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Designation: E8/E8M – 16a$^{\varepsilon 1}$

American Association State
Highway and Transportation Officials Standard
AASHTO No.: T68
An American National Standard

Standard Test Methods for Tension Testing of Metallic Materials[1]

This standard is issued under the fixed designation E8/E8M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

ε^1 NOTE—9.1 was editorially corrected in February 2020.

1. Scope*

1.1 These test methods cover the tension testing of metallic materials in any form at room temperature, specifically, the methods of determination of yield strength, yield point elongation, tensile strength, elongation, and reduction of area.

1.2 The gauge lengths for most round specimens are required to be 4D for E8 and 5D for E8M. The gauge length is the most significant difference between E8 and E8M test specimens. Test specimens made from powder metallurgy (P/M) materials are exempt from this requirement by industry-wide agreement to keep the pressing of the material to a specific projected area and density.

1.3 Exceptions to the provisions of these test methods may need to be made in individual specifications or test methods for a particular material. For examples, see Test Methods and Definitions A370 and Test Methods B557, and B557M.

1.4 Room temperature shall be considered to be 10 to 38°C [50 to 100°F] unless otherwise specified.

1.5 The values stated in SI units are to be regarded as separate from inch/pound units. The values stated in each system are not exact equivalents; therefore each system must be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A356/A356M Specification for Steel Castings, Carbon, Low Alloy, and Stainless Steel, Heavy-Walled for Steam Turbines
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
B557M Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)
E4 Practices for Force Verification of Testing Machines
E6 Terminology Relating to Methods of Mechanical Testing
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E83 Practice for Verification and Classification of Extensometer Systems
E345 Test Methods of Tension Testing of Metallic Foil
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E1012 Practice for Verification of Testing Frame and Specimen Alignment Under Tensile and Compressive Axial Force Application
D1566 Terminology Relating to Rubber
E1856 Guide for Evaluating Computerized Data Acquisition Systems Used to Acquire Data from Universal Testing Machines
E2658 Practices for Verification of Speed for Material Testing Machines

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[1] These test methods are under the jurisdiction of ASTM Committee E28 on Mechanical Testing and are the direct responsibility of Subcommittee E28.04 on Uniaxial Testing.

Current edition approved Aug. 1, 2016. Published September 2016. Originally approved in 1924. Last previous edition approved 2016 as E8/E8M – 16. DOI: 10.1520/E0008_E0008M-16AE01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

Impact of Alkali Silica Reaction on Fly Ash-Based Geopolymer Concrete

Kunal Kupwade-Patil, Ph.D.[1]; and Erez N. Allouche, Ph.D., P.Eng[2]

Abstract: This study reports the findings of an experimental investigation for alkali silica reaction (ASR) between reactive aggregates and the geopolymer matrix. Specimens were prepared using one Class C and two Class F fly ash stockpiles. Mechanical testing included potential reactivity of the aggregates via length change and compression test measurements, as per ASTM standards. Results suggest that the extent of ASR reaction due to the presence of reactive aggregates in fly ash-based geopolymer concretes is substantially lower than in the case of ordinary portland cement-based concrete, and well below the ASTM specified threshold. Furthermore, geopolymer concrete specimens appeared to undergo a densification process in the presence of alkali solutions, resulting in reduced permeability and increased mechanical strength. Utilizing ASR-vulnerable aggregates in the production of geopolymer concrete products could contribute to the economic appeal and sustainability of geopolymer binders in regions that suffer from insufficient local supply of high quality aggregates. **DOI: 10.1061/(ASCE)MT.1943-5533.0000579.** *© 2013 American Society of Civil Engineers.*

CE Database subject headings: Aggregates; Durability; Microstructures; Concrete; Fly ash.

Author keywords: Alkali-silica reaction; Aggregate; Durability; Microstructure.

Introduction

The durability of normal portland cement is a major concern in the civil infrastructure industry. Alkali silica reaction (ASR) occurs due to chemical reactions between hydroxyl ions in the pore water within the concrete matrix and certain forms of silica (Swamy et al. 1988; Diamond 1975, 1976). This reaction can lead to strength loss, cracking, volume expansion, and potentially to premature failure of the structure. Studies have shown that ASR is a multistage process that takes place at the paste-aggregate interface (Ulm et al. 2000). In the first stage, hydroxyl ions attack the silanol groups (Si-OH) and the siloxane bonds (Si-O-Si); the second stage consists of the formation of expansion products. Depending on the gel formation generated, internal pressure is created within the cement matrix, triggering macroscopic expansion and a subsequent degradation of the concrete matrix.

Diamond (1976) reviewed various reactive aggregates that caused ASR expansion. Opaline and Chalcedonic silica are non-crystalline or poorly-crystalline forms of silica that can be found in cherts, flints, sandstones, limestone, and dolomites. Tridymite and cristobalite (silicon dioxide) are other reactive forms of silica found in volcanic rocks that lead to ASR expansion. Low alkali cements used to prevent ASR often contain fly ash and granulated blast furnace slag (GGBFS) (Mulion et al. 2008; Ostertag et al. 2007). Class F and C fly ash pozzolans are effective in mitigating ASR when 30% of the portland cement is replaced by mass. Natural pozzolans and small amounts of silica fume were also found to be effective in inhibiting ASR expansion.

Davidovits first introduced the term "geopolymers" to class F fly ash forming three-dimensional (3D) silico-aluminate materials (Davidovits 2008). Geopolymers belong to a family of inorganic binders and are similar to zeolite materials with amorphous microstructures. The polymerization process involves a rapid reaction under alkaline conditions of silicon-aluminum minerals, resulting in a 3D polymeric chain and a structure of Si-O-Al-O bonds. The two primary ingredients of geopolymer binders are alkaline liquids and powder materials that are rich in silica and alumina, such as kaolinite and fly ash (Diaz et al. 2010). Alkaline liquids frequently used include sodium hydroxide (NaOH) or potassium hydroxide (KOH) in combination with sodium silicate (Na_2SiO_3). Geopolymer mortars made from activated fly ash contain high alkali content with minimal calcium content. Properties such as static elastic modulus, Poisson's ratio, compressive strength, and flexural strength of geopolymer concrete (GPC) specimens prepared from 25 fly ash stockpiles were recorded by Diaz-Loya et al. (2011). They observed that the mechanical behavior of GPC is similar to that of ordinary portland cement (OPC) concrete, suggesting that equations, akin to those provided by ACI 318-08, can be applied for GPC to determine its static elastic modulus and flexural strength. The research suggests that GPC exhibits some of the characteristics required for an engineered material with predictable properties and behavior.

The potential for, and severity of, ASR in GPCs has been suggested to be lower than in OPC concretes due to the formation of a dense bond in the vicinity of the aggregates following the initial reaction (Davidovits 2008; Garcia-Lodeiro et al. 2007; Kupwade-Patil and Allouche 2011). Alkalis involved in the chemical reaction are taken up by the amorphous component in the fly ash and converted into cementitious binders and zeolite crystals. The unutilized alkalis attack the reactive aggregates, initiating an ASR reaction while the material is still in gel form. However,

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Research Article

TENSILE BEHAVIOR OF BANYAN TREE FIBER REINFORCED COMPOSITES

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ABSTRACT

Our work mainly focuses on converting waste material into raw material and to increase the strength of the fiber reinforced polymer composite. The study has been carried out in view of highlighting advantages of natural fibers over synthetic fibers. In this work polyester is used as a matrix and banyan tree fiber is used as a reinforcing material. Tensile test specimen is made as per ASTM D638 I. Material properties of the composite have been studied with the help of different percentage weight ratios of matrix to fiber. Also the strength of composite is estimated with the variation of fiber length. In this paper methodology of conducting the fiber preparation of mould and composite have been presented.

KEYWORDS: Natural fiber, Polyester, Banyan tree fiber, Tensile test specimen.

1 INTRODUCTION

The increased environmental awareness and consciousness throughout the world has developed an ever increasing interest in natural fibres and its applications in various fields. Natural fibres are now considered as serious alternative to synthetic fibres for use in various fields[1] .The use of natural fibers as reinforcing materials in both thermoplastic and thermoset matrix composites provide positive environmental benefits with respect to ultimate disposability and best utilization of raw materials.

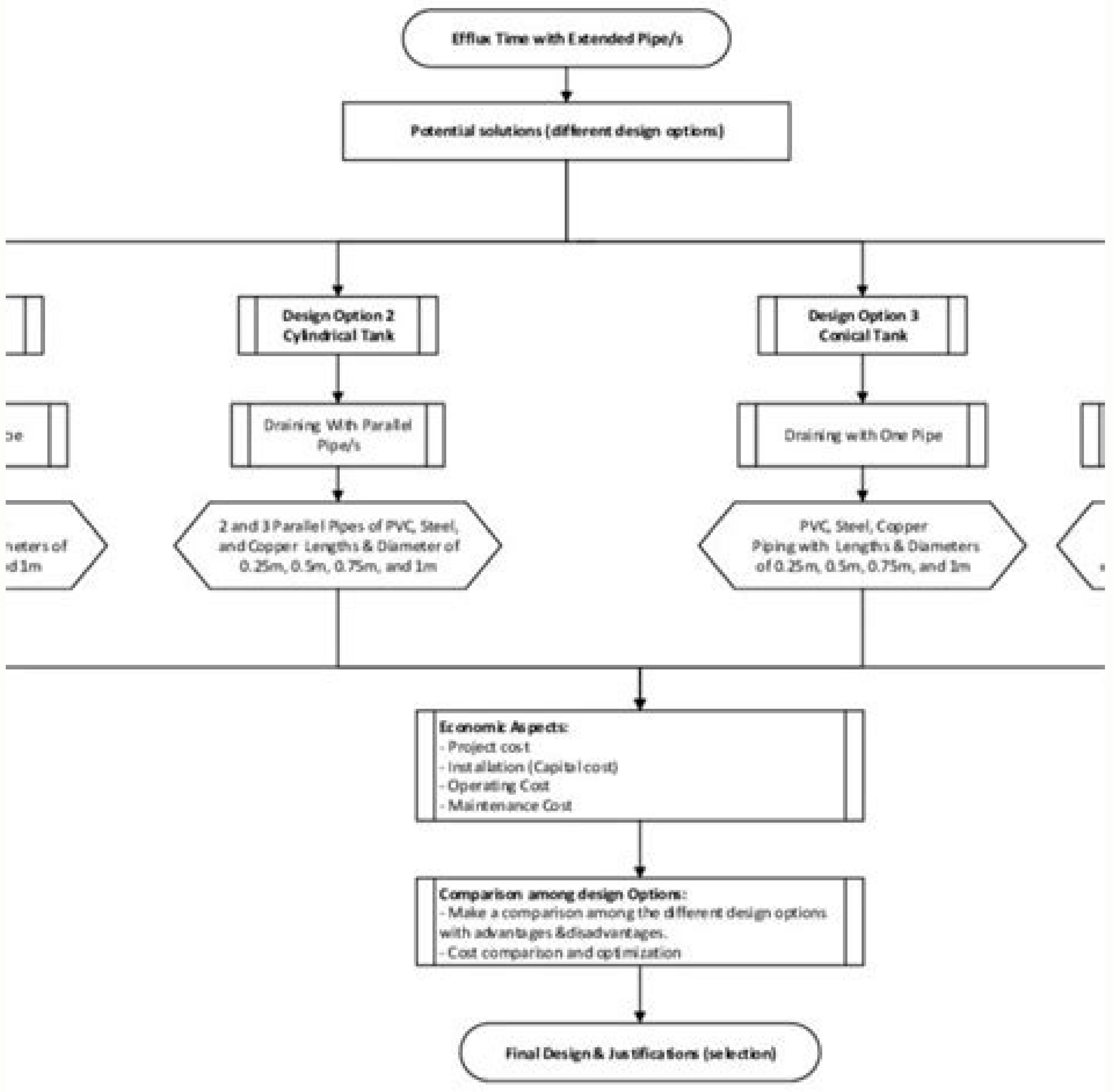
The advantages of natural fibers over traditional reinforcing materials such as glass fiber, carbon fiber etc have their specific strength properties[2], easy availability, light weight, ease of separation, enhanced energy recovery, high toughness, non-corrosive nature, low density, low cost, good thermal properties, reduced tool wear, reduced skin and respiratory irritation, less abrasion to processing equipment, renewability and biodegradability. It has been observed that natural fiber reinforced composites have properties similar to traditional synthetic fiber reinforced composites. Natural fiber composites have been studied and reviewed by a number of researchers[3] (Dufresne 1997; Dufresne and Vignon 1998; Mao et al 2000; Kaith et al 2003; Nakagaito et al 2004, 2005; Bhatnagar and Sain 2005). During the past decade, a number of significant industries such as the automotive, construction or packaging industries have shown massive interest in the progress of new bio composite materials. All these properties have made natural fibers very attractive for various industries currently engaged in searching for new and alternate products to synthetic fiber reinforced composites. The properties of natural fibers can vary depending on the source, age and separating techniques of the fibers. Ficus benghalensis, an annual fiber plant, has been found to be an important source of fibers for a number of applications since good olden days. The banyan fiber has high potential as a reinforcing fiber in polymer composites. Banyan tree is a common home and office housetree, but in the wild forests, it's a giant tree of Indian jungles. Banyan tree starts out life as an ephiphyte growing on another tree where some fig-eating bird deposited a seed. Banyan tree can get 100 inch tall and, with its massive limbs supported by prop roots, spread over an area of several acres. A famous banyan tree near Poona, India, is said to measure a half mile around its perimeter and be capable of sheltering 2000 people. The banyan tree is native to India, Sri Lanka and Pakistan. The literature review has shown scanty information on the application of this fiber as reinforcing material in the polymer composites. Keeping in view the easy availability of this new fiber a comprehensive research work[3] has been initiated in our laboratory on synthesis and study of properties of banyan tree fiber reinforced polyester resin matrix based composites.

Hence the objective of the present paper is to instigate the tensile properties of banyan tree fiber reinforced polyester composites. Unsaturated polyester resin has been chosen as the matrix material because it is relatively cheap, having lower shrinkage and can be moulded at room temperature. Accordingly, various percentage volumes of banyan fiber have been combined with an unsaturated polyester resin to produce banyan fiber reinforced polyester composites, and the extraction of fibres, testing of specimens and the resulting composite properties such as tensile strength, impact strength were reported.

Polymer matrix composite (PMC) is a material consisting of polymer (resin) matrix combined with a fibrous reinforcing dispersed phase. PMC's are very popular due to their cost effective and simple fabrication methods. Use of non reinforced polymers as structure materials is limited by low level of their mechanical properties: tensile strength of one of the strongest polymers-epoxy resin[4] is 2000 Psi (140 Mpa). In addition to relatively low strength, polymer materials possess low impact resistance.

Reinforcement of polymers by strong fibrous network permits fabrication of PMC characterized by the following properties: high tensile strength, high stiffness, high fracture toughness, good abrasion resistance, good puncture resistance, good corrosion resistance, low cost. Reinforcing fibers may be arranged in different forms: unidirectional fibers, roving's, veil mat: thin pile of randomly oriented and looped continuous fibers, chopped strands: thin pile of randomly oriented and looped short (3-4 inches) fibers, oven fabric.

Properties of PMC's are determined by: properties of the fibres, orientation of the fibers, concentration of the fibers and properties of matrix. Properties of



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ti , and , ocinºÃ etis on ,odaicnecil od soir¡Ãnoicnuf uo soir¡Ãnoicnuf uo serosseforp ,sodartsiger setnadutse riulcni m©Ãbmat ,etis od a§Ãnecil amu eS ;otudorp etsen otircsni es ahnet euq aossep reuqlauq :sodazirotua soir¡ÃusU .9 .o£Ã§Ãarepo e siairetam ed o£Ã§Ãacifissalc ,setset omoc ,o£Ã§Ãacirbaf ed sossecorp a sodanoicaler seµÃrdap ed sopit sies uoirc e siairetaM e setseT ed anaciremA edadeicoS a acifingis MTSA A .o£Ãrdap sadaredisnoc o£Ãs o£Ãn e o£Ã§Ãamrofni ed snif arap sanepa sadicenrof o£Ãs euq ,sacit¡Ãmetam seµÃsrevnoc o£Ãs sesetnªÃrap ertne sadad arbil-adagelop ed sedadinu sA .E .B .arpmoc amu rezaf ed setna saserpme setnerefid ed otudorp omsem od so§Ãerp so etnemlicaf siam merapmoc serodarpmoc so euq etimrep ele ,mednev euq erboc o racifissalc arap o£Ãrdap esse masu saserpme sa odnauQ .odil¡Ãvni etnemlagel res arap soditnam o£Ãs edadilibasnopser ed o£Ã§Ãnesi sesse euq me adidem an otecxe ,ocifÃcepse o£Ã§Ãaloiv o£Ãn uo otis³Ãporp mu a o£Ã§Ãauqeda ,o£Ã§Ãazilaicremoc ed aticÃlpmi aitnarag reuqlauq odniulcni ,satic-Ãlpmi uo sasserpxe saitnarag e seµÃ§Ãatneserper ,seµÃ§Ãidnoc sa sadot ,otartnoC etsen odacificepse euq sonem A :aitnarag ed o£Ã§Ãnesi ed o£Ã§ÃnesI .C .airahnegne ed otejorp o arap socitÃlana sodot©Ãm meââ sodasu sovitacifingis sotigÃd raredisnoc o£Ãrdap etsed opocse od m©Ãla ¡ÃtsE .setnerefid uo setnahlemes sojnarra uo soiem sortuo rop uo ;rodatupmoc uo lanimret ues ed s©Ãvarta osseca odnitimrep uo tenretnI ad knil rop ajes ,odazirotua oir¡Ãusu ortuo ajes o£Ãn euq ortuo reuqlauq arap levÃnopsid ,sotnemucod uo otudorp etse razilibinopsid edop o£Ãn odazirotua oir¡Ãusu mu)ii(.odaicneciL olep sotnemucod uo/e MTSA otudorp od osu o rasiver arap ,edadilaicnedifnoc ed otartnoc mu a otiejus ,etnednepedni rotlusnoc mu ¡Ãrevlovne MTSA a ,ossi araP .a§Ãnecil ed otartnoc etsed somret son odaicnecil olep ogap rolav o ¡Ãredecxe MTSA ad edadilibasnopser a osac muhnen mE .somret sues rop odalucniv ratse me adrocnoc e ednetne o euq ,a§Ãnecil ed otartnoc etse uel ªÃcov euq a§Ãehnocer e ,sodateloc ,sodateloc o£Ãs sodad so omoc racificepse arapââ sodasu sotnemidecorp sO 1.6.1 .seµÃrdap ed sopit sies evlovnesed MTSA A .olpitlºÃm oT .eettimmoC)TBT(edarT ot sreirraB lacinhceT noitazinagrO edarT dlroW eht yb deussi snoitadnemmoceR dna sediuG ,sdradnatS lanoitanretnI fo tnempoleveD eht rof selpicnirP no noisiceD eht ni dehsilbatse noitazidradnats no selpicnirp dezingocer yllanoitanretni htiw ecnadrocca ni depoleved saw dradnats lanoitanretni sihTÂ Ã8.1 .sdradnats ygolonimret dna ediug ,ecitcarp ,noitacifissalc ,noitacificeps ,dohtem tset era sepyt xis ehT .dohtem tset siht ni)detardyhed(detceffa eb ton yam 6122D dohteM tseT htiw lortnoc erutarepmet laiceps evah ot era hcihw)muspyg sa hcus(taeh htiw etardyhed taht slarenim ro sdnuopmoc gniniatnoc slios emoS .1 .epat lacirtcele fo ytefas eht etaulave ot stset seniltuo dradnats sihT .MTSA fo lortnoc eht dnoyeb snosaer dna ,selif wen gnidaol ,gnitset ro noitallatsni erawtfos ,ecnanetniam revres rof emitnwod dna noitpurretni cidoirep ot tcejbus eb lliw ytilibaliavA Â Ã ,Ã.Sisab suounc a no elbaliava SSECCA enilno ekam ot strofe elbanosaer esu llahs mtsa.)"doireP noitpircsbuS"(_____________ si tnemeergA siht fo mret ehT .A .stsoc evitartsinimda ro gnitnirp elbanosaer dnoyeb tcudorP eht fo esu rof sresU dezirohtuA no segrahc laiceps esopmi eesneciL yam ron ;mrof yna ni stnemucoD fo noitubirtsid ro noitcudorper klub ro tcudorP eht fo esu ecivres-rof-eef ,slairetam ,stnemucoD fo elas eht ot detimil ton tub gnidulcni ,sesoprup laicremmoc rof ,tcudorP eht ot ssecca ro ,tcudorP eht ezilitu ton yam eesneciL)vi(Â Ã.noissimrep nettirw roirp s'MTSA tuohtiw detibihorp si dna esneciL siht yb dezirohtua ton si ,esu gninrael ecnatsid rof ro ,sevreser cinortcele ro skcapesruoc ni seipoc cinortcele ro tnirp fo noisulcnI .2 .deipoc eb ton yam ti ;noitazinagro ruoy nihtiw esu lanretni rieht rof srehto ot detubirtsid eb ylno yam tnirp ypoc drah elgnis eht .sesu detibihorp .dradnats sa dedrager eb ot era stinu is ni detats seulav ehtâ5.1 .Dradnats yrtsudni eht sa dedrager era dradnats siht ni detaluclac r ehgnit weiv dna yalpsid ,eveirter ,hcraes ,esworb ot thgir eht)a(:sesneciL etiS-itluM dna etiS-elgniS)ii(.mrah elbaraperri MTSA esuac ot ylekil hcaerb rehto yivna The siht rednu sthgir sti refsnart ro ngissa ton yam eesneciL:tnemngissA .tcudorP MTSA eht ssecca nac sresU tenirohtuA ylno erusne ot sessecorp noitaciv dna noitacitnehtua yrassecen lla ekatredcinu l Â .stcudorp thguorw dna sepahs yrenifer ni elbaliava reppoc fo sdnik srevoc sreppoC fo noitacifissal C dradnatS ehT .ainavlysnneP fo htlaewnommo C eht fo swal eht htiw ecnadrocca ni deurtsnoc dna deterpretni eb llahs tnemeerg The sihT:noitcidsiruJ dna ,euneV ,waL gninrevoG .sesu dettimrep lla sebircsed esneciL sihT)i(.sruoh ssenisub lamron fo esruoc eht gnirud emit yna ta dna ,esnepxe stier ta , The siht htiw ecnailpmoc yv ot thgir eht sah MTSA.noitacifire V.seitreporp lacimehc dna seitreporp lacisyhp ,noitisopmoc ,nigiro edulcni stnemeriuqer fo selpmaxE .derahs esiwrehto ro evird drah rehtona ot deipoc ,ksid ot dedaolnwod , nideliame eb tonna P noitpircsbuS a fo dne eht ta tnemeerg The sneumatic eht eht evah (b) the right to download, store or print single copies of individual Documents, or portions of such Documents for the Authorized User's personal use, and to share such copies with other Authorized Users of Licensee within Licensee's computer network; (c) if an educational institution, Licensee is permitted to provide a hard copy of individual Documents to individual students (Authorized Users) in a class at Licensee's location; (d) the right to display, download and distribute hard copies of Documents for training Authorized Users or groups of Authorized Users. 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