.4371	0.4819	0.4409	0.4533		0.3250	0.8920	0.8742	0.6971
210	0.4371	0.4819	0.4409	0.4533		0.3250	0.7430	0.7281	0.5987
211	0.4371	0.4819	0.4409	0.4533		0.2440	0.5950	0.5831	0.4740
212	0.4371	0.4819	0.4409	0.4533		0.1620	0.5200	0.5096	0.3972
213	0.4371	0.4819	0.4409	0.4533		0.3250	0.4460	0.4371	0.4027
214	0.4371	0.4819	0.4409	0.4533		0.2440	0.3720	0.3646	0.3269
215	0.4371	0.4819	0.4409	0.4533		0.3250	0.3720	0.3646	0.3539
216	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
217	0.4371	0.4819	0.4409	0.4533		0.2440	0.3720	0.3646	0.3269
218	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
219	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
220	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
221	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
222	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
223	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
224	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
225	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
226	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
227	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
228	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
229	0.4371	0.4819	0.4409	0.4533		0.4060	0.2970	0.2911	0.3314
230	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
231	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
232	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
233	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
234	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
235	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
236	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
237	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
238	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
239	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
240	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
241	0.4371	0.4819	0.4409	0.4533		0.4060	0.1490	0.1460	0.2337
242	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
243	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
244	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
245	0.4371	0.4819	0.4409	0.4533		0.4060	0.2230	0.2185	0.2825
246	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
247	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044

248	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
249	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
250	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
251	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
252	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
253	0.4371	0.4819	0.4409	0.4533		0.2440	0.2230	0.2185	0.2285
254	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
255	0.4371	0.4819	0.4409	0.4533		0.3250	0.1490	0.1460	0.2067
256	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
257	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
258	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
259	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
260	0.4371	0.4819	0.4409	0.4533		0.2440	0.3720	0.3646	0.3269
261	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
262	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
263	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
264	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
265	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
266	0.4371	0.4819	0.4409	0.4533		0.3250	0.2230	0.2185	0.2555
267	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
268	0.4371	0.4819	0.4409	0.4533		0.4060	0.2970	0.2911	0.3314
269	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
270	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2911	0.3044
271	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2911	0.2774
272	0.4371	0.4819	0.4409	0.4533		0.4060	0.2970	0.2911	0.3314
273	0.4371	0.4819	0.4409	0.4533		0.1620	0.2970	0.2911	0.2500
274	0.4371	0.4819	0.4409	0.4533		0.1620	0.2970	0.2910	0.2500
275	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
276	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2910	0.3043
277	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
278	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
279	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
280	0.4371	0.4819	0.4409	0.4533		0.4060	0.2970	0.2910	0.3313
281	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
282	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2910	0.3043
283	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2910	0.3043
284	0.4371	0.4819	0.4409	0.4533		0.1620	0.2970	0.2910	0.2500
285	0.4371	0.4819	0.4409	0.4533		0.1620	0.2970	0.2910	0.2500
286	0.4371	0.4819	0.4409	0.4533		0.1620	0.2970	0.2910	0.2500
287	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2910	0.3043
288	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2910	0.3043
289	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773

290	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2910	0.3043
291	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2910	0.3043
292	0.4371	0.4819	0.4409	0.4533		0.1620	0.2970	0.2910	0.2500
293	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
294	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
295	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
296	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
297	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
298	0.4371	0.4819	0.4409	0.4533		0.3250	0.2970	0.2910	0.3043
299	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773
300	0.4371	0.4819	0.4409	0.4533		0.2440	0.2970	0.2910	0.2773

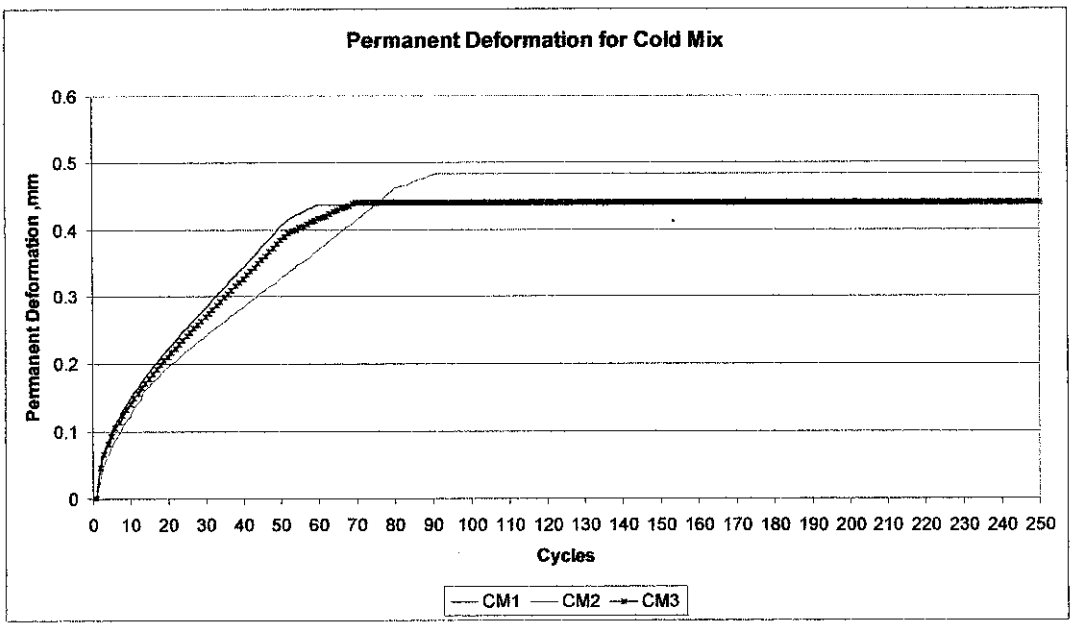

Figure B-18: Permanent deformation for cold mix samples

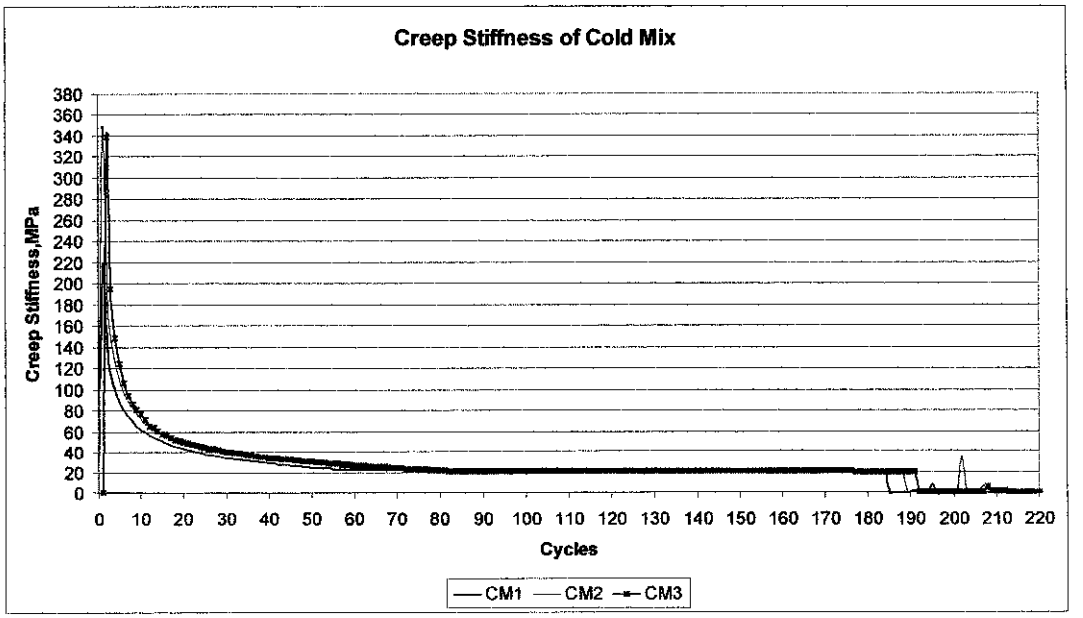

Figure B-19: Creep stiffness for cold mix samples