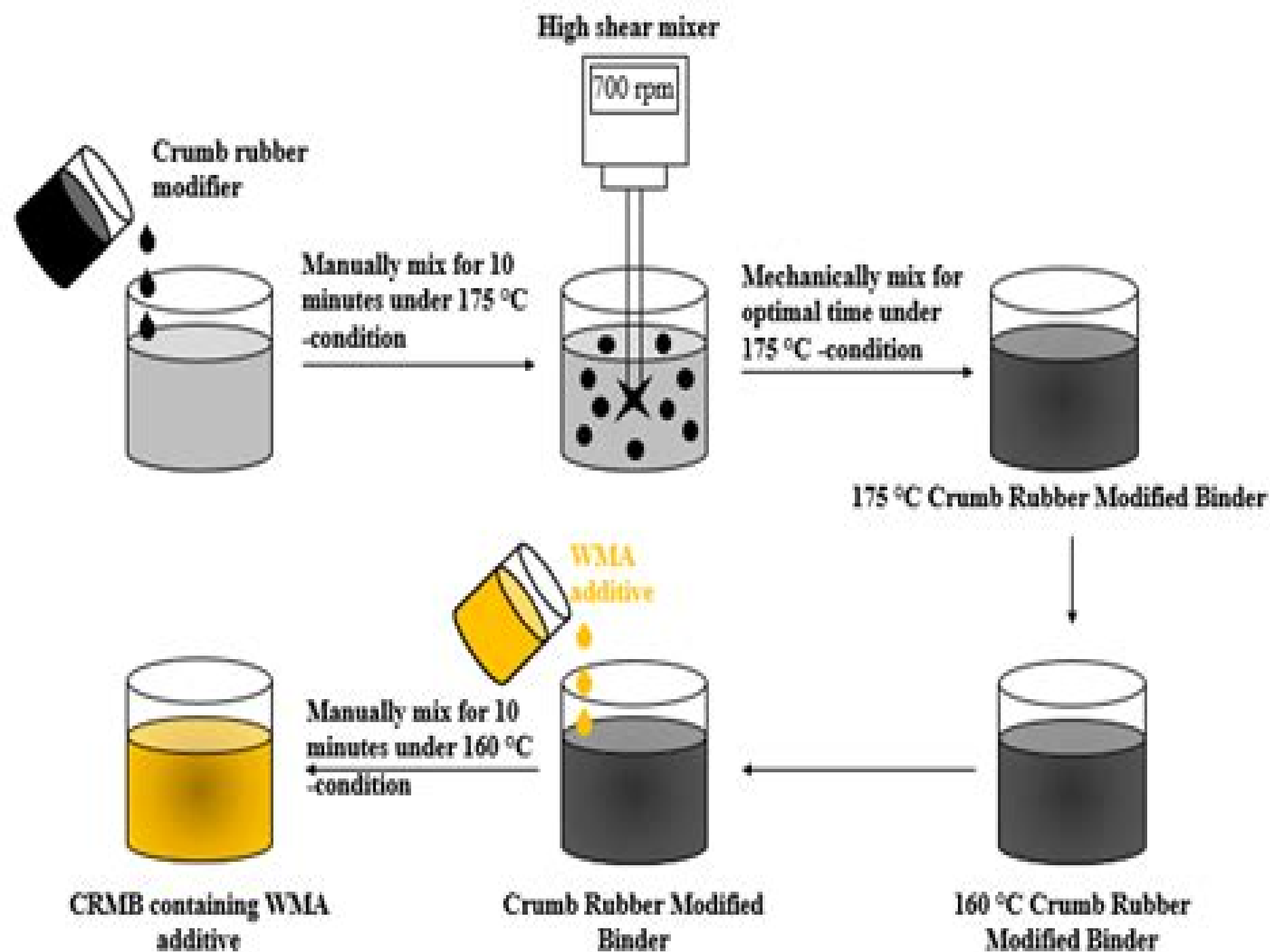




# Polymer Modified Asphalt Binders

**Mohammed Ziaur Rahaman, Zahid  
Hossain, Musharraf Zaman**



## **Polymer Modified Asphalt Binders:**

*Polymer Modified Asphalt Binders* Kenneth R. Wardlaw, Scott Shuler, 1992 ASTM Publication Code Number PCN 04 011080 08 Sponsored by ASTM Committee D 4 on Road and Paving Materials Foreword Includes bibliographical references and indexes Electronic reproduction W Conshohocken Pa ASTM International 2011 Mode of access World Wide Web System requirements Web browser Access may be restricted to users at subscribing institutions

**Characterization of Polymer Modified Asphalt Binders Containing Processed Oil** Navid Hemmati, 2023 The current study investigates the impact of processed oil on asphalt binder PG 64 22 and conjugate of it with common modifiers such as Crumbed Rubber Modifier CRM Styrene Isoprene Styrene SIS Styrene Butadiene Styrene SBS and Petroleum Resin PE The binder was tested at different temperatures and different amounts of modifiers and processed oil were added to the binder The modified binders were also aged artificially using different procedures The study found that adding processed oil to polymer modified binders reduces viscosity and improves workability while the modifiers improve the rutting resistance of them however the addition of processed oil reduces the binder's rutting performance due to decrement of viscosity The study also found that the conjugating of modifying polymers and processed oil improves the low temperature cracking resistance The study's results indicate that co-modifying polymer binders with processed oil resulted in a significant reduction in viscosity values resulting in improved workability The results also showed that increasing the processed oil concentration from 6% to 12% caused a viscosity reduction in conjugation of CRM SIS SBS and PE Even though the addition of processed oil results in a reduction in the rutting performance of asphalt binder the addition of polymers significantly improved the rutting resistance of asphalt binders The modified asphalt binders containing 6% and 12% processed oil decreased the G sin values This reduction caused improvement of fatigue cracking resistance of all binders modified with CRM SIS SBS and PE The higher concentration of processed oil means 12% showed greater reduction rate compared to the asphalt binders containing 6% processed oil The BBR results for modified asphalt binders showed that the incorporation of CRM SIS SBS and PE and processed oil improved the low temperature cracking resistance significantly due to the high penetration rate of processed oil in asphalt binders during modification

*Evaluation of Polymer Modified Asphalt Binders in Hot Mix Asphalt* Michael Shane Buchanan, 1996

Rapra Review Reports, *SBS Polymer Modified Asphalt Binder and Its Implications on Overlay Design* PC.

Hopman, AAA Molenaar, A. Srivastava, 1992 Substantially improved overlay mixes required by the modern road industry should be highly resistant to reflection cracking The mix must contribute significantly to the stiffness of the pavement even when it is applied in relatively thin layers The binder should possess a high softening temperature to reduce the sensitivity for rutting and corrugation and it should have a reasonable penetration value to minimize the chances of cracking In this paper attention is paid to the manner SBS polymer modified asphalt binders cope with this set of requirements The basic principles of this modification are outlined and emphasis is laid on the rheological and mechanical properties viscosity and

penetration test results are presented Burgers model for viscoelastic materials is used in an attempt to describe the visco elasticity Results of indirect tensile tests are reported including the tensile strengths and the elastic moduli Repeated loading tests have been done on polymer modified and plain asphaltic concrete mixes The results are mutually compared concerning fatigue behaviour elastic moduli and crack propagation characteristics The paper describes various trial sections with special attention to comparative tests carried out in an Australian accelerated loading facility

**Detection of Polymer Modifiers in Asphalt Binder** Stacey D. Diefenderfer, 2006 This study addressed the evaluation of alternative test methods to identify the presence of polymer modifiers in performance graded binders for the purpose of quality assurance A method of identification is presented in AASHTO T302 Polymer Content of Polymer Modified Emulsions and Asphalt Binders that uses Fourier transform infrared FTIR spectroscopy to evaluate the constituent elements in binders or emulsions With proper calibration output from FTIR can be used to determine the presence and approximate content of polymers in an asphalt binder AASHTO T301 Elastic Recovery Test of Bituminous Materials by Means of a Ductilometer offers an alternative method to determine the presence of polymer by evaluating the elasticity of the binder Samples of binder were collected from contractor tanks and tested in accordance with AASHTO T301 and AASHTO T302 The performance grade was verified in accordance with AASHTO M320 Test results were evaluated to identify calibration needs test variability and choice of preferred methodologies for adoption into the quality assurance program Results of the study identified the use of either FTIR analysis or elastic recovery as a timesaving alternative to full fledged performance grading in the initial investigation of concerns about the presence of polymer Both methods identified binders containing varying polymer contents with no instances of false positive identification However based on the results of this study neither method is suitable to determine binder grade The investigator recommends that the elastic recovery and FTIR analysis be incorporated as quality assurance tests to verify the presence of polymer in mixtures that specify the use of polymer modified asphalt binders Following this the frequency of quality assurance sampling of polymer modified binders should be increased to ensure that inferior material is not being used in premium mixtures Further AASHTO T301 should be adopted in place of Virginia Test Method 104 for use with unaged binders Incorporating the use of elastic recovery testing and FTIR spectroscopy as alternatives to performance grading will benefit VDOT by allowing increased quality assurance testing of premium asphalt mixtures This will result in minimizing VDOT s risk of acceptance of inferior material and maximizing the benefits of using premium materials Typically performance grading is performed once per month on one binder sample from each active grade of binder in a VDOT district This is estimated to result in testing less than 5% of the binder lots used in any district during a typical month Although neither elastic recovery testing nor FTIR spectroscopy was shown conclusively to determine binder grade almost all PG 76 22 binders shipped into Virginia contain polymer modifiers Thus the detection of the polymer is a first level indicator for quality assurance The potential cost of these tests is approximately 200 per test for elastic recovery and approximately 120 per test

for FTIR spectroscopy Overall the increased testing is expected to result in improved pavement quality by reducing the acceptance of inferior material

**Laboratory and field evaluation of polymer modified asphalt binders and mixtures**

Hassan Faghihnia Torshizi,1991      *Evaluation of Polymer Modified Asphalt in Hot Mix Pavements* Charles Ifft,1989 Polymer modified asphalts have recently been the focus of much attention in the U S due to claims that polymer additives will lengthen the life of an asphalt pavement Much of the published research on this topic has been concentrated on the effects of polymer modifiers on binder and mixture properties The goal of this testing is to predict from laboratory testing the actual field performance of an asphalt concrete Over the years specifications have been developed for conventional asphalts that allow pavement performance to be predicted from certain binder tests These conventional binder tests do not fully address the special characteristics of polymer modified asphalt binders and need revision to be an effective tool in predicting pavement service life This paper presents the findings of a two part laboratory research program intended to relate binder and mixture properties of polymer modified asphalts The preliminary testing involved five asphalt binder types and a variety of binder and mixture tests Promising test procedures were further investigated in the final testing program where ten asphalt binders were examined Simple linear regression was used to determine the strength of a relationship between pairs of binder properties and mixture properties The preliminary testing showed penetration toughness and tenacity and force ductility to have the most promise in predicting mixture performance The final testing contained enough data to be analyzed with both simple linear regression and multiple regression Penetration toughness and tenacity force ductility again were the test procedures that had binder properties that correlated well with mixture properties

*Rheological Properties of Polymer-modified Asphalt Binders* J. Kent Newman,Transportation Research Board,1997      Characterisation of Polymer Modified Asphalt Binders for Roads and Airfields IR. Arya,SS. Bose,PK. Jain,1992 This paper elaborates on the characterisation of styrene butadiene styrene ethyl vinyl acetate low density polyethylene polypropylene wax and hydroxylterminated polybutadiene modified asphalts by penetration temperature sensitivity thermogravimetric analysis penetration ratio cohesion adhesion stability tensile strength and flexural fatigue test The benefits obtained by the modification of asphalt with polymers are improvement in quality of asphalt as defined by increased cohesion adhesion elastic recovery and reduced temperature sensitivity The significant characteristics of polymer modified asphalts are high stability tensile strength stiffness and extended fatigue life The effects of wax in waxy asphalts is reduced by incorporation of polymers

Understanding the Performance of Modified Asphalt Binders in Mixtures Kevin D. Stuart,John S. Youtcheff,2000 The overall objective of this study was to determine if the Superpave high temperature rheological properties of polymer modified asphalt binders correlate to asphalt mixture rutting resistance An emphasis was placed on evaluating polymer modified asphalt binders with identical or close high temperature performance grades PG s but varied polymer chemistries Eleven asphalt binders were obtained for this study two unmodified asphalt binders an air blown asphalt binder and eight

polymer modified asphalt binders High temperature asphalt binder properties were measured by a dynamic shear rheometer DSR Mixture rutting resistance was measured by repeated shear at constant height RSCH and the French Pavement Rutting Tester French PRT The first objective was to verify the findings of a previous study using a different aggregate In the previous study it was found that the Superpave high temperature asphalt binder properties correlated to mixture rutting resistance with few outliers and a change in high temperature PG from 70 to 76 increased rutting resistance However the correlation between RSCH and asphalt binder G<sub>sind</sub> delta depended on DSR frequency The data suggested that a low DSR frequency such as 0.1 rad/s might provide a better grading system than the standard DSR frequency of 10.0 rad/s This would require a change in the current asphalt binder specification A diabase aggregate was used in a previous study The data using a second aggregate a limestone aggregate in combination with four of the asphalt binders agreed with the findings from the diabase mixtures The second objective was to retest the diabase mixtures at 70 degrees Celsius using RSCH The test temperatures used in the previous study were 50 degrees Celsius for RSCH and 70 degrees Celsius for the French PRT The polymer modified asphalt binders had continuous high temperature PGs ranging from 71 to 77 Therefore it was recommended that the test temperature for RSCH be increased to 70 degrees Celsius Again the correlation between RSCH and G<sub>sind</sub> was dependent on DSR frequency The data suggested that a low DSR frequency such as 0.1 rad/s might provide a better grading system However it is not known whether this finding applies to pavements or is related to the accelerated nature of the RSCH test Furthermore G<sub>sind</sub> delta at 0.1 rad/s did not clearly provide a better correlation to RSCH than the high temperature PGs of the asphalt binders The degree of correlation between the French PRT and G<sub>sind</sub> at 70 degrees Celsius did not depend on DSR frequency and there was only one outlier A correlation between the French PRT and high temperature PG provided no obvious outliers No changes to the specification are recommended based on the French PRT results

### **Chemical, Physical, and Thermodynamic Properties of Neat and Polymer Modified Asphalt Binders**

Lawrence Michael France, 1997 *Polymer Modified Asphalt Binder* Terry L. Hardison, Arkansas. State Highway & Transportation Department. Division of Planning and Research, 1992

**Installation and Laboratory Evaluation of Alternatives to Conventional Polymer Modification for Asphalt**, 2015 The Virginia Department of Transportation VDOT specifies polymer modified asphalt binders for certain asphalt mixtures used on high volume high priority routes These binders must meet performance grade PG requirements for a PG 76-22 binder in addition to elastic recovery requirements This typically results in the use of binders containing styrene butadiene styrene SBS modifiers However other polymer modifiers may also be used to achieve the PG 76-22 classification One of these modifiers is a copolymer of SBS and polyethylene PE SBS PE another modifier is ground tire rubber GTR This study was undertaken to investigate the suitability of SBS PE modified PG 76-22 binder and GTR modified PG 76-22 binder for use in Virginia Each modified binder was used in a 12.5 mm nominal maximum aggregate size mixture to pave approximately 2.3 lane miles All mixtures were produced as

warm mix asphalt using a foaming system The binders evaluated included a typical SBS polymer modified binder as a control and binders modified with SBS PE and GTR During construction all processes were documented and material was sampled for evaluation Binder and mixture tests were performed Binder testing included performance grading and multiple stress creep and relaxation testing Mixture testing included volumetric analysis dynamic modulus and flow number tests and cracking rutting and fatigue analysis Binder testing indicated that the control binder and SBS PE modified binders met VDOT specifications for classification as a PG 76 22 binder the GTR modified binder graded to a PG 70 22 binder as it did not meet the PG 76 22 high temperature specification and did not pass the elastic recovery requirement Laboratory mixture testing indicated that the performance of the SBS PE modified mixture should be similar to that of the control mixture Laboratory test results for the GTR modified mixture were mixed with some indicating that the performance was similar to that of the control mixture and some indicating that the performance may be less than that of the control Based on the study SBS PE modified binders should continue to be allowed as an alternative to SBS modified binder provided specifications for PG 76 22 binders are met However further investigation of GTR modified binders is suggested before recommendations can be made In addition long term evaluation of the field site is recommended for validation of the laboratory findings Polymer Modified Asphalt Durability in Pavements ,2007 The project was designed to develop 1 a better quantitative understanding of the relation between laboratory accelerated binder aging and field aging 2 a test procedure to measure properties of an aged binder that relate to failure on the road and 3 a proposed specification for estimating the relative durability of binders in the presence of oxidative aging Tests were conducted on original base and polymer modified binders laboratory compacted mixtures and pavement aged binders The project necessarily evolved to a more comprehensive approach to improving pavement service life

**Evaluation of Modified Asphalt Binders** Ronald E. Reese,1989 **Design and Construction of Asphalt Concrete Using Polymer Modified Asphalt Binders** TS. Shuler,DI. Hanson,RG. McKeen,1992 A full scale experimental pavement was constructed to compare low temperature cracking performance of asphalt concrete containing two types of styrene block copolymers and an ethylene based polymer each at two levels of concentration in a relatively soft asphalt cement The experiment was designed to compare field performance with observed behavior in the laboratory

**Nonrecoverable Compliance and Recovery Behavior of Polymer-Modified and Reclaimed Asphalt Pavement-Modified Binders in Arkansas** Mohammed Ziaur Rahaman,Zahid Hossain,Musharraf Zaman,2018 For quality assurance and quality control purposes suppliers and users of asphalt binders follow the widely used dynamic shear rheometer DSR test method AASHTO T 315 Standard Method of Test for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer DSR to capture viscoelastic properties of polymer modified binders PMBs and reclaimed asphalt pavement RAP modified binders even though it is designed for unmodified asphalt binders AASHTO T 315 is inadequate to characterize modified binders because of the relatively small impact of the phase angle and strain levels on

the rutting and fatigue factors respectively The recently approved multiple stress creep recovery MSCR test AASHTO T 350 Standard Method of Test for Multiple Stress Creep Recovery MSCR Test of Asphalt Binder Using a Dynamic Shear Rheometer DSR results can better relate the laboratory based and field rutting of PMBs and additive modified binders In the current study Superpave and MSCR tests were performed to evaluate viscoelastic properties of selected asphalt binders certified in Arkansas A total of 32 binders were tested in the laboratory Among these 8 were unmodified binders 18 were PMBs and 6 were RAP modified binders The nonrecoverable compliance and MSCR percent recovery data of tested binders were analyzed for the grading purpose and establishing the MSCR percent recovery criteria for local service temperature and traffic conditions The developed guidelines are expected to be helpful for transportation agencies in Arkansas to adopt the MSCR test method in their quality control processes

**Performance Properties of Polymer Modified Asphalt Binders (PMA) Containing Wax Additives** Mithil Mazumder, 2016 The study presents an experimental evaluation of the rheological properties of control and polymer modified asphalt PMA binders containing wax additives and a comprehensive comparison between these two binder types The control and PMA binders with the additives were produced using two of the available warm asphalt processes i e LEADCAP and Sasobit and then artificially short term and long term aged using the rolling thin film oven RTFO and pressure aging vessel PAV procedures Superpave binder tests were carried out on the binders through the rotational viscometer RV the dynamic shear rheometer DSR and the bending beam rheometer BBR In general the results of this study indicated that 1 the addition of wax additives into the control and PMA binders decreases the viscosity as expected 2 the reduction in viscosity was quite similar for both the binders with wax additives 3 the percentage increase of rutting resistance due to the additives was much higher for the control binder compared to the PMA binder 4 both the control and PMA binders showed the similar trends in terms of fatigue cracking and low temperature cracking behavior after the addition of wax additives

**Modeling of the Linear Viscoelastic Response of Polymer Modified Asphalt Binders at Intermediate and High Temperatures** Fariborz Gahvari, 1996



## Whispering the Techniques of Language: An Psychological Quest through **Polymer Modified Asphalt Binders**

In a digitally-driven world wherever monitors reign great and quick interaction drowns out the subtleties of language, the profound secrets and mental nuances concealed within phrases often move unheard. However, located within the pages of **Polymer Modified Asphalt Binders** a captivating fictional value pulsating with organic emotions, lies an extraordinary quest waiting to be undertaken. Published by a skilled wordsmith, this charming opus encourages readers on an introspective trip, delicately unraveling the veiled truths and profound affect resonating within the cloth of each word. Within the psychological depths with this touching review, we can embark upon a genuine exploration of the book is key styles, dissect its captivating writing design, and fail to the strong resonance it evokes heavy within the recesses of readers hearts.

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